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THE MAGAZINE OF TECHNOLOGY INTEGRATION

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intel inside

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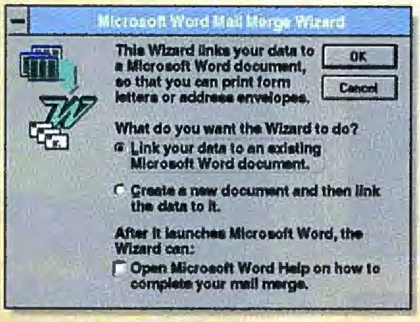

Mail Merge Wizard works directly with Microsoft Word to place your selected data into the document of your choice.

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ASE.

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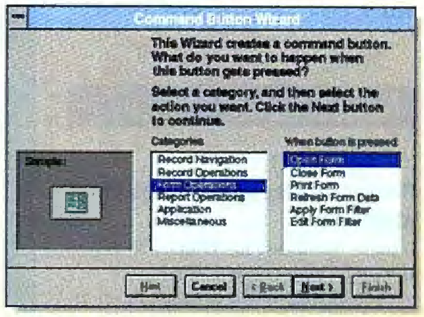

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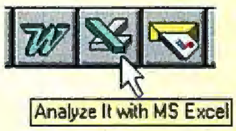

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JULY 1994 VOL.19, NO.7

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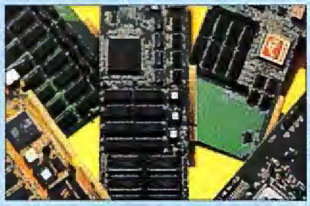

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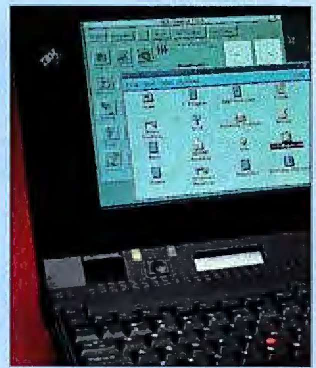

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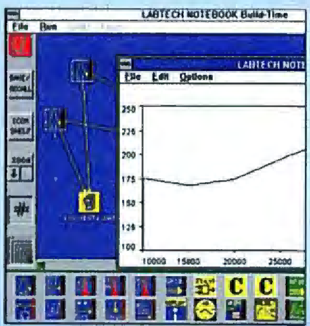

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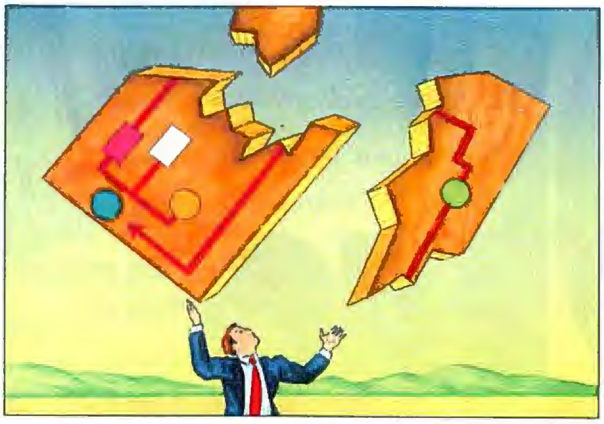

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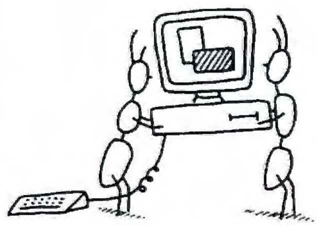

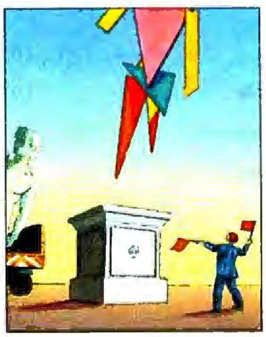

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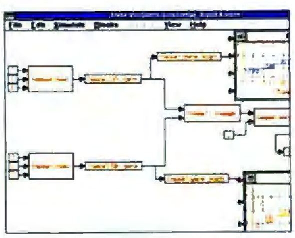

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From the BYTE BBS at 1200-9600 bps: Dial (603) 924-9820 and follow the instructions at the prompt.

BYTE Contents by Platform

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

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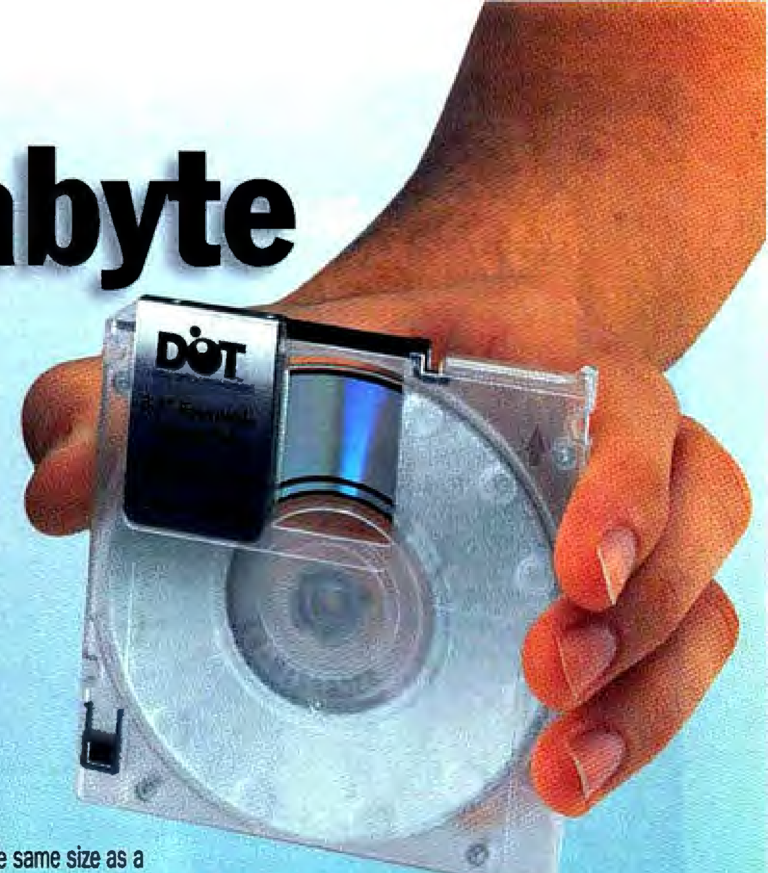
230 Megabyte

3600 RPM



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The power of Apple, IBM and Motorola.

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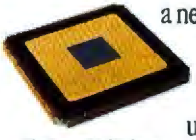

The PowerPC 601 has a lot of power inside it: the combined resources of IBM, Motorola and Apple.

The RISC technology of Power Macintosh brings a whole new level of performance to personal computing. Software written to take advantage of its unique new capabilities, in fact, will run significantly faster than the same programs written for 486 or Pentium processor-based PCs.

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The power to run MS-DOS, Windows and Macintosh software.

Many Power Macintosh configurations come bundled with SoftWindows™ from Insignia Solutions, an innovation that lets Power Macintosh run hundreds of off-the-shelf MS-DOS and Windows applications at 386 and 486 performance levels. (Of course, Power Macintosh runs thousands of Macintosh productivity programs, too.)

This is just the most recent example of Apple's commitment to making it easier for MS-DOS and Windows users to take advantage of Macintosh innovations.

The power of RISC for as little as $1,819.*

These days, the whole personal computer industry is buzzing about the potential of RISC processor technology in PCs.

"My next computer will be a PowerPC. I was using Intel-based machines long before the PC was a glimmer in IBM's eye, but as Emerson said, foolishly held consistency is the hobgoblin of little minds.... It's time for a change, and the time is now," wrote Bill Machrone in *PC Week*. "That next machine will probably wear an Apple logo.... Apple appears to be a good six months ahead of IBM in terms of [PowerPC] product development and software integration."

Power Macintosh	6100/60	7100/66	8100/80
Processor	PowerPC 601	PowerPC 601	PowerPC 601
Speed	60 MHz	66 MHz	80 MHz
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Hard disk storage	160MB or 250MB	250MB or 500MB	250MB to 1GB
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From left, the new Power Macintosh 8100/80, Power Macintosh 7100/66 and Power Macintosh 6100/60.

Introducing Power Macintosh.

Apple

Buy Now or Wait?

The choice of CPUs and operating systems make changing platforms a real concern

Lately, I've been getting mail asking if now is the time to buy desktop systems or if waiting for faster systems to become available is best. At first I was surprised—it's an age-old question with an age-old answer: There will always be something better and faster on the horizon no matter how long you wait. BYTE readers know that, and that they should ask that question at first confused me.

But at the heart of the question is whether now is the time to make a platform change. It's not just a matter of debating the merits of the next Intel 80x86–compatible machine; it's far more complicated and extends beyond CPUs to operating systems and videoconferencing.

On the CPU front, there are a lot of choices, and even more are coming. Even staying with Intel doesn't necessarily make the choice easy. With 100-MHz 486s available, you may question the need to go to the Pentium. And if you are buying systems for dedicated, noncompute-intensive applications, a 100-MHz 486 may seem like overkill. If you've been considering Windows NT or the symmetrical-processing version of OS/2, your decision is further complicated by deciding whether two or more CPUs is the right answer, and whether those multiple processors ought to be 486s or Pentiums.

If your needs today are less critical than they'll be several months from now, you are probably also questioning whether to wait for one of the new Pentium competitors from Cyrix, AMD, or NexGen. Each promises to be a compatible alternative to the Pentium, with different twists for performance gains. And if you are considering one of the Pentium competitors, surely you're also wondering what Intel is doing with the P6, the reported Pentium follow-on. Little is known about the P6. That could be bad news for Intel, because unless it starts releasing real technical information about the P6, it stands to lose significant market share to forthcoming competitor CPUs and to Intel's own 486 and Pentium alphabet soup (e.g., SX, DX, and P54C) of confusion.

Meanwhile, for most companies, staying with Intel-based machines is not etched in stone, and CPU offerings from DEC, Mips Technologies, Hewlett-Packard, IBM, and Motorola may be tempting. All promise higher-than-Pentium performance, and, generally speaking, they all require a move away from DOS and Windows. If you are replacing older Macs, it's no problem; you can run essentially the same operating system and applications on the Power Mac. Otherwise, you are faced with a gut-wrenching operating-system decision.

While the upcoming replacement for Windows—Chicago—brings welcome improvements, it won't support multiple CPUs, and it was not written for anything other than Intel CPUs. So the choice becomes focused on OS/2 and Workplace OS from IBM, or NT and the promised Daytona and Cairo. And yes, there is still Unix in 31 flavors. The most notable ones are SunSoft's Solaris, SCO's Unix, and IBM's AIX. The latter is interesting because IBM has been demonstrating a version of AIX on its prototype PowerPC-based systems. The wild card is Apple's System 7, which the company plans to port and license to other platforms.

The big problem is that choosing a new operating system is a lot like getting married—if things don't work out, the separation and divorce can be long and painful. Then there's the video question. While most organizations have already made some commitment to multimedia-equipped systems, the step to systems ready for videoconferencing is a little bigger to make.

All in all, it is a complicated problem, and the answers are not easy. Remember that the CPU and operating-system wars are just heating up, and while the editors of BYTE predict that RISC CPUs will dominate the future, no one knows whose RISC CPU will be the clear winner. The best strategy for the short term is to go ahead and replace systems that *must* be replaced now. Choose from what's available today. But as you consider systems that can wait until next year, my advice is to try out the different platforms in your environment. Base your decisions on how well a platform's technology fits into your specific needs and on whether that technology will continue to answer your enterprise-wide needs in the future. And we'll do our best to help you sort through it all. ■

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

The course of computing is hereby changed.

From the old.

*(Actual size.)**

The chip on the left is getting a little old.

Its 15-year-old technology has been pushed to the limit. It worked well enough for yesterday's character-based computers, but it's having a hard time keeping up with the demands of today's computers and software.

The new PowerPC™ microprocessor from Motorola, however, is just getting started.

It's based on advanced RISC (reduced instruction set computing) technology, the technology most experts agree is the only way to reach the performance levels required by the new generation of computers and software.

Taking full advantage of its RISC technology, the Motorola PowerPC microprocessor runs

The PowerPC Microprocessor. *The RISC Chip.*

To the new.

(Smaller, cooler, faster, cheaper.)

faster, runs cooler, occupies less space and consumes less power. Surprisingly, it costs considerably less than the chip on the left.

POWERED BY MOTOROLA

The first computers based on the PowerPC microprocessor are now arriving. Apple's awesome new Power Macintosh™ computers are here. Potent PowerPC personal computers from IBM* are on the way. Computers powered by the chip on the left, it seems, are on the way out.

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Circle 163 on Inquiry Card.

Strong Feelings about Componentware

Congratulations on being one of the first magazines to publish some straight scoop on OOP (object-oriented programming) in the May cover story called "Componentware." This can only mean one thing: OOP has lost its luster as a marketing gimmick. Will we ever stop being swayed by false promises? You can't turn chicken soup into a cure for cancer by simply stirring the pot a little.

Ernie Deel
Marietta, GA

Your May cover copy "Object-oriented computing has failed. But componentware...is succeeding" is causing many headaches. Why the sensationalist title? Why is it that in the cover story, everything other than Microsoft's VBX/OCX is an alternative? Why did you ignore companies such as ParcPlace Systems, Oberon Software, Inference, Easel, and at least a dozen others? I don't know, maybe I'm just overreacting to your title page, which should have been called "Component Objects: A Look at VBX and Everything Else."

Chris Stone
Framingham, MA

Did you get your headaches before or after you read our cover story?—Eds.

I want to congratulate you on popularizing a new buzzword, *component software*, in the May cover story. Unfortunately, this is not what we software engineers need. We already have a reputation for jumping from one technological fad to the next and having more buzzwords than nearly any other profession. But hey, it sells magazines. And it sells software.

VBXes are cute and great for prototyping; however, I can't extend them as I can with C++ objects. As Visual C++ incorporates templates, my bet is that any leftover hype for OLE will continue to wane. Borland has a wonderful object-oriented library called OWL (Object Windows Library) that is based on templates. And between inheritance and templates, C++ has a rich set of features for creating reusable code. VBXes are not the epitome of reusability.

David Cox
Rochester, NY

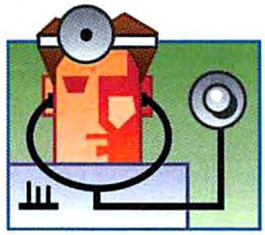
No, I don't think "VBXes are the epitome of reusability," and I didn't say that; however, despite many flaws, they are surprisingly useful for exchanging chunks of reusable code in binary form. I did, however, describe NextStep as having the same advantage that VBXes have but without VBXes' limitations, and I aired some issues that are being debated in a very lively way in the object community—notably, the COM/SOM controversy. I've heard of OWL, and in the cover story, I discussed its new relationship with Novell's AppWare and what implications follow from that. If your impression of the article was that VBXes are the be-all and end-all or that C++ is dead, then please reread it—that is not at all the message.

—Jon Udell

Presenting...The Carnation Award!

Jerry Pournelle has the market on orchids cornered, so I suppose I will have to settle for awarding a carnation to BYTE for the Honorable Mentions and Dubious Achievements page that has been appearing in the Lab Reports lately. I hope that by showcasing excellence and stupidity in product design, manufacturers will be encouraged to strive for the former and eliminate the latter.

Steve Dunn
Toronto, Canada



An Unfair Comparison?

I don't know much about database software or database servers, so to broaden my knowledge, I read articles such as "Justifying NT" (April). Unfortunately, the narrow scope of the article and the explanation of test results described on pages 150–151 cause me to wonder if the information is reliable. The testing is performed using OS/2 1.3 because "Microsoft recommends OS/2 1.3, rather than OS/2 2.1, as the best operating system on which to run it." Is it not the responsibility of BYTE to test the manufacturer's claim? In addition, results for Query 2 are not shown because "NT would not process this query." Perhaps it would be of interest to see the numbers for those systems that did manage to perform the task. One wonders how NT can be viewed so favorably when it cannot process a list of 100 orders.

Richard Hodges
Los Angeles, CA

For 16-bit OS/2 applications, version 1.3 is a faster, leaner platform. However, the point of the article was to assess how one RISC-capable operating system, NT, can and cannot fit into an enterprise setup. The conclusions were decidedly mixed: NT can be a good applications server, but don't plan to toss out your file server and put in NTAS. Funny, you don't claim it was unfair to slam NT for its lousy performance on the file-server tests on a token-ring LAN where it lacked 32-bit drivers, or how we showed that OS/2 was superior there.—Jon Udell

Helping Physicians On-Board

Scott Wallace did a fine job describing some of the problems and benefits of a computerized patient record system (May). The most difficult hurdle in the whole process, however, will be helping physicians on-board. I recently attempted to assist a pediatrician in keeping a database of his patients' records, but he was overwhelmed by it all and gave up. Doctors are trained to provide medical care and have no time to double as data-entry clerks. A way must be found to get the necessary data into useful digital formats easily. Then we will have to figure out a cheap way to put reams of hard copy data sitting in millions of file cabinets all around the country into appropriate databases—or the only people with complete medical profiles will be those who were born yesterday.

Devin Struck
Cleveland, WI

BYTE Helping Out in the Workplace

Your article on object-oriented databases (April) clarified a misconception that I learned about only two days previously in a meeting discussing an IT (information

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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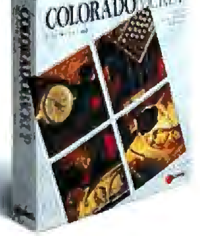

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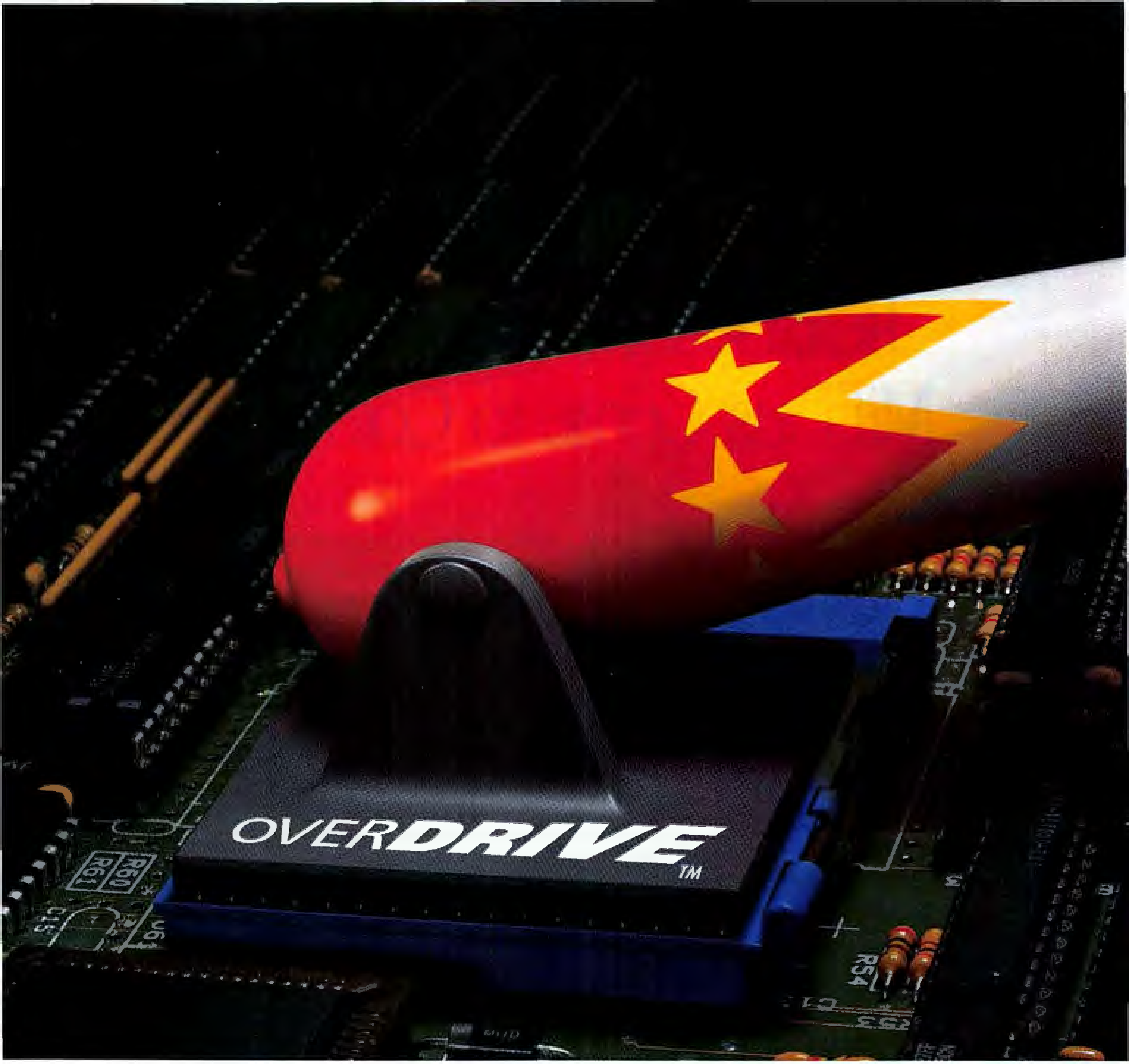

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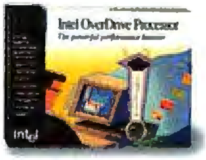

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technology) project. I was able to understand the impedance problem and distributed the article at work the next week. Your magazine does a great job covering not only the present state of IT but also where the computer industry is going.

Randall Thomas
New York, NY

Compliments to the Staff

I want to express my gratitude to you for your well-known and interesting magazine. To me, a systems analyst and editorial staff member of the *National Informatic Publication*, I consider BYTE's technical information excellent. It is also a serious and engaging magazine. I want to give your editors my regards for their professionalism and the exquisiteness of their work.

Obilio Sánchez
Habana, Cuba

SPECint92 Projections for PA-RISC

Your article "Intel Pushes the 80x86 Envelope" (April News & Views) included a chart on the SPECint92 projections for enterprise workstation CPUs. The performance of Hewlett-Packard's high-end workstation PA-RISC chips was not stated at all, whereas other vendors (e.g., Sun Microsystems and Mips) quoted numbers for some of their high- and low-end performance chip families. I believe we should have the same opportunity: Our high-end PA-RISC 7150 chips now achieve a 135 SPECint92 rating. By 1996, we project the PA-RISC 8000 chip will perform at over 500 SPECint92 marks.

Jan Silverman
Advanced Technology Marketing Manager
Hewlett-Packard Co.
Cupertino, CA

Cultural Faux Pas

I was surprised to see the illustration accompanying your State of the Art article on relational databases and data manipulation ("The Great Debate," April). The picture contains a list of data entries showing race and religion. I consider this example to be questionable and misleading, especially as it comes from a worldwide computing authority. Most countries that have issued legislation to prevent misuse of computer archived information have imposed strict limitations on the storage and processing of personal data regarding race, religion, and political ideas.

Michael Console Battilana
Udine, Italy

The illustration was not meant to suggest that this type of data should routinely be collected or disseminated. Although at present, data collection for legitimate purposes is not so strictly regulated in the U.S., there is an ongoing privacy debate. Your objection to the fictitious data pictured in the illustration provides a timely reminder of the kinds of cultural differences that all companies (including publishers) should be mindful of when addressing an international audience.—Eds.

No Substitute for Intelligence

Jerry Pournelle's column is the main reason I continue to subscribe to BYTE. I appreciate the way he explains things without hammering the reader with benchmark test results and an alphabet soup of acronyms. For instance, his description of the DOS and Windows capability in OS/2 (March) somehow gets to the truth of the matter, where any number of detailed benchmark tests simply fail. I am reminded of a wise old friend who once said, "There's no substitute for intelligence!" Pournelle captures the essence of what is important and gives a decent idea of what works and what doesn't. It's always a good read.

Richard Hodges
Los Angeles, CA

Fixes

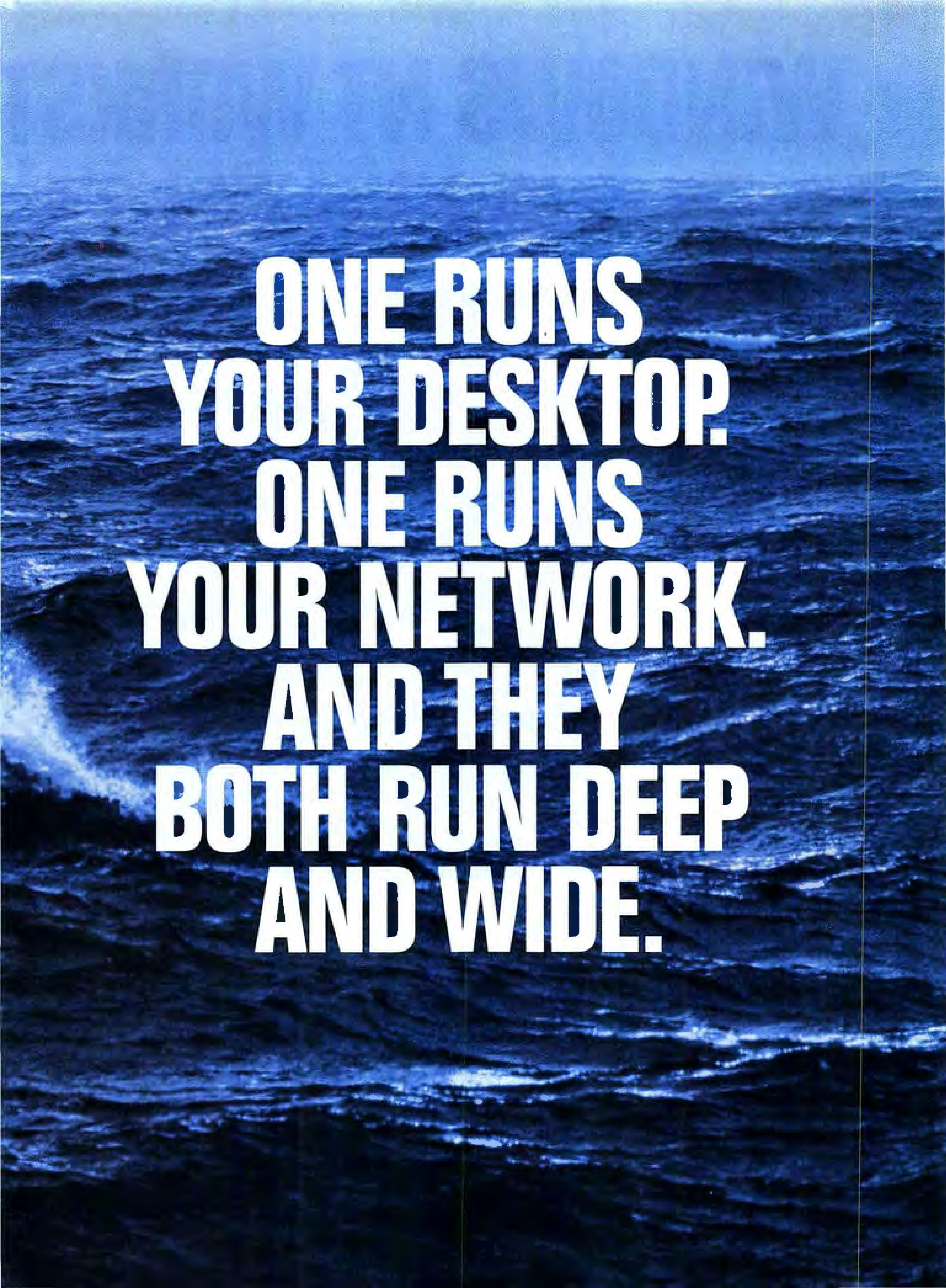
On page 41 of our April issue, we should have stated that Lotus and Borland were debating a copyright infringement, not a patent infringement. Also, on page 84, the address for Persistent Data Systems, Inc. should read: P.O. Box 38415, Pittsburgh, PA 15238.

In "Head to Head: 71 Printers" (May Lab Report), the correct as-configured price for the Genicom Model 7170 is $4635. In the same story, the correct price of the Tektronix Phaser 200e is $2995. It supports A4 paper and offers RS-232 as standard and Ethernet as an option.

In the 1994 Reader's Choice Awards (June, page 65), a mistake appears in the Software Product of the Year box on page 66. The winner is correctly identified as IBM OS/2, but the name Microsoft appears beneath, making it appear that Microsoft produces the product. We regret the production error that introduced the mistake and apologize for any confusion that resulted. ■

COMING UP IN AUGUST

- **STATE-OF-THE-ART: PERIPHERAL BUSES**
  We'll examine the latest and the proposed variants of SCSI (e.g., SCSI-3, fast, wide, and serial), as well as the newest high-speed serial buses. We'll also feature Fibre Channel (Texas Instruments' P1394/Apple's FireWire), an evolving transmission standard that lets you move video and other data types bidirectionally at 1 Gbps.
- **LINKWORKS**
  Digital's object-oriented work-flow package is strong on design and functionality.
- **LAB REPORT: HIGH-PERFORMANCE DESKTOP PCS**
  New processors mean the best prices ever—if you choose wisely. We use our benchmark suite to identify the best systems for business applications.
- **APPLE'S NEW TOP-OF-THE-LINE POWERBOOKS**
  The PowerBook Duo 280c and the PowerBook 540c both have active-matrix color for video and multimedia work. The 540c has a new, all-in-one design, and both are packed with new technology.
- **ROUNDUP: VIRUS PROTECTION NLMS**
  In this interconnected world, viruses are even a greater threat to the corporate environment. We'll evaluate NLMs (NetWare loadable modules) that detect, remove, and prevent viruses from your network.
- **MANAGING ENTERPRISE DOCUMENTS**
  More potent desktop applications coupled to LANs and WANs (wide-area networks) are raising the stakes on enterprise document management.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YOUR NETWORK.
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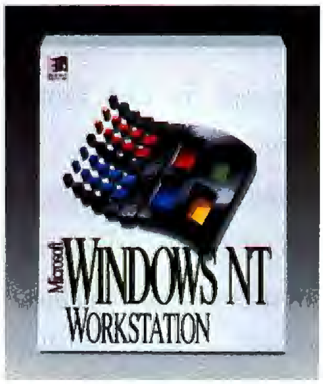


Microsoft

News & Views

WINDOWS DATABASES

Borland Readies dBase, Takes Aim at Microsoft

In the battle of PC databases, both Microsoft and Borland have set their sights on having it all

STAN MIASTKOWSKI

As late as Borland's release of dBase for Windows is, it will probably still beat Microsoft's FoxPro for Windows to market by several months in offering a full event-driven programming model with object-programming extensions for dBase programmers. Borland was expected to release the long-delayed first version of dBase for Windows in June.

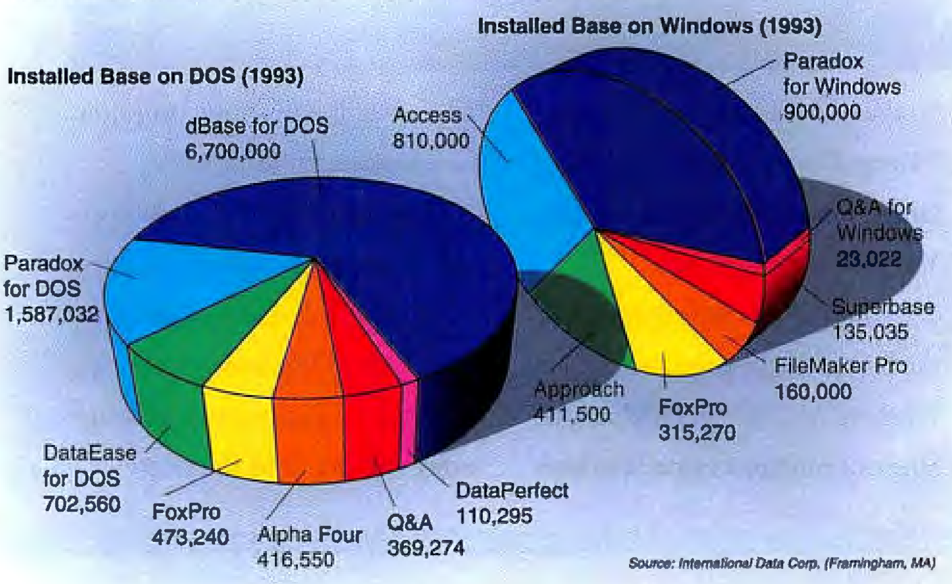
Although Microsoft is catching up in market share in the PC desktop database market (see the chart), Borland says it still has a worldwide installed base of 6.7 million dBase developers and users, many of whom have waited for a 100 percent dBase language– and file-compatible Windows database. The large installed dBase market, analysts say, gives Borland a fighting chance to recapture market share in the desktop database arena with dBase 5.0 for Windows (note the shift from Roman to Arabic numbering with the first Windows version).

Microsoft released FoxPro 2.6 for Windows this spring, and although the database targets dBase programmers, some developers who have used the latest version say it lacks 100 percent compatibility with dBase, making it a problematic solution for a mixed environment of dBase for DOS and FoxPro users. For example, with FoxPro, dBase indexes and memo fields must be converted to FoxPro's own format, and FoxPro does not support concurrency of dBase IV files in a mixed FoxPro/dBase environment on a network.

"When you do a `Use` on a .DBF file, FoxPro has to automatically convert memo fields to its own FoxPro format," says Dick Harding, president of Compucon (Menlo Park, CA), a consulting company and developer of custom database applications. He says Microsoft's solution is for developers to take the .DBF database file and copy it to another named file without the memo files. "That's fine for 500 records, but what if you have a 10-million-record file?" asks Harding, who uses FoxPro and has tested a prerelease version of dBase for Windows. "This is a problem."

Janet Walker, group program manager of Microsoft's Fox Business Unit, says FoxPro 3.0 will include a true Windows event model that will obviate the need for the complex coding currently associated with using FoxPro's foundation `Read` command (index incompatibilities with dBase should remain, however). FoxPro 3.0, the first Windows and NT versions of which should ship sometime between late 1994 and mid-1995, will include all the events, properties, and methods found in Visual Basic today; object-programming extensions; a data dictio-

Worldwide Stand-Alone Desktop Databases Installed



Source: International Data Corp. (Framingham, MA)

dBase for Windows' two-way graphical development tools let users and developers build queries, design forms, and generate reports without writing any code. However, you can edit source code generated by the graphical tools. Changes made are instantly reflected in the associated form.

nary; and other features, Walker says. (Borland is working with Intersolv (Rockville, MD) and other third parties to provide a data dictionary for dBase for Windows.)

dBase for Windows and Paradox 5.0 for Windows, which is expected to ship in August, are the keys to Borland growing its installed base. BYTE previewed prerelease versions of both programs. The version of Paradox 5.0 for Windows that BYTE used was far from being a quantum leap from version 4.5, but it shows a great deal of improvement in integration and ease of use. Paradox 5.0 for Windows is notable for its many new Experts, programs that guide you through the common yet complex schemes of creating reports, forms, and graphs. Borland claims 5.0 is two times faster across the board than 4.5, but BYTE could not confirm this because of the debugging code in the beta version.

dBase 5.0 for Windows puts a new face on a familiar programming language. Borland is counting on its two-way interface (see the screen) to bring a generation of dBase programmers into the brave new world of object-oriented programming. The beta version that BYTE tested was not yet ready for performance testing.

Unlike Paradox, whose object-oriented tools and language result in a product that's different from its DOS namesake, dBase 5.0 for Windows is also completely compatible with dBase III Plus and IV files and programs. Based on BYTE's use of an early beta version, it appears that the migration from .DBF files to client/server is as painless as it is to move from DOS to Windows: Users move around server tables with the same `skip`, `go top/bottom`, and `locate for` commands they have used for years. Once connected to the database, you design forms and reports or write code just as you would for local data, accessing database tables with the familiar `use` command.

Although the database arena is fragmented into numerous segments, including desktop, developer, and client/server, the lines between these segments are becoming increasingly blurred. As companies downsize and move their line-of-business applications to networked PCs, developers are asking for databases that combine a fast and flexible development environment with the ability to access corporate data stored in SQL databases.

Howard Dresner, program director at the Stamford, Connecticut–based Gartner Group, says the consulting group has five different definitions for client/server but that most PC databases conform to only one of them: front-end remote access of data residing on a networked database server. The database server could be a PC, a minicomputer, or a mainframe running another database, such as Oracle, Sybase, DB2, InterBase, or even a different PC database.

The graphical shell of all major PC databases wraps around the core code that performs the complex low-level chores of handling data. In this realm, Borland claims to have an advantage: Paradox 5.0 for Windows and dBase 5.0 for Windows share the BDE (Borland Database Engine), as does the Quattro Pro spreadsheet Borland recently sold to WordPerfect. Currently, Access and Visual Basic share Microsoft's Jet engine, while FoxPro runs on the FoxPro engine.

The benefits of the shared-engine approach include reduced storage requirements and a consistent development platform. Today's PC databases hide the complex details of the SQL commands from users by translating normal queries, but Borland and Microsoft handle this translation process in very different ways.

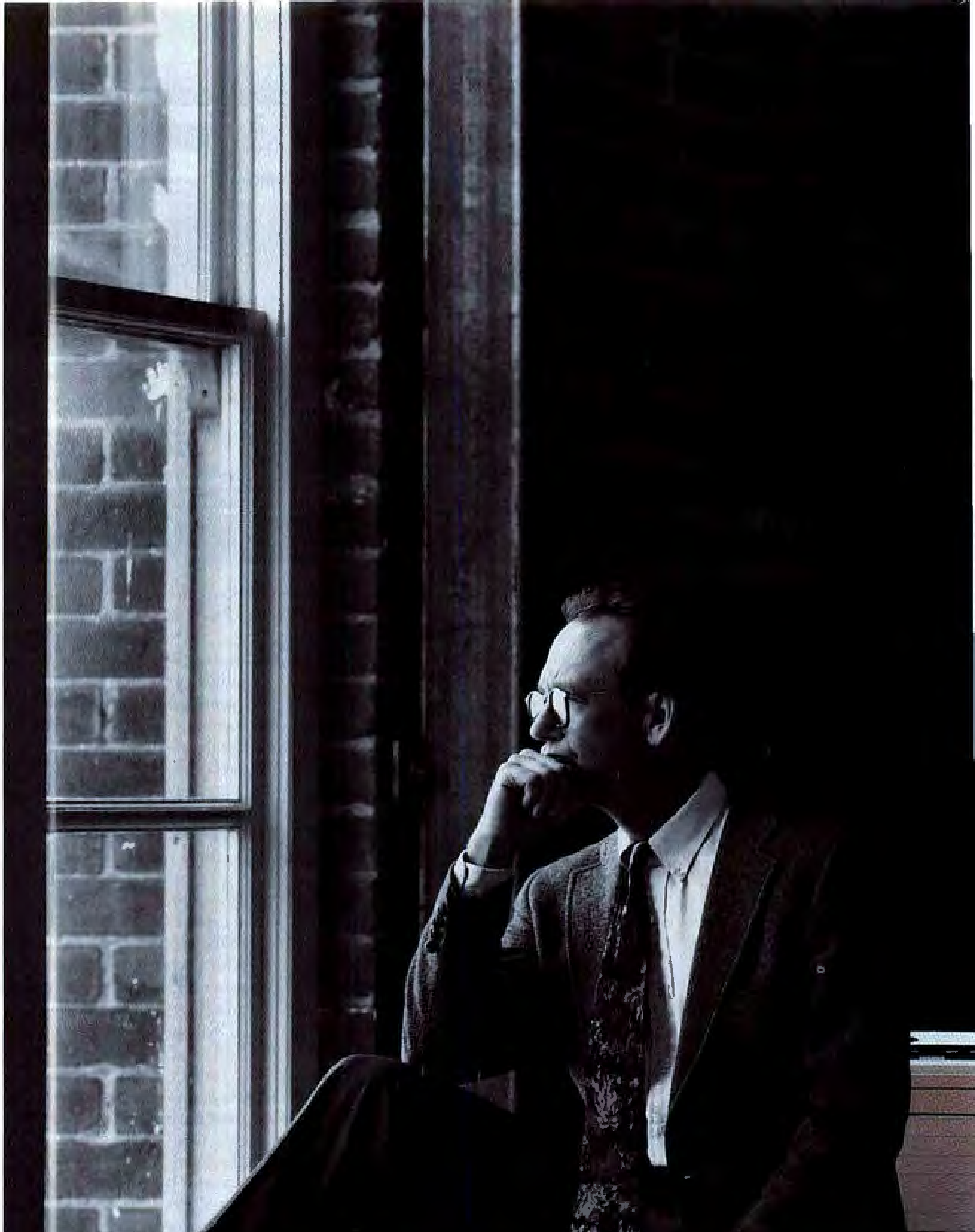
Borland's approach is to include SQL translation capabilities directly in its BDE. The integrated SQL Link of both dBase 5.0 for Windows and Paradox 5.0 for Windows directly accesses Oracle, Sybase, Informix, DB2, AS/400, SQL Server, and InterBase servers. The SQL Link can also access other SQL databases that have ODBC (Open Database Connectivity) drivers. Borland contends that its integrated client/server approach has several important advantages over ODBC, including the ability to use virtual tables, faster access to remote data, and heterogeneous joins (using a mix of multitable local and remote data at the same time).

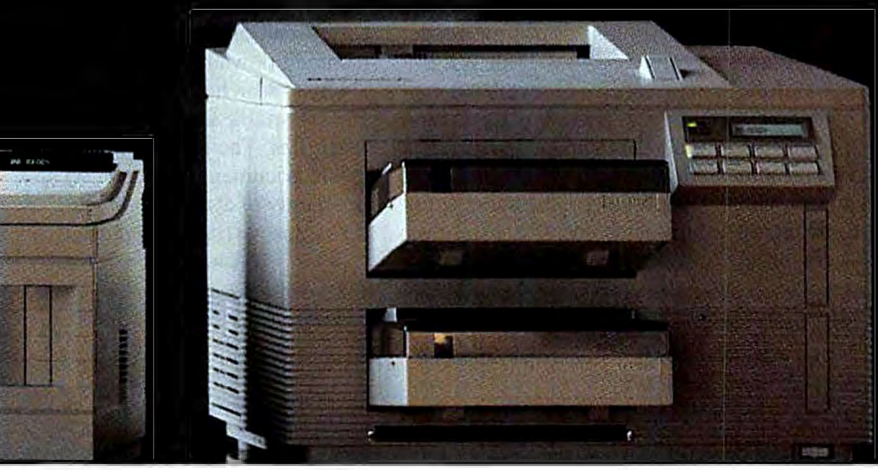
Instead of incorporating client/server capabilities directly in its core Jet engine, Microsoft's approach is ODBC, a company-developed "middleware" standard that's been widely adopted by the database community. Microsoft ships a handful of drivers with its applications, and many database makers (e.g., Oracle) include or sell ODBC drivers for their products. Third-party companies such as Q+E Software (Raleigh, NC) sell other ODBC drivers and development kits. At last count, there were over 140 such drivers available for various applications.

Analysts say that neither Borland nor Microsoft currently has a large presence in the client/server arena. But both companies hope to make a dent in the client/server business. The question remains whether corporate customers (largely Fortune 1000 companies) will be impressed. "Borland is going upstream and trying to compete with Oracle and Sybase," says Nicole Roth, an analyst for International Data (Framingham, MA). "They [Borland] have good technology, but it's going to be tough for them."

dBase developers have patiently waited for dBase for Windows. Will the product turn out to be worth the wait when Borland releases it? Based on use of a prerelease version, we think so. But, as one Borland product manager said, "It better be."

—Additional reports by Mark Hettler and Dave Andrews



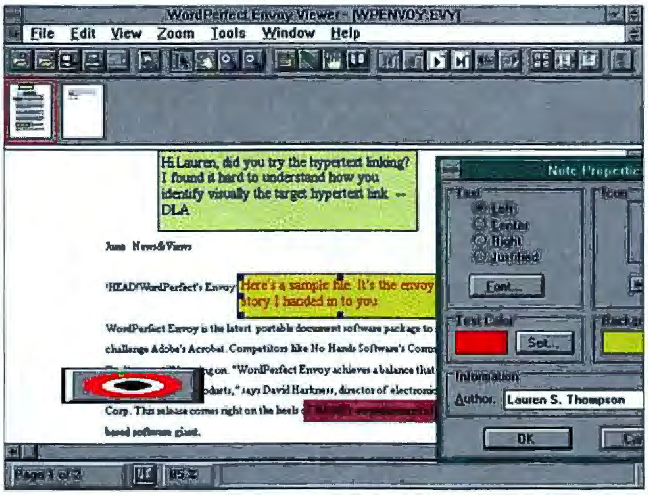


PORTABLE DOCUMENTS

WordPerfect Enters Paperless-Document Arena

What was once a small club is turning into a crowd. WordPerfect's family of products, code-named Envoy, is the most recent entry in the cross-platform, portable-document arena, joining others such as Farallon Computing's Replica, No Hands Software's Common Ground, and Adobe's Acrobat family.

Earlier this year, Farallon released the first Mac version of Replica, which joined the company's Replica for Windows, released last year. At press time, WordPerfect planned on releasing the first Windows and Mac versions of WordPerfect Envoy in June.



One use for WordPerfect Envoy is to let several people review and annotate a single document. A thumbnail view of the document appears at the top left of the screen.

Three components make up WP Envoy: a printer driver for creating portable applications from all Mac and Windows applications (support for Power Mac and Unix applications is planned for later this year); a viewer for viewing, annotating, manipulating, or printing WP Envoy files; and a run-time file that combines a WordPerfect Envoy file with an embedded viewer to create a self-opening portable document.

WordPerfect is also making available an SDK (software development kit) that lets developers customize the look of the interface that's presented to someone who's reading a document such as an electronic brochure or catalog. "Publishers don't want their electronic book to have the same interface as their competitor's book," says David Harkness, director of electronic publishing tools at WordPerfect.

Based on use of a prerelease version of Envoy for Windows, WordPerfect's program appears to combine some of the high-end features of Adobe's Acrobat family (e.g., font substitution for TrueType and PostScript Type 1 fonts) with useful group-collaboration tools not currently supported in Replica or Common Ground (e.g., hypertext links and the ability to consolidate annotations and other comments from several reviewers of a document into a single master file).

In contrast to No Hands' Common Ground run-time reader, which lacks support for searching and text exporting, WP Envoy's run-time reader is identical to the full WP Envoy reader—except that it cannot send files directly to mail via VIM (Vendor-Independent Messaging), MAPI, or AOCE (Apple Open Collaborative Enviroment). Replica's run-time reader, however, is extractable and offers all the features of the full Replica reader, including scrolling, zooming, support for the Rich Text Format when copying text to the clipboard, and tools that let you copy individual elements of a vector graphic to the clipboard.

While WordPerfect works on finishing Envoy, its competitors are busy adding features to their next releases. No Hands officials say the next versions of Common Ground, slated for release later this year, will add support for hypertext links and annotation. Farallon says the next versions of Replica will likewise add support for hypertext links, as well as the ability to consolidate multiple annotations into a single document.

And sources say Adobe will announce in August a new version of Acrobat that features support for third-party extensions by means of a plug-in architecture; security (e.g., password protection and the ability to set read-only privileges); a trimmed-down reader; and the ability to search across multiple PDF (Portable Document Format) files. The portable, electronic document arena should see plenty of action as companies improve their programs.

—Lauren S. Thompson

Portable Document Highlights

Product/Company/Price	Embed viewer? (embedded viewer size)	Minimum RAM under Windows	Platforms supported	Text resolution
WordPerfect Envoy WordPerfect, (801) 225-5000 $189	Yes, but only opens Envoy document to which the run-time viewer is bound (300 KB).	500 KB free.	Windows and Mac in June; Unix and Power Mac later this year.	Scalable. Doesn't preserve exact look during font substitution.
Replica Farallon Computing, (510) 814-5000 $99	Run-time viewer is free; opens multiple Replica documents (200 KB).	500 KB free.	Windows and Mac; Power Mac later this year.	Scalable if font present or embedded; otherwise uses 300 dpi for printing and screen resolution (72 dpi on Mac, 96 dpi on Windows) for screen display.
Common Ground No Hands Software, (415) 802-5800 $189.95	Run-time viewer opens multiple Common Ground documents, but no search or zoom capabilities (75 KB).	650 KB free.	Windows and Mac; Power Mac later this year.	Not scalable. Supports four resolutions: 72, 100, 200, and 300 dpi. Preserves font look.
Acrobat Adobe, (415) 961-4400 Exchange, $195; Distiller, $695; Reader, up to $50 per person	No run-time viewer; requires each recipient to buy Acrobat Reader.	2.1 MB free.	Windows, Mac, DOS, Unix.	Scalable. Preserves font appearance during substitution.

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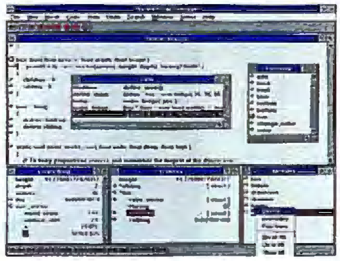

The advanced multi-platform debugger accelerates the development cycle by increasing the bandwidth between you and your application.

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 [1]PC Magazine, March 29, 1994

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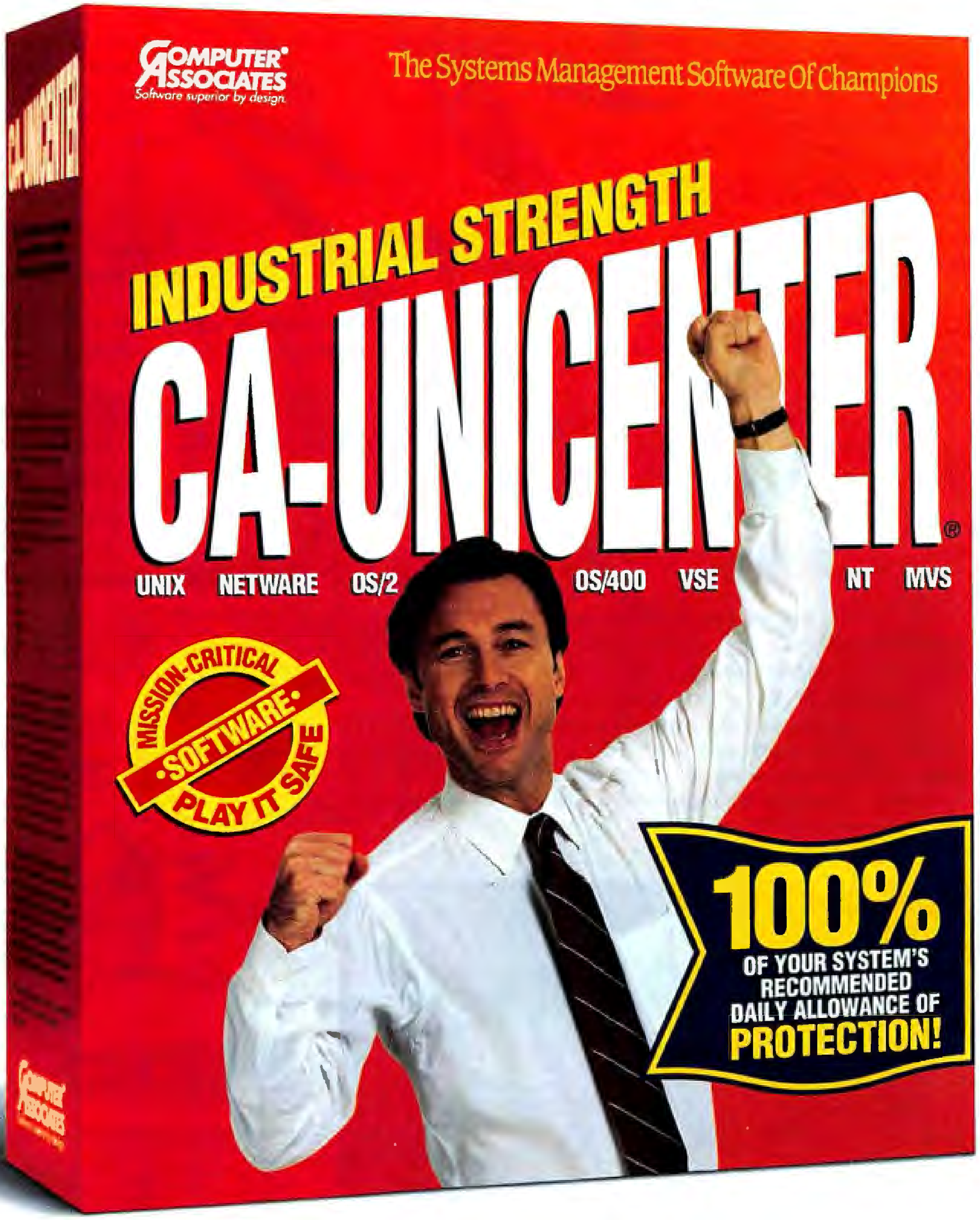

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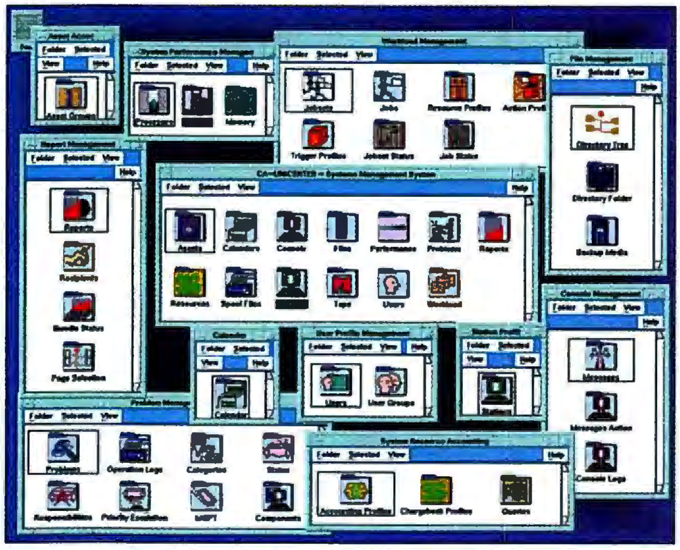

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NETWORKING

The Best of Interop+Networld

Editors from McGraw-Hill's TechNet magazines—BYTE, *Data Communications*, *LAN Times*, and *Open Computing*—recognized companies at the May Interop+Networld '94 for products that exemplify and advance global networking.

The **Best of Show** (and also **Internetworking**) co-winners were Fore Systems and NetEdge Systems for their co-developed switching solution that links Ethernet, Token Ring, and other LANs with ATM (Asynchronous Transfer Mode) networks. NetEdge Systems ((919) 361-9000) offers it as ATM Connect release 1.1, and Fore Systems ((412) 772-6600) markets it as the Lax-20 LAN Access Switch.

XSoft ((415) 424-0111) won in the **Applications** category for Visual Recall, a document management system for NetWare workgroups.

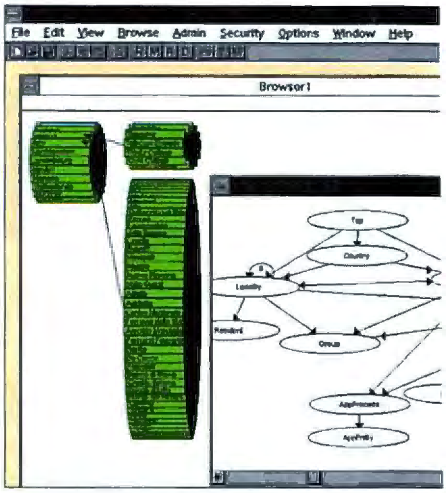
EZ-RPC for Windows NT, OS/2, and VMS, from NobleNet ((508) 460-8222), took top honors in the **Application Development Tools** category. EZ-RPC lets you develop cross-platform client/server applications from stand-alone applications.

NetFrame Systems' ((408) 944-0600) ClusterServers 2500 and 4500 won in the **Server Hardware** category. These servers allow multiple operating systems and processors to coexist with a common backplane, shared memory, and an independent messaging layer while supporting the hot swapping and addition of all components.

AT&T and Novell won the **WAN** (wide-area network) **Services** award for NetWare Connect Services, which offers secure network access to public, private, and commercial services.

Telco Systems' Fiber Optics Division ((617) 551-0300) took the **WAN Equipment** award for its HyperLynx-50 and HyperLynx-50 Hubs, which are ATM/Sonet multiplexers that combine T1 service with ATM transport, offering broadcast-quality video and monitoring for usage-based billing.

Isocor ((310) 476-2671) won in the **Messaging/E-Mail** category for MAPIware, a development toolkit for message-enabling applications. MAPIware allows the development of client/server Windows or Unix interfaces for a variety of data-exchange functions, including work-flow forms.



Isocor's MAPIware represents information about a global X.500 directory system of users in a graphical Rolodex. In the schema designer, you can modify network schemata, such as security or routing, graphically.

Symantec ((503) 334-6054) won the **Network Peripherals/Storage** award for its Norton Enterprise Backup software, which features automatic routing of data to tape servers and disaster-recovery tools.

SynOptics ((408) 764-1085) took top honors in the **LAN Hardware** category for the LattisSwitch 28115, a fast Ethernet switching hub. The 28115 has 16 shielded RJ-45 ports, allowing individual configuration of each port for 10- or 100-Mbps operation.

Cogent Data Technologies ((206) 378-2929) won in the **Network Interface Card** category. Cogent's EM964 PCI Quartet, a four-port Ethernet PCI (Peripheral Component Interconnect) LAN adapter, supports 132-Mbps data transfer with predictive pipelining and an on-board bridge.

CheckPoint Software Technologies ((415) 346-4131) won best **Security** product with its FireWall-1 software, which provides complete Internet connectivity with security.

Make Systems ((415) 941-9800) won the **Network Management** trophy for NetMaker XA, a set of interactive data management tools for enterprise networks.

INTEROP RUNNERS-UP

Applications: the InterAp applications suite for accessing the Internet, California Software ((714) 729-4224); the Zip Office Server for Lotus Organizer and cc:Mail, which links scheduling systems across LANs to IBM PROFS and OfficeVision, Attachmate ((416) 979-1380).

Application Development Tools: the Enterprise/Access 2.0 toolkit, which combines centralized screen-scraping logic and client/server technology, Apertus Technologies ((612) 828-0300); version 3.0 of the Virtual Socket Library, which provides a consistent transport-level network API for client/server development, JSB ((408) 438-8300).

Server Hardware: Workgroup Server 9150, a PowerPC 601–based server, Apple ((408) 996-1010); the AS/400 Advanced Server from IBM ((914) 766-4530).

WAN Services: the Interexchange Switched Multi-megabit Data Service, which provides secure high-speed connections between MCI and other local providers, such as Bell Atlantic, MCI Telecommunications ((404) 668-6000); SITA's Frame Relay service, which carries networked applications across over 200 countries at 2 Mbps, SITA Group (Hayes, England, +44 81 730 1322).

WAN Equipment: the Artemis Broadband Data Service Unit, which lets ATM islands connect to T3 or E3 lines, Larscom ((408) 988-6600); the multiprotocol ACP 70 access device, Telematics International ((305) 772-3070).

Messaging/E-Mail: Z-Mail, a cross-platform E-mail system, Z-Code Software ((415) 898-8649); the Intelligent Messaging III back end, Banyan Systems ((508) 898-1000).

Network Peripherals/Storage: Typhoon 30, a 30-ppm networked printer, Dataproducts ((818) 887-8000); the Q7 advanced tape library, which has up to 560 GB of storage, Transitional Technology ((714) 693-1133).

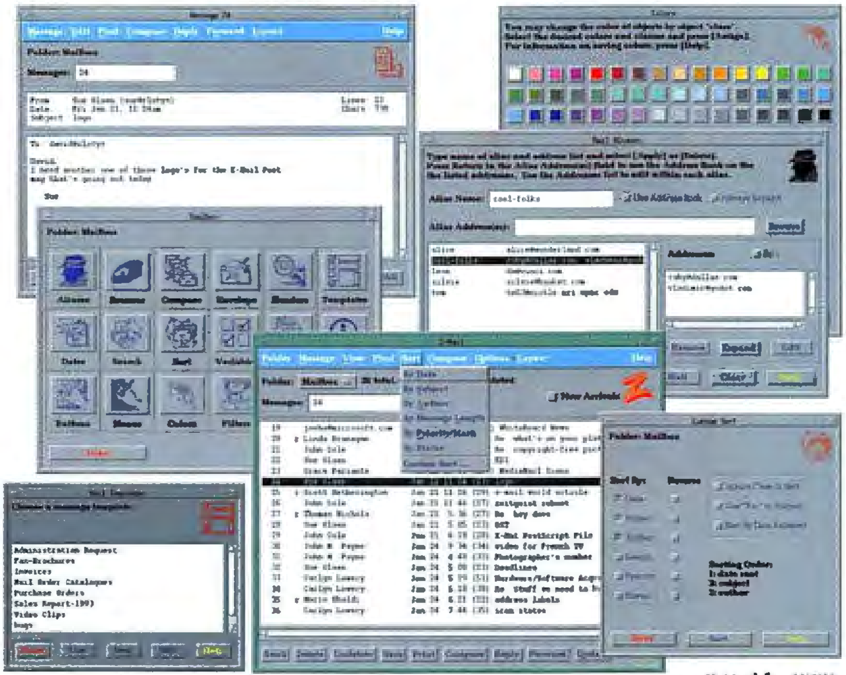
LAN Hardware: the 100VG Hub-15, which supports the proposed 100VG-AnyLAN IEEE 802.12 100-Mbps standard, Hewlett-Packard ((800) 533-1333); the Enterprise Hub, an ATM Ethernet switch module that provides ATM backbone access, routing, and bridging for workgroups, Hughes LAN Systems ((415) 966-7300).

Network Interface Card: the 10-/100-Mbps EtherExpress PR/100 adapter, Intel ((503) 629-7000); the Performance Series Ethernet IIp Adapter for PCMCIA from Xircom ((818) 878-7600).

Security: the CyberSafe Challenger tool for developing secure authentication for distributed systems, CyberSafe ((206) 883-8721); AuditWare, a multiserver auditing tool for NetWare, Preferred Systems ((203) 937-3000).

Network Management: Spectrum 3.0, a distributed, multiuser network management platform with telephony and PBX management, Cabletron ((603) 332-9400); the Netscout Resource Manager proactive manager of network devices, Frontier Software Development ((508) 851-5700).

Internetworking: Direct Route, a connection-oriented, protocol-independent, internetworking technology that provides dynamic bandwidth and on-demand access between LANs, Symplex Communications ((313) 995-1555); the IEN 1000 intelligent branch-office hub/router, Hypercom ((602) 866-5399).



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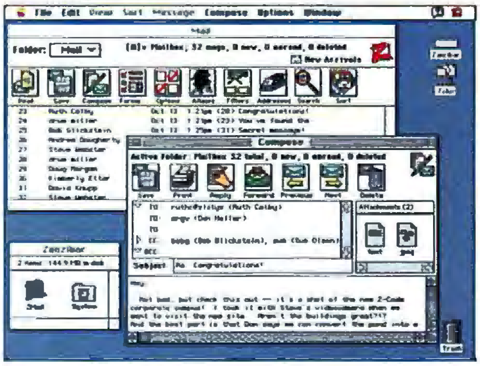

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BUS TECHNOLOGY

High-Speed 1394 Train Still at the Station

Hardly anyone talks much about the "plug" half of "plug and play" when the subject turns to making PCs easier to use. But the jumble of unique ports and cables used to connect various peripherals stirs the ire of even hard-boiled computer managers. And the relatively slow speed of most of these connections is threatening to choke off the data-heavy multimedia revolution.

But the IEEE's Project 1394 (P1394, also known as FireWire) is poised to simplify and greatly accelerate PC connections. P1394 is a proposed high-speed serial-bus interface standard that promises to consolidate all of today's peripheral I/O interconnections into a single, universal interface for both Mac and Windows PCs. The P1394 interface could replace parallel, serial, video, audio, SCSI, keyboard, and even AC power connections on a PC with two or three identical, narrow (less than an inch wide) serial ports that use the same thin twisted-pair cable. Multiple devices can run off each port through branching or daisy-chaining techniques.

P1394 can shuttle data at rates of 100, 200, and 400 Mbps, with four of its six shielded wires dedicated to data and control signals (the other two are used to carry power). Higher rates are possible, and they will be backward-compatible with previous speeds. Just as important as speed for many multimedia applications, P1394 supports a "guaranteed bandwidth" for real-time data transfers. However, P1394 is not intended to be a networking standard. Among other things, the distance limitations of serial interfaces would make network use problematic.

Apple, IBM, Texas Instruments, NCR, and DEC are among those represented on the P1394 committee, and all say they are committed to the new serial interface. Peripheral companies, including hard drive makers Adaptec, Maxtor, and Western Digital, also say they're behind P1394. Microsoft has yet to take a position on it at this writing.

When users will begin seeing P1394 products is less clear. Apple says it will wait until next year at the earliest to use it in Macs. IBM, DEC, and others won't say when they'll begin using it. But add-on boards with the P1394 interface could begin showing up later this year. TI says it has begun production of a P1394 chip set for such boards, which will likely be available first as prototypes for PC makers.

The P1394 interface won't be just for computers. Consumer electronics and industrial companies are interested in using P1394, reports Mike Salas, a project manager at TI for P1394. That trend, he notes, will make it easier to link PCs with everything from camcorders to factory assembly lines.

—**Christopher O'Malley**

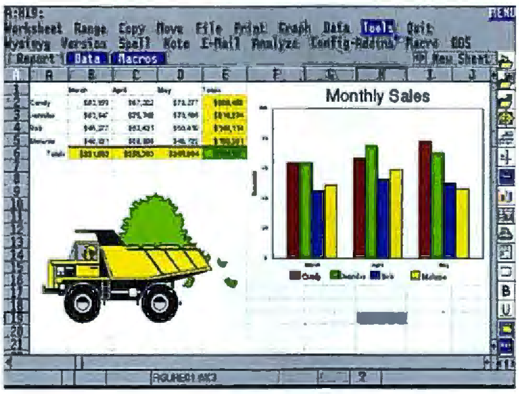
SPREADSHEETS

1-2-3 Proves DOS Isn't Dead

Lotus Development isn't letting 1-2-3 for DOS die in the shadow of its Windows spreadsheet. Lotus plans on releasing in July 1-2-3 release 4 for DOS, a solid upgrade of 1-2-3 release 3.x. But it's a stretch to call this release 4, because it can't directly retrieve a WK4 spreadsheet created by 1-2-3 release 4 for Windows.

Release 4 for DOS offers many slick features, most of them proven in 1-2-3 for Windows. For example, each spreadsheet comes with a nameable index tab, and you can use spreadsheet names in place of letters when you write formulas. A live status bar provides information about current selections—fonts, cell formatting, and named styles. Clicking the status bar lets you rapidly change the settings. Release 4 finally offers dialog boxes, à la release 2.4.

Release 4's main menu sports a Tools selection that consolidates new features with ones that were available in release 3.x via add-ins. You can trigger the Add-In Manager from the Tools menu, and you can activate Auditor, Backsolver, and Solver. The Tools menu also has options for spelling checking, attaching annotations to cells, accessing E-mail (this works only if you also have Lotus's cc:Mail release 4.02 for DOS), and managing multiple versions of a single worksheet file.

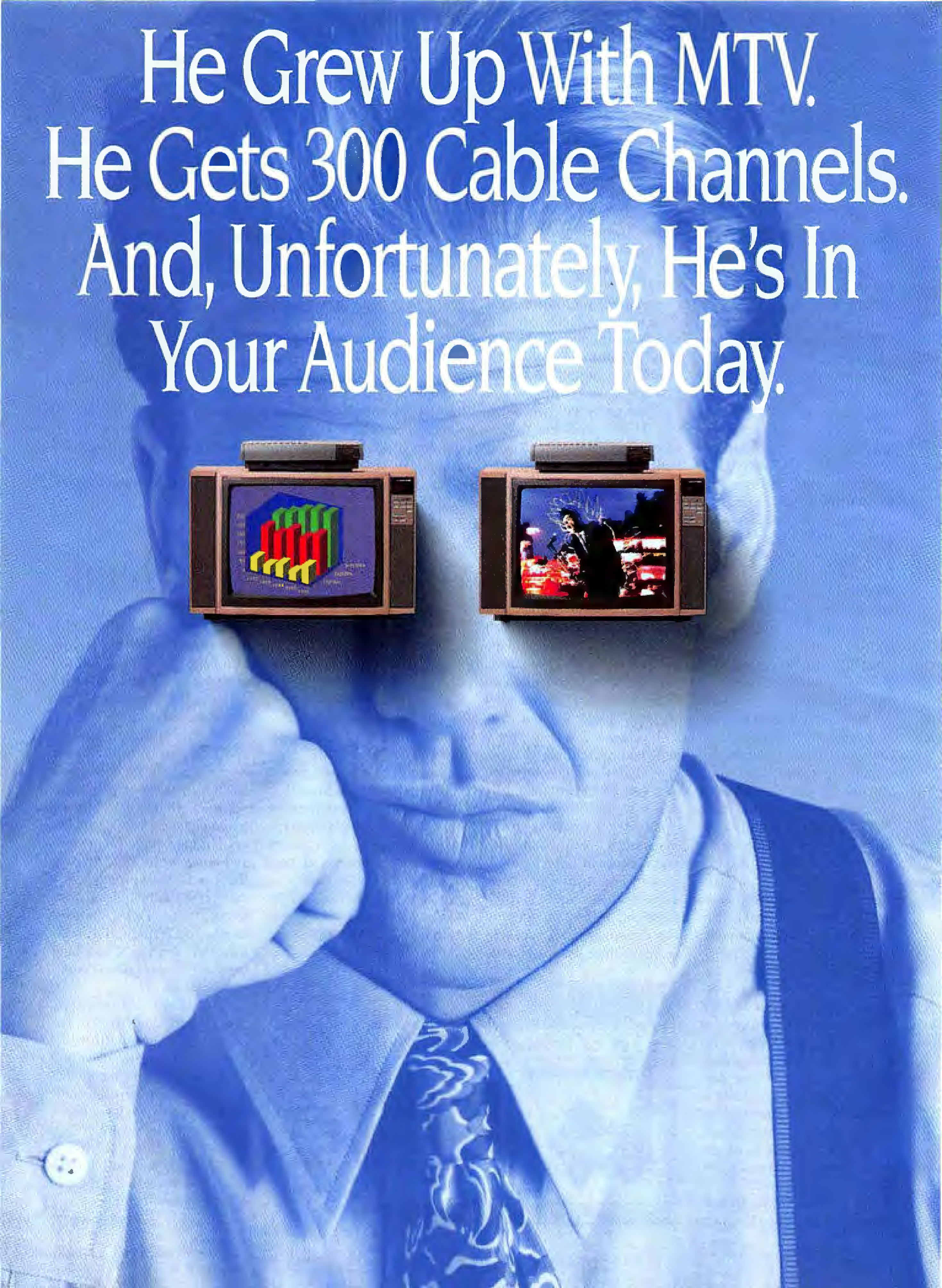


If you've seen 1-2-3 for Windows, the release 4 for DOS spreadsheet might look familiar. It includes SmartIcons, nameable index tabs, scroll bars for navigating, and a live status bar.

Other features include a command to fit columns to their widest entries and a collection of spreadsheet templates called SmartSheets (these include a schedule planner, an investment analyzer, and a net-worth calculator). Your existing spreadsheets should load without incident in release 4 for DOS, macros should run as they did in release 3.4, and you'll still find the / and : menus almost completely intact.

How does 1-2-3 release 4 compare to Quattro Pro, its only serious competitor? If you're already using an earlier release of one or the other, you should upgrade within your product line if you have powerful enough hardware (1-2-3 release 4 requires 2 MB of RAM). If you're choosing your first spreadsheet, 1-2-3 release 4 has the most features.

—**Daniel Gasteiger**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PERSONAL INFORMATION MANAGERS

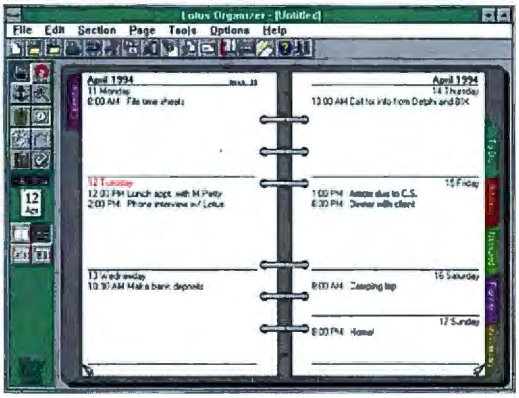
PIMs Are Not So Personal Anymore

Recognizing that few people in today's workplace work alone, software developers are adding group-collaboration features to PIMs (personal information managers.

Even companies that have released PIMs for the first-time PC user say their strategic goal is to enable users on a network to share information. Officials at Polaris Software ((619) 592-7400), developer of PackRat and Advantage, a new PIM for novice users, say both will be network capable within the next 12 to 18 months.

Lotus Organizer 1.1 for Windows from Lotus ((617) 577-8500) supports information interchange between PIM schedulers via Lotus's cc:Mail. Lotus is also coming out with other platform versions of Organizer. The first of these, Organizer 1.1 for the Mac, is already shipping. Organizer 1.1 for MS-DOS is slated for release in July. Both versions support group scheduling, calendar, and to-do functions, but lack personal address books. Jensen-Jones (Red Bank, NJ) has been shipping its groupware-enabled PIM, Commence 2.0, since June of 1993.

Arabesque Software ((206) 869-9600) officials say Ecco Professional 2.0 and Ecco Simplicity support the sharing of schedules, phone books, and outlines over MAPI-, VIM-, or MHS-based E-mail systems.



Lotus is planning on releasing versions of its Organizer information manager, which features a notebook-metaphor front end in Windows, on other platforms.

Barbara Baird, director of product marketing for Lotus Organizer, says that modern PIMs must address the fact that one person's schedule can impact other people in the office. "You need the 'PIMness' for yourself," she says. "But a lot of your workday involves a lot of other people."

—Alexis Tannenbaum

FONTS

Three Programs Help Manage, Create Fonts

A trio of new products make it easier to manage, generate, and manipulate fonts on your PC. And, to varying degrees, these products attempt to solve the problem of document portability (i.e., maintaining the original design when sharing documents among multiple users).

The most well-known of these new products is Adobe Type Manager for Windows, the font-rasterizer program from Adobe Systems ((415) 961-4400) that converts an outline font into a pattern of dots for imaging on a raster device, such as a monitor or a printer. Version 3.0 maintains all that is good from the ubiquitous prior releases, including superb on-the-fly rendering of screen and printer fonts. Version 3.0 also adds support for Adobe's Multiple Master technology, which had previously been available only on the Mac, and network font sharing.

Multiple Master fonts let you generate thousands of font variations for a single Multiple Master typeface. ATM 3.0 has simple controls that let you adjust any element of a Multiple Master font (e.g., weight, width, style, and optical size), creating a customized design as needed. One Multiple Master font is included with the 30 fonts that ship with ATM 3.0. What you don't get is the ability to do font substitution, a feature included in SuperATM on the Mac and slated for a future update under Windows.

Font substitution is at the heart of FontWorks from ElseWare ((206) 448-9600). When you open a document, FontWorks' sophisticated Panose type-matching system will find the closest visual replacement from among the 150 TrueType fonts included with FontWorks. The font is then instantly generated by the software. The font library takes up just 2 MB of disk space, making this program a great solution for mobile computing users.

The third product, FontChameleon from Ares ((415) 578-9090), has a single master font outline and descriptors of more than 200 popular fonts that can be generated on-the-fly in TrueType or Type 1 formats. FontChameleon lets you adjust the width, height, and other aspects of a font; blend two fonts into a totally new design; and otherwise slice and dice the type to your heart's desire. FontChameleon is frugal with its disk space (a description file for a font takes up about 5 KB) and works cross-platform on Windows or the Mac. It's the most expensive of these products but offers more benefits to professional designers.

—Jon Pepper

Font Wrap-Up

	ATM 3.0	FontWorks	FontChameleon
Price	$60	$129.95	$295.95
Key feature	Multiple Master technology	Font substitution	Font manipulation
Number of fonts	30	150	200
Type	Type 1	TrueType	TrueType or Type 1
Pros	Easy to use	Advisor; font management	Cross-platform
Cons	No font substitution	No support for Type 1; no manipulation	No substitution
Key audience	General business	General business	Designers

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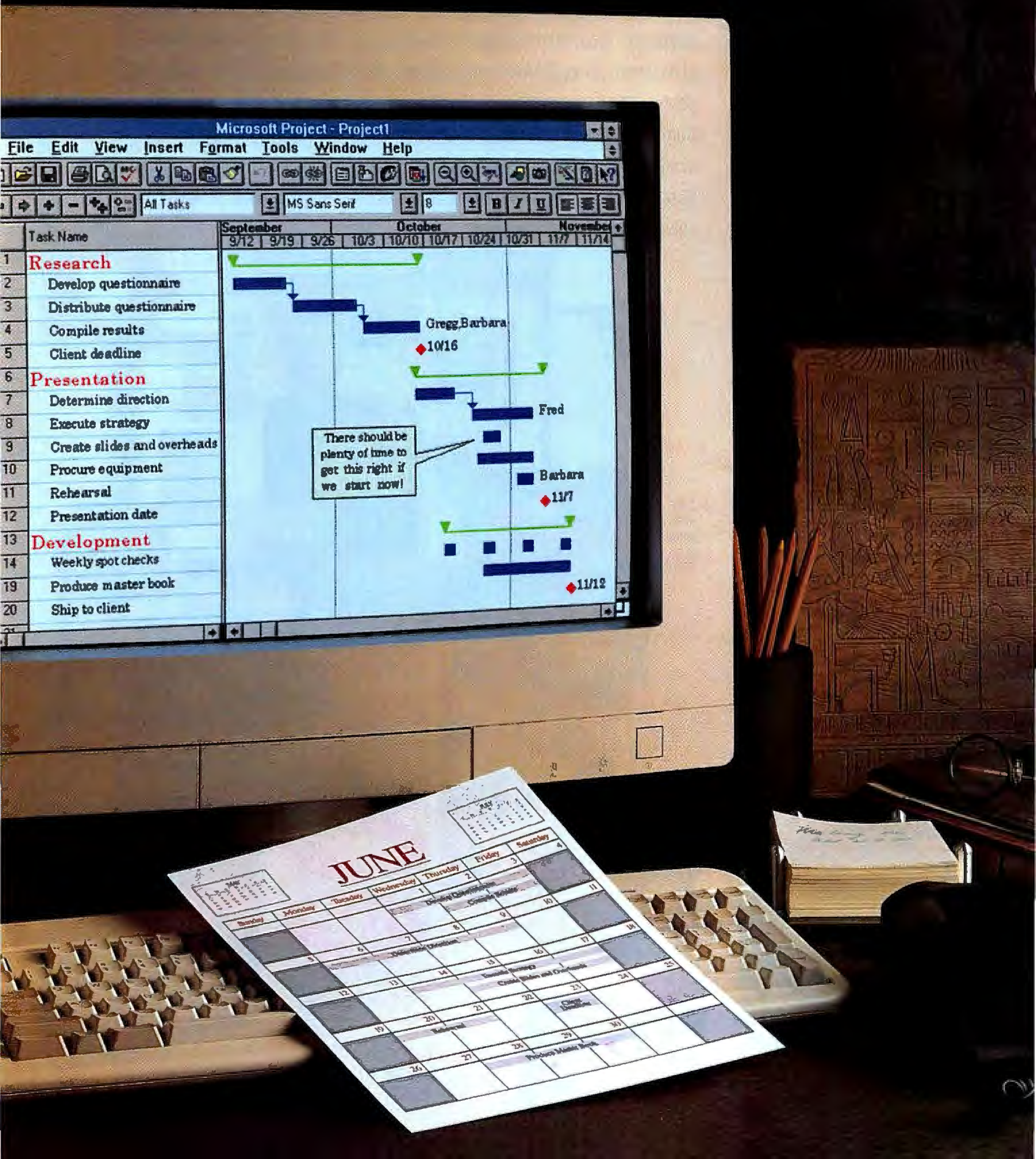

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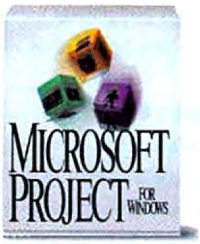


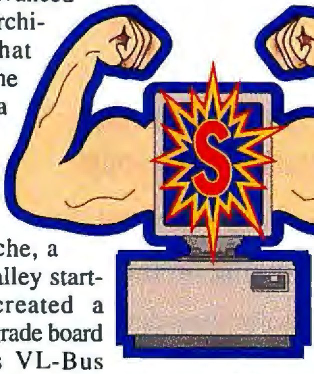
The world's most popular business project planning software just got better with Microsoft Project version 4.0.

Microsoft

PC UPGRADES

Turn Your PC into a Powerful RISC Machine

By integrating a Mips R4x00–compatible CPU with an advanced memory architecture that obviates the need for a conventional SRAM (static RAM) cache, a Silicon Valley start-up has created a unique upgrade board that turns VL-Bus PCs into high-performance RISC systems for Windows NT. The board is offered as a low-cost alternative to a standalone Mips-based computer and as a one-box solution for dual-platform software developers.



Known as the Nitro-VLB Windows NT Booster, the board is the first product from ShaBlamm Computer ((408) 730-9696). The Nitro-VLB was expected to ship in May at prices ranging from $1095 to $2595, depending on the CPU/memory configuration. The board plugs into the VL-Bus slot of an 80x86-based PC.

Two key components of the Nitro-VLB are its RISC CPU and memory architecture. The CPU is an Orion R4600, a Mips-compatible chip jointly developed in 1993 by Integrated Device Technology (Santa Clara, CA) and Quantum Effect Design (San Jose, CA) and manufactured by IDT and Toshiba America (Irvine, CA). At 100 MHz, the 64-bit R4600 is rated at 73.8 SPECint92 and 63 SPECfp92—about the same as a 66-MHz Pentium, although the R4600 chip sells for roughly half the price. Higher-end versions of the Nitro-VLB will use R4600 chips clocked at 133 and 150 MHz.

To enhance performance even further, ShaBlamm uses 4 MB of memory on the PC's motherboard as a DMA buffer and populates most versions of the Nitro-VLB with 16 or 32 MB of interleaved EDRAM (enhanced DRAM). EDRAM is an advanced memory technology from Ramtron (Colorado Springs, CO) that integrates 2 Kb of 15-nanosecond SRAM with 4 Mb of 35-ns DRAM on a single chip. This eliminates the need for a secondary CPU cache based on SRAM; in effect, the main memory is the cache. ShaBlamm says this design is very effective when running a preemptive multitasking operating system, such as Windows NT, that would frequently miss a smaller SRAM cache as the CPU handles several large applications.

At $1995, the Nitro-VLB comes with a 100-MHz CPU, 16 MB of EDRAM, and Windows NT. The 150-MHz configuration costs $2595. The $1095 version has no memory and accepts standard 72-pin DRAM SIMMs instead of EDRAM. The performance of the $1095 version suffers by about 15 percent, but because DRAM chips are currently denser than EDRAMs, the memory can be expanded to 128 MB instead of 32 MB. Higher-density EDRAMs that allow expansion to 64 MB and 128 MB are scheduled to ship later this year.

—Tom R. Halfhill

CODE TALK

RICK GREHAN

High-Altitude, Top-Down Programming

In 1986, long before the concepts of object-oriented, RAD (rapid application development), and visual programming became fashionable, a database applications builder called Magic, which embodied all of these concepts, showed up. Magic (Magic Software, Irvine, CA, (714) 250-1718) runs under DOS, Unix, and VMS and will soon (possibly by the time you read this) have a Windows version. Magic produces code that is easily ported across the above-mentioned operating systems; supports more database back ends than I can spend space listing; and is definitely worth investigating.

Let me clarify. Magic is object oriented in the sense that the entities you define—data types, files, and even programs—are stored centrally in tables for easy reuse. Additionally, references are always made to the original definition. So if you define a "vendor number" data type and use it to define fields in multiple files in your database, a later redefinition of *vendor number* will require that you edit only its original definition.

As for being RAD, Magic is truly "programming that is not programming." This, admittedly, takes some getting used to. For instance, you do not build an application by writing procedural code, as you would in C or C++. Nor do you build an application by populating a form with visual objects (e.g., buttons and scroll bars) and then attaching code to the objects, as you would in, say, ObjectView or PowerBuilder. Magic does provide visual objects—pull-down and pop-up menus, data-entry screens, and so forth—and, therefore, is a kind of visual programming.

But working in Magic is an act of winding through a forest of nested dialog boxes, filling in fields as you go. It's like high-altitude, top-down programming. The designers of Magic have identified all the high-level procedures that anyone might conceivably need to manipulate a database (and there are surprisingly few); building an application means specifying the order of execution of those procedures.

You might wonder if Magic may be missing that one procedure that your application will need. It's unlikely. I haven't come up with anything that it can't do, and the third-party reviews I've read about earlier versions of Magic (I used version 5.60) suggested no one else has, either. Even if you do have some wacky procedure that Magic can't handle, you can extend the system with user-defined procedures and functions that you write in C (libraries for Borland and Microsoft C are provided with the DOS version).

Understand, however, that although Magic promises rapid application development, it does not promise rapid proficiency. If you come from a procedural-programming background, as most of us do, getting up to speed in Magic will require a lot of mental gear-shifting.

You should work diligently through the provided tutorial; this is not a system that you can simply jump into and instantly begin swimming. Once you get going, though, the results should prove to be pretty spectacular.

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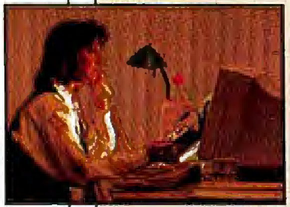

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PROGRAMMING

Next's Enterprise Objects Framework

The NextStep 3.0 development system came with DBKit, a data-access layer that you could easily wire to data-aware user-interface controls. Next hoped this would become its own version of ODBC (Open Database Connectivity). By offering drivers, or *database adapters*, for Sybase and Oracle, the company hoped third-party NextStep developers would create more adapters and write the database applications that would exploit them. For the most part, that didn't happen.

"Now we're admitting that we were wrong," says Rick Jackson, director of product marketing for Next. DBKit's ODBC-like layered architecture didn't really exploit the power of an object system like NextStep. The forthcoming Enterprise Objects Framework, announced at the NextStep Expo in June, aims to fix that.

The new approach focuses on building objects that abstract data and the business logic that governs the use of that data. The Enterprise Objects Framework connects abstract data indirectly to real sources of data—initially SQL back ends, but potentially OODB (object-oriented database) engines as well. Developers who construct abstract models will, of course, have to consult closely with the database administrators who own the storage engines.

The Enterprise Objects Framework also connects abstract business logic indirectly to applications screens. Consider, for example, the problem-escalation logic that's bound up in a typical customer-service application. Expressed as a business object, that logic becomes a corporate asset that's not hard-wired to any client application. It can even appear as a network service that, using Next's Portable Distributed Objects, could run on a non-NextStep system, such as HP-UX.

"Corporate clients told us they needed to decouple business logic from applications in this way," says product manager Felix Lin. It's an attractive idea, and one that Next hopes will showcase the maturity of its object technology just as some of those corporate clients begin kicking Taligent's tires. **—Jon Udell**

EMBEDDED PROCESSORS

Motorola Enables Custom Microprocessors

Motorola has announced an ambitious program to better serve the needs of the 32-bit embedded-microprocessor market. Called FlexCore, the program enables third-party manufacturers to incorporate standard Motorola microprocessor cores into custom designs. Using standard cell technology, third parties design their custom logic around a Motorola core and then hand off the design to Motorola for fabrication.

According to Jim Reinhardt, manager of M68000 Family Marketing and Applications, "Any one company with the expertise to design an ASIC can take advantage of FlexCore." According to Motorola, the benefits of FlexCore are substantial. By integrating the microprocessor with the custom logic, third parties require fewer parts, less power, less area, and fewer interconnects to realize their designs. This, in turn, results in lower costs and higher reliability.

Companies will be able to take advantage of FlexCore in two ways. One group will marry a Motorola core with custom logic to create a custom solution that provides a company with a competitive solution. SunDisk (Santa Clara, CA), the flash storage maker, will use FlexCore in its controllers.

Another group will use FlexCore and custom logic in mass-market chips. In some cases, Motorola may form partnerships with such companies to market the resultant chip. This is the tack taken by Peerless Systems (El Segundo, CA), which has married a static EC000 core with its imaging technology to create a single-chip laser printer controller, the 68322.

In addition to disk and printer controllers, Motorola expects FlexCore to enable new, more cost-effective communications devices, hand-held computers, set-top boxes, and video-game controllers.

Motorola currently offers two 68000-based cores for FlexCore, the 68000-based EC000 and a static 68020 core. A 68030 core is expected this year, followed by a 68040 core in mid-1995. Late 1995 will bring a PowerPC core and one based on the newly announced 68060. The 68060 is the end of the line for the 680x0 architecture in desktop systems, but FlexCore ensures it will prosper in embedded applications. **—Bob Ryan**

Whatever Happened to . . . ?

ScriptX (see "Kaleida Hopes that X Marks the [Multimedia] Spot," Microbytes, September 1992 BYTE)

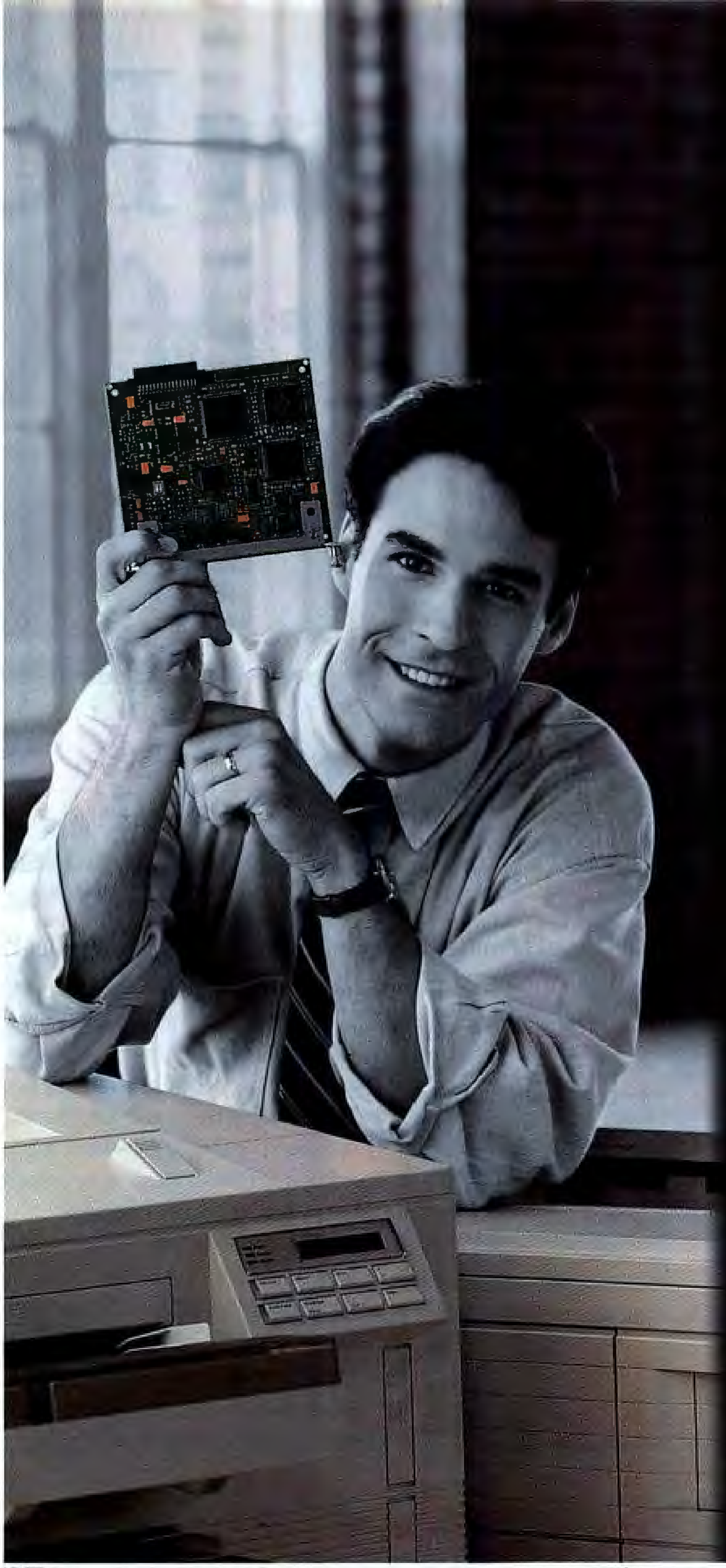
Kaleida (Mountain View, CA), the joint multimedia software company formed by IBM and Apple, is looking at September for the release of software development kits based on ScriptX, the company's object-oriented programming language for creating multimedia titles. The company says over 200 sites are currently working with prerelease versions of ScriptX.

The development kits will include Kaleida Media Player run-time engines that will enable software titles written in ScriptX to play on both Mac and Windows platforms. The company says it will eventually release run-time engines for OS/2, Power Macs, and Unix.

The unreleased COS (Consumer Operating System) and Malibu, a graphics acceleration and memory-control chip, are being "transitioned out of the company," according to Kaleida spokeswoman Diane Samples. COS and Malibu were part of an early PowerPC-based, interactive TV Hardware Reference Platform that Kaleida designed for its developer partners.

Simon (see "Simon Says: Communicate," February BYTE)

Officials at BellSouth Cellular (Atlanta, GA) don't have a release date for Simon, the communications-based PDA (personal digital assistant). "The wireless fax component on occasion will not complete," says Nicole Lipson, spokeswoman for the company. "It's a random problem that is extremely hard to pin down."



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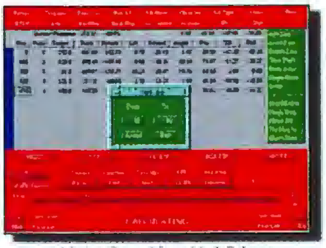
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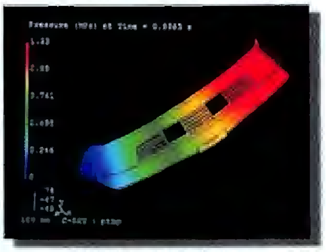
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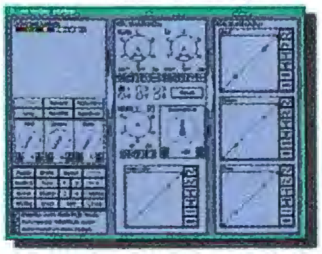
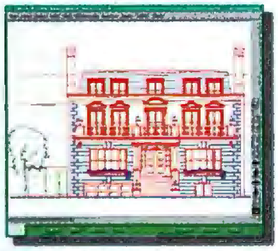

XV (Shareware) from John Bradley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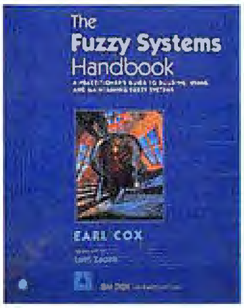
Put Fuzzy Logic to Work



JON UDELL

When it's time to roll up your sleeves and put fuzzy logic to work, Earl Cox can show you how to turn theory into practice. His excellent *The Fuzzy Systems Handbook* presents a complete fuzzy-modeling system (source code included) and explains how to use it. Suppose you want to construct a risk-assessment system. Ultimately, you want to be able to write and process rules like this:

If age is around 17, risk is very high; if age is young and number_of_accidents is above normal, risk is very high; if number_of_accidents is below normal, risk is somewhat low.

You start by constructing fuzzy sets for each input variable. The concept *young*, for example, yields a set of values over some range of ages from 16 to 85, such that 16 is 0.99 young, 36 is 0.42 young, and so on. The concepts *17* and *old* likewise produce sets of values, which are then altered by applying the modifying words *around* and *very*. Depending on the function you choose to generate it, a fuzzy set may appear as a bell curve, a triangle, or a trapezoid. What's the right function to use? Business applications seem to work best with nonlinear functions, and process-control applications with linear ones, Cox reports. However, you should keep an open mind and be prepared to experiment because this science is in its infancy.

Next, you apply the AND operator. Here, too, there's a choice of functions that you can use to produce an output fuzzy set that represents the intersection of a pair of input fuzzy sets. Cox recommends that you try the simplest first—the minimum of each pair of input values. Noting that a single low value in any input will heavily affect the output, however, he goes on to present a family of alternative AND operators along with their associated truth tables. Ultimately, rule processing maps the fuzzy input variables to the fuzzy output variable that represents risk, and "defuzzification" extracts a final number—if age is 19, number_of_accidents is 3, and distance_to_work is 35, risk might be 0.98.

Fuzzy logic is a calculus of everyday concepts. With Cox's toolkit and techniques, you can begin to compute using such concepts. It's up to you, of course, to figure out what *young* and *above normal* should mean. ■

THE FUZZY SYSTEMS HANDBOOK

Earl Cox
AP Professional
ISBN 0-12-194270-8

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Jon Udell is a BYTE senior technical editor at large. You can reach him on the Internet or BIX at judell@bix.com.

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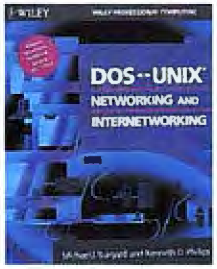

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NOT ROCKET SCIENCE

SPACE SHUTTLE PHYSICS—NEWTON'S LAWS OF MOTION **Britt Communications, 3311 Bob Wallace Ave., Suite 203, Huntsville, AL 35805, (205) 536-9967, $59.95**

Combining physics and the space shuttle in one package opens the door for exciting possibilities, but this particular attempt still needs polishing. To run it, you need a Mac with a 12-inch monitor (8 bits, 256 colors), 4 MB of RAM, System 7.0, and a CD-ROM drive. QuickTime 1.6.1 is provided. Double-clicking on the space-shuttle icon starts an animated sequence of a space-shuttle cockpit and a QuickTime movie of the launch. Once in space, you are in the cockpit animation, with choices for Shuttle System, Rocket Stuff, and Space Warp.

Shuttle System covers the history of the U.S. shuttle program from 1972 through the present and makes some educated guesses of where the program will be in the year 2000. Rocket Stuff explores Newton's laws and the various components of rockets. Space Warp presents the history of rockets and the space program in general in two sections: Early (1232–1940) and Modern (1940–2000).

The QuickTime movies displayed in a small window on the screen of a 14-inch AV monitor appear grainy and a bit jittery, with poor contrast at times, making it difficult to distinguish details. You get 4.8 MB of documentation on the CD.

The title implies that you will be able to learn about the physics of the space shuttle, but this assertion falls a bit short. You are introduced to Newton's laws in an elementary, incomplete—and in one instance incorrect—manner. The lesson on the Law of Inertia falls prey to mixing two frames of reference: an accelerating frame and a stationary frame. The resulting explanation of motion is misleading and incorrect.

Space Shuttle Physics provides a few hours of educational and entertaining material for folks who want more than a glimpse of the space shuttle on the evening news. But a more complete and correct exploration of the physics behind the shuttle would bring justice to the title.

—Hughes Pack

networks. Once the connection has been made, your PC can take advantage of the resources that Unix network users have enjoyed for years.

In a chummy style, Burgard and Phillips discuss nearly every hardware and software issue involved in this cross-platform connection. They briefly evaluate many products. They go into theory, practice, and installation needs for a host of methods.

The authors also explain many aspects of the Unix world and its services in terms that a DOS/Windows expert user will easily understand, for example, `getty` and `gettydefs`, UUCP, Unix E-mail, SNMP, PPP (Point-to-Point Protocol), and SLIP (Serial Line Internet Protocol). On the PC side, they cover network cards, multiport cards, IRQs (interrupt requests) and I/O memory addresses, the separate pieces to a PC-resident protocol driver, and hundreds of other issues and products.

The book doesn't limit itself to TCP/IP and IPX/SPX. There is also information on Banyan Vines, terminal emulations over serial connections, and Internet access providers.

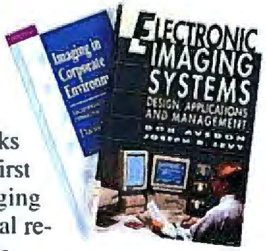
Burgard and Phillips' book does not have the technical depth that will let you develop products for making the connection between DOS and Unix. It covers only what you need to make the connection with products that already exist. It is *not* like so many network books: so much theory that you are better suited for writing a research paper than for making an actual connection. This book is all you need to make the connection real.

—Ben Smith

ELECTRONIC IMAGING

ELECTRONIC IMAGING SYSTEMS: DESIGN, APPLICATIONS, AND MANAGEMENT by Don Avedon and Joseph R. Levy McGraw-Hill, ISBN 0-07-002484-7, $40

IMAGING IN CORPORATE ENVIRONMENTS by Daniel Minoli McGraw-Hill, ISBN 0-07-042588-4, $40



McGraw-Hill has served up two books on the hot topic of imaging. The first is a would-be primer on electronic imaging systems; the second is a valuable technical resource on a wealth of image-related topics.

Electronic Imaging Systems is well organized and covers all the right topics. That's the good news. The bad news is that the book is very spotty: Authoritative, well-focused sections are intermixed with irrelevancies and misinformation. Further, the book wanders from topic to topic and occasionally serves up observations that appear to have been translated poorly from another language. For example, "Even for the fastest computers, getting data in and out of stored memory is as slow as the spin of a disk."

In the case of the book by Daniel Minoli (which is misnamed *Imaging in Corporate Environments*), an evenly weighted, comprehensive approach to the subject of electronic imaging was traded for a series of technically authoritative essays. That's the bad news. The good news is that the topics are appropriately selected, and the presentation of the material and analysis are generally superlative. ■

—Scott Wallace

Intel Technology Briefing

Pentium™ Processor Systems

Taking PCs To The Next Stage

KNOW A POWERFUL PC WHEN YOU SEE ONE.

If you want top performance from your PC, start with the top-performing processor: the Pentium™ processor from Intel. But if you want a truly exceptional PC, don't stop there. Today's best PCs are well-balanced systems with each component optimized to take full advantage of the processor's capabilities, highly tuned and working together to give you the best possible system performance. In this Brief, you'll learn what elements make a great PC.

A GREAT PC IS THE SUM OF ITS PARTS.

As processors become faster and more efficient, system designs have also continued to move forward. While some of the first systems introduced with the Pentium processor in mid-1993 were not designed "from the ground up" to take full advantage of its performance and features, today's PC designs are better.

Systems available now not only leverage the strengths of the Pentium processor, they also integrate other advanced features that, together, give you the best performance from the total system and give you a far more powerful PC than you get with an Intel486™ processor-based system.

HOW TO FEED A HUNGRY PROCESSOR.

The Pentium processor can handle data far faster than many memory systems can supply it. When that happens, the processor sits idle, which is a waste of a powerful resource. That's why it's critical to have a memory subsystem that can keep up with the data processing capabilities of the Pentium processor.

Well-designed memory systems can increase the flow of data in several ways. One key method is interleaved RAM subsystems. These are dual banks of memory that work together to supply data to the processor so it doesn't sit waiting. One bank provides data while the other prepares data for the next cycle; on the next request, they alternate roles.

A second-level, or off-chip, cache can also substantially increase memory performance in Pentium processor systems by retrieving data from the memory in bundles, instead of item-by-item, and making it readily available to the processor. More advanced caches use the write-back method. Unlike the write-through technique, the write-back design caches both information read from and written to RAM.

TO PROCESS FASTER, DIVIDE AND CONQUER.

While it's important that the processor be fed data and instructions as fast as possible, it's not necessary to have it involved in or controlling all of the computer's functions. High-performance PCs incorporate "intelligent" subsystems that increase efficiency by relieving some of the processor's workload.

One such subsystem is a disk drive that fetches data before the processor requests it (read-caching), and accepts data before the drive is ready to write it (write-caching).

Another key way of increasing performance is with a video graphics card that has the built-in ability to execute functions such as drawing lines, manipulating shapes and zooming in with only minimal instruction from the processor.

SEE PERFORMANCE ADD UP ALL ACROSS THE SYSTEM.

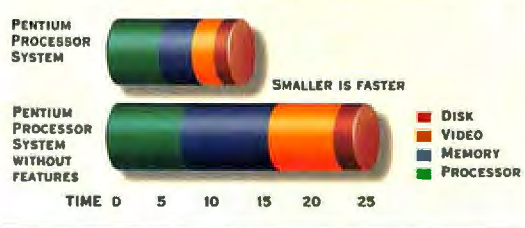
System features such as an adequate second-level cache, a PCI local bus, and a full-featured VGA card let the subsystems of a PC operate at maximum efficiency and performance. And that means the Pentium processor will too. The cumulative effect is a more powerful PC all the way around.

1. PENTIUM PROCESSOR

THE PENTIUM PROCESSOR'S ADVANCED SUPERSCALAR ARCHITECTURE ENABLES IT TO EXECUTE UP TO 166 MILLION INSTRUCTIONS PER SECOND, OR MIPS. (SEE BACK PAGE)

HOW KEY ARE SUBSYSTEMS?

WHEN THE SECOND-LEVEL CACHE, PCI LOCAL BUS, AND "SMART" VIDEO GRAPHICS CARD ARE NOT INCLUDED IN A PENTIUM™ PROCESSOR SYSTEM, APPLICATIONS TAKE SIGNIFICANTLY LONGER. WHILE THE PROCESSOR'S TIME IS ABOUT THE SAME, THE SUBSYSTEMS TAKE NEARLY THREE TIMES AS LONG.

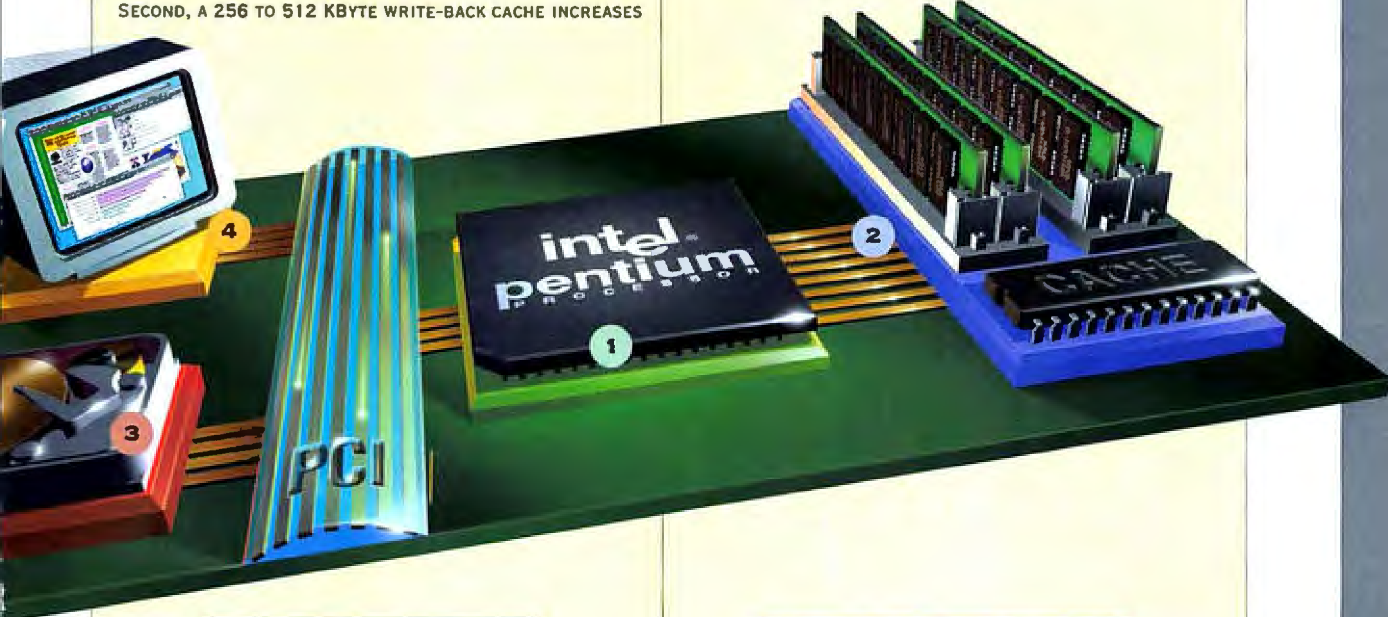


PENTIUM™ PROCESSOR SYSTEMS

PENTIUM PROCESSOR-BASED SYSTEM PERFORMANCE IS MAXIMIZED BY ADVANCED SYSTEM FEATURES IN EACH OF THESE MAIN AREAS.

2. MEMORY SUBSYSTEM

KEY COMPONENTS OF A MEMORY SUBSYSTEM ARE: LARGE FAST RAM, ADEQUATE SECOND-LEVEL WRITE-BACK CACHE, AND WIDE PROCESSOR-TO-MEMORY BUS. FIRST, A GOOD-SIZE (8 TO 32 MBYTE) RAM WILL ENABLE THE PROCESSOR TO EFFICIENTLY RUN LARGE APPLICATIONS AND ADVANCED OPERATING SYSTEMS SUCH AS WINDOWS,* OS/2* AND UNIX.* SECOND, A 256 TO 512 KBYTE WRITE-BACK CACHE INCREASES MEMORY PERFORMANCE BY HELPING COORDINATE THE SPEED OF THE PENTIUM PROCESSOR WITH THE SLOWER RAM. AND THIRD, A 64-BIT BUS INCREASES THE FLOW OF DATA BETWEEN THE PROCESSOR AND THE SYSTEM'S RAM AND MEMORY CACHE. A 30% OVERALL INCREASE IN SYSTEM PERFORMANCE CAN BE OBTAINED BY OPTIMIZING THESE MEMORY COMPONENTS AS SPECIFIED.**



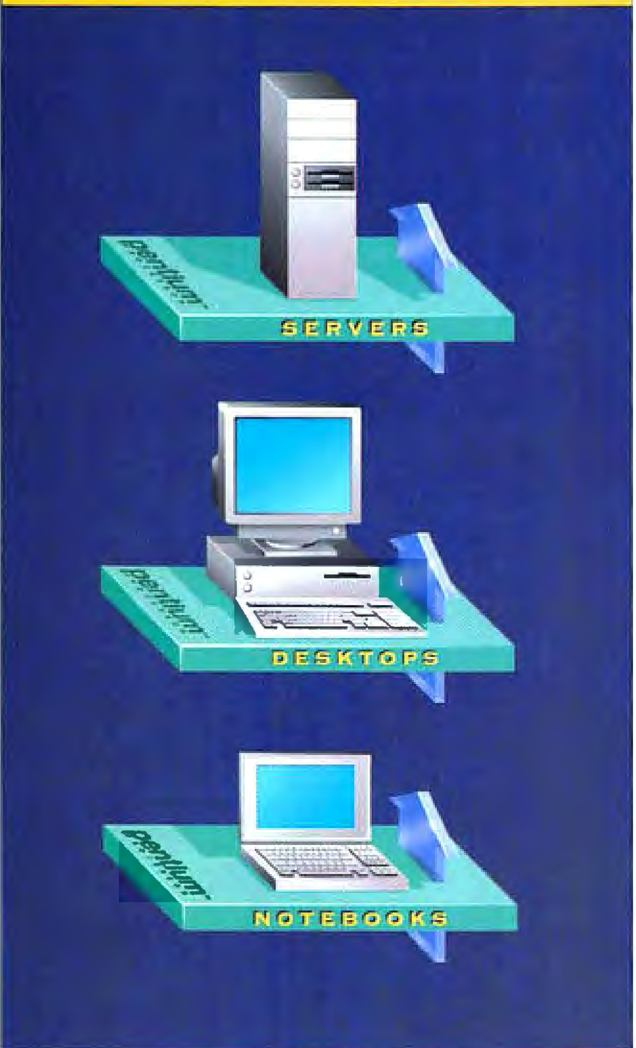
3. HARD DISK

HIGH-PERFORMANCE HARD DRIVES HAVE AT LEAST 340 MBYTES OF CAPACITY, PROVIDE AN AVERAGE SEEK TIME OF 12 MILLISECONDS, SPIN A MINIMUM OF 4,500 ROTATIONS PER MINUTE, AND HAVE A 128 TO 256 KBYTE HARD DISK BUFFER CACHE WITH BOTH WRITE-CACHING AND READ-CACHING CAPABILITIES. THESE FEATURES WILL ENSURE FAST DATA TRANSFER RATES. A HARD DISK WITH THESE SPECIFICATIONS CAN INCREASE OVERALL SYSTEM PERFORMANCE BY OVER 10%.

4. GRAPHICS & I/O SUBSYSTEM

THE PCI LOCAL BUS GREATLY IMPROVES I/O PERFORMANCE, ESPECIALLY GRAPHICS. THE PCI BUS CAN TRANSFER DATA BETWEEN THE PROCESSOR AND THE PERIPHERALS AT UP TO 132 MBYTES/SECOND, FAR FASTER THAN THE ISA BUS RATE OF 5 MBYTES/SECOND. A FULL-FEATURED, PCI-COMPATIBLE VGA CARD, WITH AT LEAST 1-2 MBYTES OF VIDEO RAM (VRAM), WILL FURTHER ACCELERATE GRAPHICS PERFORMANCE. THIS COMBINATION CAN INCREASE SYSTEM PERFORMANCE 43%.**

More Powerful Pentium™ Processor Systems on Every Level.



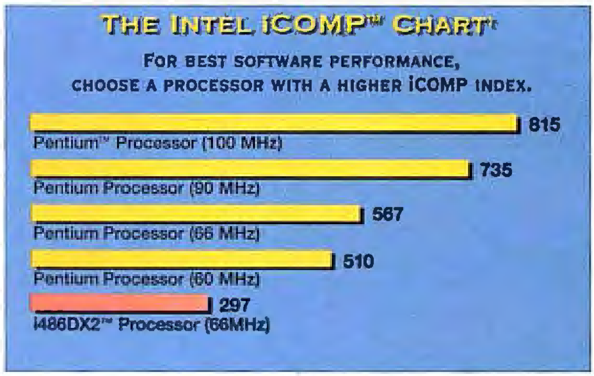
The Pentium processor combines the kind of performance normally reserved for high-end workstations with the flexibility and compatibility needed for desktop systems, and the low-power consumption necessary for notebooks. (Notebooks available late 1994.)

The Pentium™ Processor Family.

The Pentium processor family is designed to meet the needs of today's, and tomorrow's, sophisticated software applications. And while the Pentium processor has taken processor technology far beyond what was once thought possible, it's still guaranteed to be software-compatible with previous members of the Intel Architecture.

The Pentium processors increase performance over the Intel486 microprocessors by a wide margin. The performance of the Pentium processor at iCOMP index 815/100MHz, in fact, is over two and one-half times that of the Intel486DX2 at 66MHz. And we're still improving the Pentium processor, which in its next version will run at clock speeds of up to 150MHz.

In addition, since the Pentium processors at iCOMP index 735/90MHz and 815/100MHz are based on 3.3-volt rather than 5-volt technology, and have comprehensive power management capabilities, they're extremely energy efficient. Which makes notebooks and energy-efficient PCs ideal applications. These Pentium processors also have built-in dual processing capabilities that will allow system designs to run two Pentium processors in a single system, for an even more powerful PC.



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242091-001

Parallel Course

DICK POUNTAIN

STEVE KELLER © 1994

Nowadays several computers can generate realistic ray-traced images, and some of them can even do it fast. A rendering demonstration I recently witnessed was impressive for one special reason: The PC doing the rendering was executing the same ray-tracing program in parallel on an Intel 486, four Inmos T800 transputers, and four Mips R3000s. What made this feat possible was Taos (pronounced "dowse," as in the Chinese philosophy Taoism), a radically different, object-oriented parallel operating system.

Roots of Taos

Most operating systems are created either by large computer companies or by university researchers, but Taos is different—it's the product of a devoted group of enthusiasts with an idea that was well ahead of its time. The principal architect of Taos is Chris Hinsley, formerly a professional games programmer with hit titles for the Atari ST and the Commodore Amiga to his credit. Although writing solely in assembly language, Hinsley devised his own object-oriented development style based on macros, which sparked the original idea for Taos. Fired by the launch of Inmos's transputer architecture, Hinsley wanted to create a real-time operating system that could harness the parallel-processing power he believed would be needed for future multimedia systems.

The Taos operating system uses objects from the ground up to enable processors based on different architectures to work together on the same problem

When I first wrote about Taos in the International edition of the March 1991 BYTE, it seemed outrageously removed from the mainstream. Today, many of the concepts it is built on are showing up in the commercial operating-system world. Everyone wants a microkernel now, but Taos is already a nanokernel system, with its tiny 12-KB kernel running on each processor in a parallel network. Taligent promises objects from the ground up with dynamic binding; Taos has had them from the start.

One difference is Taos doesn't really aspire to mainstream desktop status; instead, it is a fast and skinny system for embedded applications. Tao Systems is promoting it into the multimedia and games console markets.

The Virtual Processor

By far, the most radical aspect of Taos is its hardware independence. Taos programs are all written in the machine code of a VP (virtual processor), which is called VPcode. The Taos kernel translates VPcode into the native machine code of each real processor immediately before running it—there is little or no run-time penalty, unlike earlier interpreted systems (e.g., the UCSD p-system), which were slow. Taos's fine-grained object orientation and dynamic binding makes this translation strategy feasible: VPcode modules are always small (typically a few hundred bytes), so they can be translated on the fly as they load from disk into memory. Huge monolithic applications like Excel or WordPerfect wouldn't lend themselves to this approach. But Tao Systems' translator supremo Andy Henson stressed to me that a fast modern CPU can actually translate VPcode faster than a hard drive can transfer data.

The imaginary VP is a 32-bit little-endian RISC machine with 16 registers. It supports data types from 8-bit bytes up to 64-bit double integers and 32- or 64-bit IEEE floating-point numbers. Hence, the VP is a reasonably good match to most real RISC chips like the Alpha, Mips, ARM, and PowerPC, if somewhat short of registers by today's standards. It supports around 60 simple RISC-like arithmetic, logical, and branching instructions, as well as a few special pseudoinstructions. These latter include TAO, which calls Taos kernel routines, and LIT, which marks literal data that needs to be translated (e.g., from little-endian to big-endian).

The Taos assembler, VPASM, outputs VPcode that you can run directly or you can convert to native code by manually invoking the appropriate translator. The listing "VPcode at Work" shows a sample of VPASM source code. Currently, Tao Systems has translators for the Intel 286, 386, and 486, the Inmos T800 and T9000 transputers, the Mips R3000, and the ARM 601. The PowerPC and the DEC Alpha are next in the pipeline; it takes around six worker-months to produce a new translator.

VPcode at Work *A sample tool written in VP assembly language. This tool changes the backdrop picture shown on the Taos GUI desktop to another bit-map file that you select from a browse window.*

```
include "tao.inc"

node bproc,CONTROLTP,0,TEMPLATE
      control 0,1024,DATATP,0,0,0,0
      component plmthd2-bproc
      compend
      tstring plmthd2,"DESK/BACKDROP"
nodeend bproc

node tl_b,TOOLTP,VP,TEMPLATE
      tool "DESK/BACKDROP"
      ;inputs
      ;r6=control object pointer

      allocstruct 80,r7
      loop
            ;request filename from user
            cpy r7,r0
            lea bpath,r1
            qcall GUI/GI_BROWSE
            breakif r8=0

            ;GUI will be parent
            inquire "BACKDROP",0
            breakif r8=0

            ;send name to backdrop
            cpy r7,r1
            qcall LIB/PA_SEND
      endloop
      freestruct 80
      ret

      string bpath,"BITMAPS/*.TBM"
      toolend tl_b
      nodeend tl_b

end
```

The Taos Object Model

Taos is a message-passing operating system whose software model is based on objects, processes, and messages. An *object* is a bundle of data and code that consumes memory, while a *process* executes an object and consumes processor time. The Taos hardware model involves multiple processors each with a local memory, connected by a network of communications links. Every processor in this network runs a copy of the Taos kernel and the translator from VPcode to its own native code. Whenever Taos creates a new object, it allocates the object to a processor and then starts a process to execute the object.

All Taos objects are constructed from variable-size blocks of contiguous memory called *nodes*. Each node contains two link fields so that the kernel can manage them in doubly linked lists. Nodes can contain data or code, and they have a type field that identifies the type of object they hold. Taos itself doesn't type-check the application of operations to data, although you can implement such type-checking at a higher level within an OOP (object-oriented programming) language.

While stored on disk or in transit over a communications link, nodes exist as unbound templates, but once nodes are loaded into memory, they are converted to "process-ready" form, and it's at this time that any translation of VPcode to native code takes place. The Taos kernel on a particular processor inserts a process-ready node onto a list of other process-ready objects, from where it can be processed according to the type of object it holds.

Tools, Control Objects, and Classes

Taos's predefined system object types are tools, control objects, bit maps, graphical objects, and class objects, but programmers are free to define new types. A *tool* is a node containing executable code that can act on the data contained in an object, to perform calculations or send and receive messages. A *control object* is the Taos equivalent of a program, consisting of one or more component tools that are executed in sequence. Control objects are the smallest unit of parallel distribution and execution under Taos. They are not, however, the smallest unit of memory management, because the kernel can retrieve individual tools from disk and make them process-ready. The kernel that creates a new control object distributes its template (using a special load-balancing algorithm) onto some processor, which starts a process to execute the object. When the last component of the control object is finished, the control object closes, and its process terminates. Every component has at least two tools associated with it: one that executes the component and one that cleans up after it dies.

A control object's template contains only the text names of its component tools, not their actual code. When the kernel creates a new control object, it first checks whether any of these specified components are already in memory, and if so, it just points to them—otherwise, it fetches them from disk and makes them process-ready (first translating them, if necessary). Binding under Taos is thus fully dynamic so that no module gets loaded until it is needed and only one copy is ever present in memory. The Taos processes that execute control objects are lightweight, equivalent to "threads" in operating systems like OS/2, and more than one process can share the same tool's code in multithreaded fashion.

Class objects provide the highest level of organization under Taos. A class encapsulates a group of message-passing objects that can run in parallel, hiding them behind an OOP method interface. Users of classes like Window or PolygonWorld make method calls to the class object (e.g., to open a new window) and are shielded from the complexity of the underlying parallelism that's generated by the execution of the objects hidden within the class.

The Kernel and Memory Management

The simplest version of the Taos kernel is just 12 KB in size and is responsible

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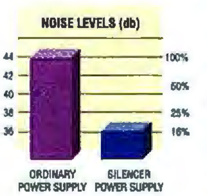

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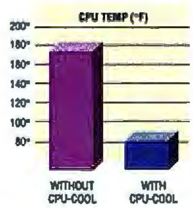

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for multitasking (via a time-sliced process scheduler), memory management, and the mail and naming systems. Tao Systems is working on a Posix-compliant version of the kernel that implements virtual memory and memory protection on microprocessors that have suitable MMU (memory management unit) hardware, but the 12-KB version does not offer these features.

All executable code in Taos is contained in tools, apart from the small bootstrap loader on each processor that must be in native code. Even the kernel itself is built from tools and is largely written in VP-code. Device drivers are just like any other process, running outside and in parallel with the kernel. Link drivers running outside the kernel handle all I/O messages, although the kernel handles some local I/O support mechanisms such as data caching.

A process called the Migrator, which runs outside the kernel, is responsible for relocating tool objects in memory and for incremental garbage collection. The lifetime of a Taos tool in memory is determined by its status, according to four different degrees of volatility:

1. Virtual tools are loaded, translated, and bound only when another tool calls them. The translated code remains in memory until the tool's reference count (which the kernel keeps) falls to zero, after which the kernel can flush the code whenever it needs memory. The kernel may relocate a virtual tool at any time.
2. Nonvirtual tools get loaded and bound at the same time as the tool that references them, and they remain in memory, exempt from relocation, for at least the lifetime of their caller.
3. Semivirtual tools are loaded and bound only when called, like virtual tools, but they then remain in memory like nonvirtual tools.
4. Nonvirtual tools can be flagged as *embed*, which causes the translator to embed them as in-line code in their caller's code. This is a speed optimization that is extensively used in the kernel code.

Taos Kernel Calls

This selection from among the 64 Taos kernel calls gives some impression of the kind of services that the kernel provides.

Mailbox Management

SENDMAIL	Send a mail message.
COPYMAIL	Copy a mail message then send the copy.
READMAIL	Read a mail message from a mailbox.
READTYPE	Read a mail message from a mailbox; wait until specified type arrives.

Control Object Management

STARTCONTROL	Start a control object locally.
OPENCONTROL	Create a control object and start locally.
OPENCHILD	Create, distribute, and start a control object in the network.
OPENARRAY	Create, distribute, and open a number of different control objects.
OPENFARM	Create, distribute, and open multiple instances of a control object.
OPENDEVICE	Create and transport a control object to a specified processor and start it.
OPENGLOBAL	Create, distribute, and open multiple instances of a control object. Guarantee one control object on every processor.
OPENREMOTE	Create and transport a control object to a specified processor for distribution from that processor, then start it.
OPENPIPE	Create, distribute, and open a pipeline of control objects.

Tool Object Management

VCALL	Virtual call tool object.
OPENTOOL	Request tool object load.
CLOSETOOL	Close tool object.
FLUSHNAMES	Flush named tools from local tool list.
FLUSHTOOLS	Flush nonreferenced tools from local tool list.
UNCLOSETOOL	Increments a tool object's reference count.

General Object Management

VADDR	Obtain address of embedded object.
OBJPROC	Process an object using the existing thread.
LISTPROC	Process a linked list of objects using the existing thread.
LISTTEST	Search list for types of node.

Processor Type ID and Mailbox ID

FINDTYPE	Inquire processor ID of a processor node of specified processor type and with a minimum memory requirement.
GETMYID	Inquire mailbox ID of own control object.
GETPARENT	Inquire mailbox ID of parent control object.
GETSERVER	Inquire server mailbox ID for an object.
NETINFO	Inquire processor and network information.

Message Passing

Because Taos does not support shared memory, the only way for objects existing in the address spaces of different processors to interact is by exchanging messages. The lightweight asynchronous mail system works through just two kernel operations, SENDMAIL and READMAIL, and it's nonblocking so that the sender continues executing without waiting for a reply.

All Taos messages are sent to mailboxes belonging to processes, which act as queues for incoming messages. When a control object is created and executed, it automatically receives a default mailbox, whose mail address is simply the ID of the child process that executes the object. The new control object can then send mail to any other object whose mailbox address it knows—every object knows the address of its own children, parents, and named resources like disk drives and CRT displays. Messages may contain a whole list of successive destination addresses for forwarding, along with the address of their sender in case a reply is requested.

Taos messages are assigned distinct types. The kernel reserves 16 types, which include arrays, streams, and executable code; error and debugging data; and screen refresh, mouse, and keyboard events. A further 16 types are free for programmers' use. The kernel on each processor handles all incoming mail for its local objects, all outgoing mail, and mail to be forwarded to another

processor. The typing system enables the kernel to trap system messages (e.g., executable code) and also allows user-defined objects to prioritize the way they read their waiting mail. Objects can employ the READMAIL kernel call to read messages from their mailbox, adding a list of the desired message types as a parameter. The result of such a call might be a message of the required type, or the news that there are no such messages—if the mailbox contains no messages at all then READMAIL suspends the calling process until some mail arrives so that you can use mail messages to awaken sleeping objects.

Bearing a passing resemblance to Motif, the Taos GUI is actually a class object that requires just two hardware-specific primitives to work with any display type.

Taos's link drivers hide the details of the physical transport mechanism that implements the communications links from user programs (although real-time performance issues may sometimes intrude). In the rendering demonstration I mentioned earlier in this article, the transputers were connected via their serial links, while the Mips R3000 chips were connected together through FIFO (first-in/first-out) chips, and all of them talked to the 486 host CPU via the PC's VL-Bus.

Execution in Parallel

Taos is a fully distributed operating system that doesn't attempt to exert central control over the execution of parallel applications. Obviously, in practice, you must pick out one processor from which to boot the system, but once all the kernels are booted Taos programs tend to spread out over the network of processors in an almost organic manner, controlled by a distributed load-balancing algorithm. If you examine the "control object management" subsection in the text box "Taos Kernel Calls" on page 56, you'll see the kind of services that are available for spawning remote processes. These kernel calls use the mail system to transfer executable VPcode from one processor to another.

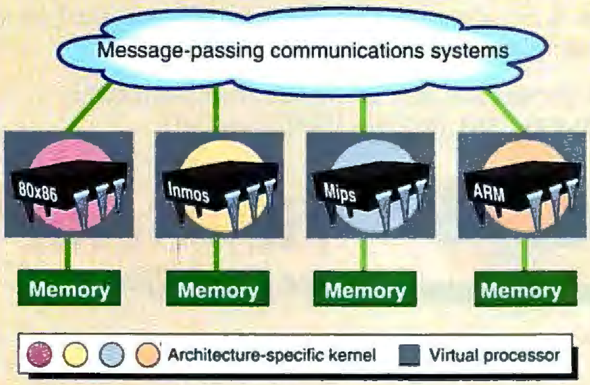
Information about the system's performance and current loading is stored in the link drivers that control each communications channel. At boot-up, each link driver benchmarks the processors to which it's attached (by timing the VPcode translator). This number is then divided by the number of processes currently running to give a measure of available power for each processor. The automatic load-balancing algorithm uses these power figures in the allocation of new processes. When a tool object arrives at a processor, the local kernel inspects all the links leading outward and asks "is there one of my nearest neighbors who's got more spare power than I have?"—if so, the object is passed on; if not, it executes here.

Applications that dynamically spawn many parallel processes spread out like water running down a mountain, the flow seeking out the lowest points, or *gullies*, in processor-loading space.

Each link driver also maintains a table of encoded information about the network topology, used by the kernel to route messages. These tables are dynamically updated at run time so that if a new processor is added to the system, news of its existence spreads outward like a wave. The nature of the routing algorithm reduces the probability of deadlock due to circular message paths, and it can usually find multiple paths between two processors (if they exist), which provides a degree of fault tolerance if a link fails.

A programmer can always override the automatic load balancing and allocate objects to specified processors, by using the OPENDEVICE or OPENGLOBAL calls, while OPENREMOTE invokes a partially automatic mechanism where you explicitly send many objects to a particular processor but let Taos distribute them automatically from there. For example, you could specify that a 1000-process ray-tracing calculation should be run by sending groups of 100 objects to 10 different processors, with Taos completing the distribution.

The Taos Architecture



The Taos operating system runs on a virtual processor. Hardware-specific kernels translate Taos VPcode into native code. The virtual processors communicate using an object-based message-passing system.

The Parallel PC

Although Taos can support its own file and display systems, the current release version is PC-hosted, using the MS-DOS file system and an SVGA graphics adapter for display. I received Taos on six 1.44-MB floppy disks, although more than three of these were filled with bit maps and MPEG animations. I was able to run Taos happily on my 486DX2\66 Elonex PC as a single-processor operating system, coexisting on the same hard disk with Windows (though hardly surprising, it would not run under Windows).

Taos comes with a very simple GUI whose look and feel is loosely modeled on Motif. Control objects that you store in the Taos/Control directory automatically appear on a pop-up menu from where you can execute them with a mouse click. To supplement this GUI, you can open a shell window and use a command-line interface, with a syntax that resembles DOS. But unlike DOS, Taos command lines represent genuine pipelines in which each successive command launches a separate process whose output is fed to the next.

continued

The most immediately striking attribute of Taos is its blazing graphics speed; you can grab a window in which an image is being ray-traced and whirl it vigorously around the screen while tracing continues unhindered. The GUI, which is packaged as a Taos class object, works with a device-independent virtual screen with only two hardware-dependent primitives to put and get bit maps to the real screen. Apart from SVGA adapters, Tao Systems currently implements the GUI for several of Inmos's graphical TRAMs (transputer modules). Processes running on remote processors can open screen windows by sending messages to the processor running the GUI, rather like a lightweight version of the X Window System.

In addition, Taos encapsulates the MS-DOS filing system within its own object model so that DOS hard drives are mapped into Taos servers; therefore, you can send messages about the objects the servers hold. For example, a control object called Trace.Ctl, which is referenced in Taos by the message \@PC1\Control\Trace, is simply the DOS file C:\Taos\Control\Trace.Ctl; @PC1 is a Taos server object that aliases my C:\Taos directory.

Taos Directions

At present, Taos is deficient in the sort of development tools that Unix or DOS programmers expect to find—the small Taos team has devoted most of its time over the last two years to getting the kernel and VPcode translation system robust and to building a variety of graphical tools for manipulating and displaying ray-traced images and MPEG animations, all written directly in VPASM assembly language. There's a BASIC compiler that uses a QuickBasic-like dialect but as yet no C compiler; however, there is a library called the Taos HLL Toolset, accessible from VP assembly language or BASIC, which provides the functionality of the ANSI C library including `malloc`, `sprintf`, `fscanf`, and others. Work is under way on an in-house C++ implementation.

The much hyped "multimedia revolution," which puts a new premium on inexpensive but high-performance graphics, may prove to be a window of opportunity for Taos. SGS-Thomson/Inmos has made a technology sharing agreement with Tao Systems to use Taos on its next-generation processors (code-named *Chameleon*) in the games, visualization, and multimedia markets.

Tao Systems is negotiating with a large Japanese communications corporation, which is evaluating Taos as an operating system for the TV set-top boxes that will control the new domestic multimedia services. These units will have to decrypt, decompress, decode, and otherwise mangle real-time data streams for "video-on-demand," videophone communications, and other services yet to be invented. This will require large amounts of processing power but must be delivered at domestic electrical-appliance prices. A small, hardware-independent parallel operating system begins to look very attractive; you can shop around for this week's best processor deals and issue inexpensive upgrade cards to provide more processing power. ■

Company Information

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Circle 976 on Inquiry Card.

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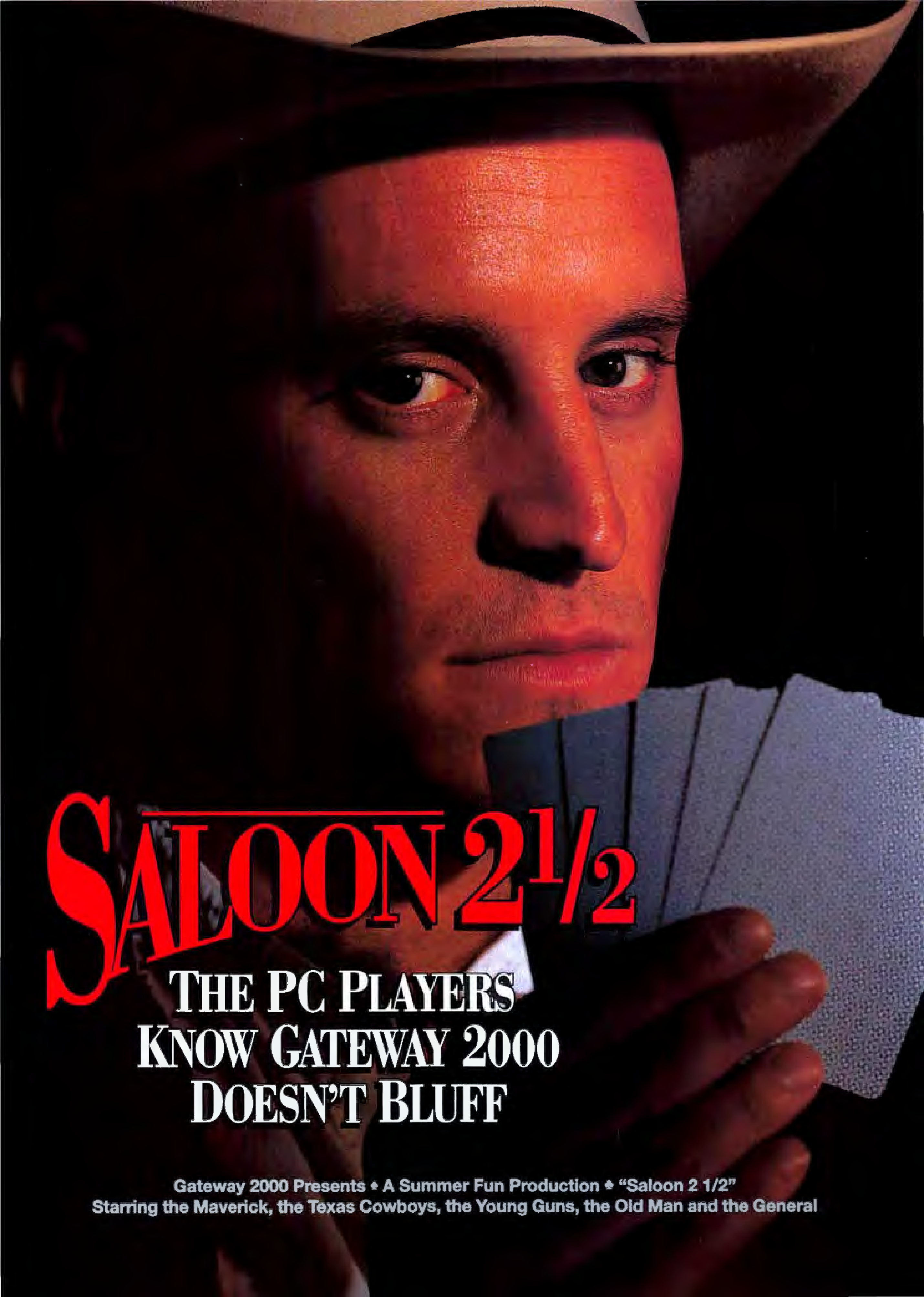
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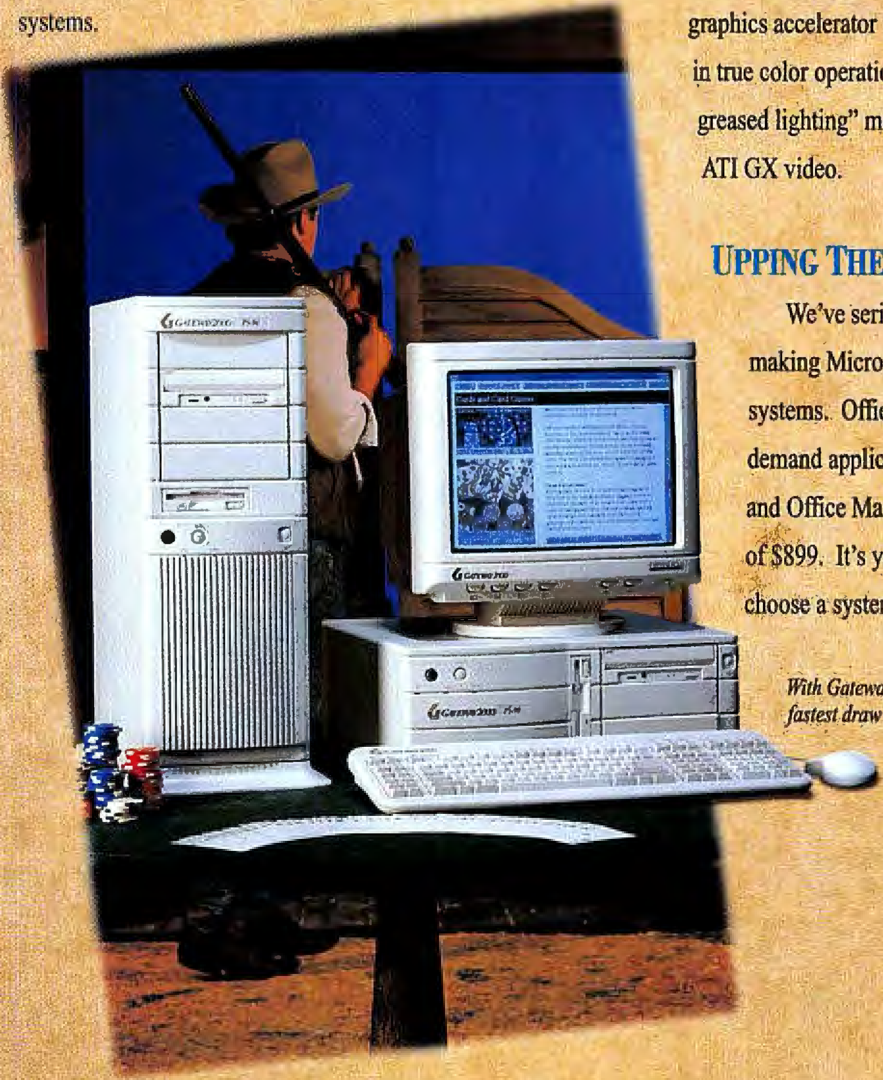

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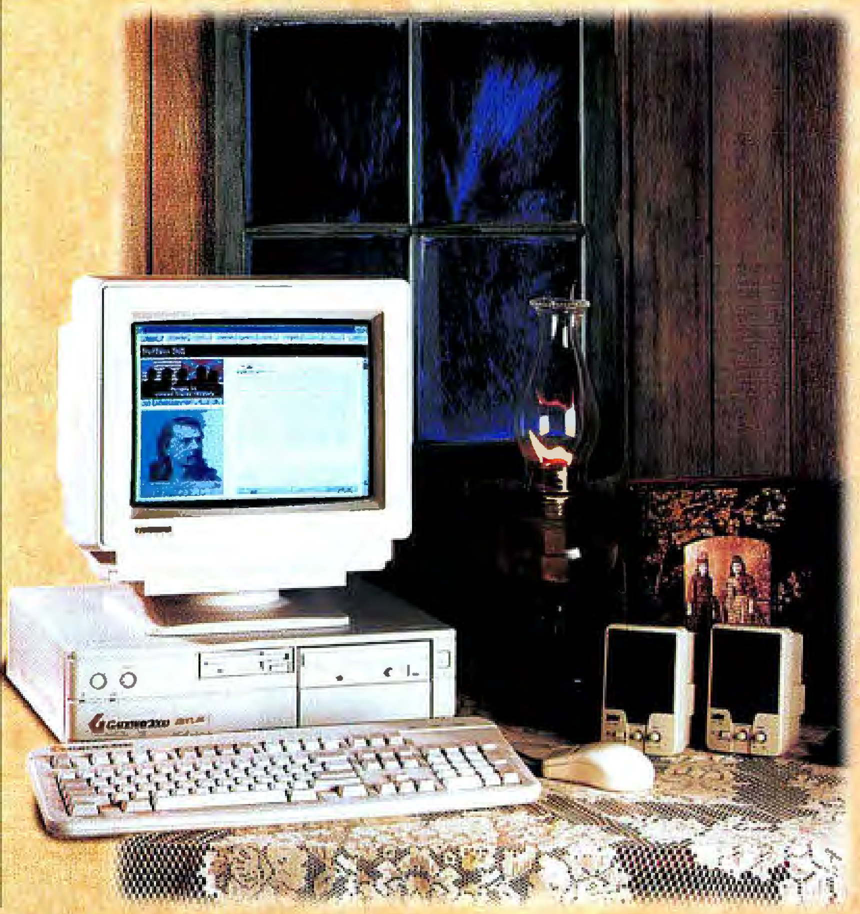

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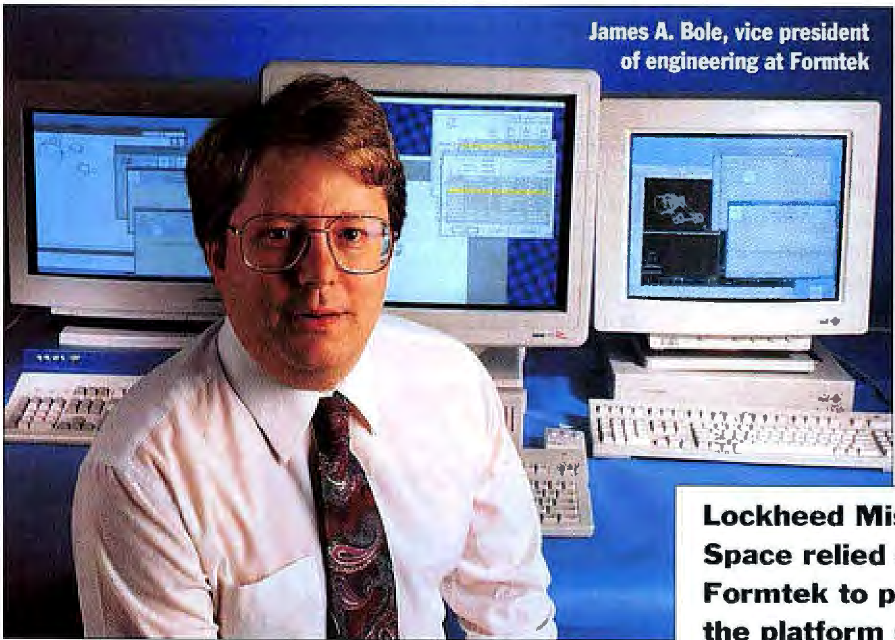
SCOTT WALLACE

For LMSC (Lockheed Missile and Space Corp.), the challenge was clear, though hardly simple. The DoD (Department of Defense) wanted a new missile and wanted it fast. Up for grabs was a $688 million program to not only design and develop a new missile but also demonstrate and validate accelerated engineering techniques that could be used in other DoD programs.

To engineer the missile within the DoD's 24-month time frame—five years is the usual—LMSC needed to change the way it designed and engineered missiles. It also needed a sophisticated engineering data management system, which it didn't have time to develop on its own. The system would have to be able to route engineering documents to engineers working on a variety of platforms to capture their comments and input for the engineering review process. After extensive review of a variety of systems, LMSC fired off a fax to its six short-list vendors in September 1992, which consisted of a lengthy survey of the vendors' systems, software, services, and future strategies. If vendors wanted to remain in the competition, they had to respond within 72 hours. This was LMSC's first test of the vendors' readiness to support a program whose success depends on squeezing time out of an already highly compressed schedule.


James A. Bole, vice president of engineering at Formtek

Lockheed Missile and Space relied on Formtek to provide the platform support for the program

Concurrent Engineering

Key to the U.S. Army's Thaad (Theatre High Altitude Area Defense) "kinetic kill" interceptor missile program is concurrent engineering or, as it is called at LMSC, IPD (integrated product development). An Institute for Defense Analysis report, *The Role of Concurrent Engineering in Weapons Systems Acquisition*, defines IPD as "a systematic approach to the integrated, concurrent design of products and their related processes, including manufacturing and support. This approach is intended to cause the developer, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements."

The Thaad program is LMSC's first production use of IPD. Since the award of the Thaad contract to LMSC in October 1992, the program has depended heavily on a combination of methodology and technology to stay abreast of a 24-month schedule that calls for design, development, and prototype manufacturing of a completely new type of missile (see the figure "IPD Uses Teaming and Technology to Compress Time"). In the past, this phase would have had a duration of five years or more.

LMSC relied on its IBM 3090-based computer-integrated engineering and manufacturing systems during previous missile development programs and initial preaward planning targeted them to support the Thaad project as well. Problems with this approach surfaced quickly. One problem was cost: Mainframe services turned out to be beyond the budget of the program, which targeted client/server price and performance and was built on client/server technology. Another more important problem was functionality: The mainframe system was geared toward local workgroups and could not be suitably restructured to support the large, geographically dispersed teams on this highly classified project. In addition, the Thaad project called for multicorporate teaming—something new to LMSC on this kind of program. Efforts to modify and enhance in-house mainframe services to support the Thaad development agenda were unsuccessful. However, in the process, a clear understanding of the program's needs was developed, making LMSC well prepared to specify its system and evaluate vendors to support the Thaad project.

Thaad Information Management System

The principal TIMS (Thaad Information Management System) selection criteria included seamless support of existing applications and a uniform user interface—no matter which of many

Design

Thaad platforms the application was running on. Within a month of sending out its fax survey, LMSC had made a decision. From a list of vendors that included IBM, Control Data, SDRC (Structural Dynamics Research Corp.), Sherpa, and Interleaf, LMSC selected Formtek, a Pittsburgh-based engineering document management vendor that spun-off from Carnegie Mellon University in 1982. The approximately $2.5 million contract called for Formtek to provide LMSC with software (40 percent of contract value), as well as software development and support services (60 percent of contract value) over a two-year period. No hardware was involved in the deal.

To keep this complex project as simple as possible, LMSC basically layered Formtek's engineering data management software onto its own networks and desktop infrastructures—which LMSC was expanding to support the Thaad project. The resulting system would support Mac, Silicon Graphics, DEC, Hewlett-Packard, IBM RS/6000, and PC workstations, as well as all the information environments and data types found on the Thaad project. Users primarily run engineering applications supported by FDDI (Fiber Distributed Data Interface) backbones for data transfer and Ethernet LANs for user connectivity. Sited on LMSC's campus in Sunnyvale, California, the Thaad program is classified and operates out of restricted-access facilities replete with "secure and reliable" networks and computing systems, in addition to a "data fire wall" that protects the project's information resources from intrusion.

You Don't Have to Be a Rocket Scientist

The principal purpose of TIMS is to improve and expedite the design-review process. This boils down to managing a wide variety of electronic documents and supporting their on-line review on various platforms by many different people, who can't or won't invest the time to come up to speed on applications. "These people are rocket scientists. They're busy, and they don't want to learn how to use some new piece of software," said Mark Kadrich, network systems manager for the Thaad program at LMSC. "Some users are just beginning to master E-mail, messaging, and conferencing. Layer on top of that an automated meeting system, and you have some very confused users."

The combination of novel applications, mixed user skills, and an extremely tight development schedule helped to keep everyone focused, including those in charge of developing and supporting TIMS. "The goal was to help the program: We were not trying to develop an information management system for its own sake," noted Kadrich. Building the review environment on in-place networks, workstations, and user-applications skills meant that a minimum of implementation support and training was required—and a minimum of user resistance was generated. All this was critical, because the system needed to be operational and pulling its weight less than four months from the contract award.

continued

OVERVIEW

Aggressive schedules are old hat at LMSC (Lockheed Missile and Space Corp.), but the U.S. Army's Thaad missile program was something else. It required an order-of-magnitude improvement in product development cycle time.

Concurrent engineering, or IPD (integrated product development), fit the bill. Rather than a linear development process, teams with complete responsibility for major subsystems would operate in parallel. If this teaming approach could be successfully coupled with a system supporting on-line conferencing and design reviews, it would be possible to support the program's aggressive schedule.

For its engineering data management system, LMSC needed seamless support of in-use applications and a uniform user interface on Thaad program platforms. Existing classified and secure networks would support in-place desktop systems running a new engineering information management system capable of managing both informal work-in-progress electronic discourse and formal design reviews. Over time, the system would be linked through a secure, encrypted channel to a similar, nonclassified system.

LMSC selected Formtek in late October 1992, after a rigorous qualification process. By February 1993, the vendor had its prototype system in place.

SYSTEMS VIEW

A wide array of platforms and applications are used at LMSC to develop design and engineering documentation—everything from a Cray supercomputer to IBM mainframes to Hewlett-Packard and DEC workstations to PCs and Macs. Applications include CAD/CAM, geometric modeling, and finite analysis, as well as database, drawing and presentation, project management, spreadsheet, word processing, and process-planning packages.

FDDI (Fiber Distributed Data Interface) backbones and Ethernet TCP/IP LANs connect nearly 800 users and provide the infrastructure for TIMS (Thaad Information Management System). Based on existing workstations, networks, and applications, TIMS leverages the skill sets of its users and over time, has been contoured to its users' needs.

Primarily a Mac and Unix client/server environment, TIMS supports a variety of engineering data and document management functions. As the Thaad program matures, it will be necessary to link TIMS to legacy manufacturing and purchasing systems.

PROJECT VIEW

A dynamic partnership between LMSC and Formtek supported the development of the program's keystone application: design review. Without this, the Thaad two-year development program would have taken five years to complete. Because a new development methodology was being put in place, neither users nor managers had a proper foundation for assessing their needs.

LMSC can now record and archive the product development process, resulting in a chronology of each design's evolution and a repository of practical engineering processes. Because IPD methodology grants complete responsibility to design teams (including budget and purchase commitments), the ability to play back and analyze the overall development process made LMSC confident that it would be able to contain its costs and meet the objectives of the program.

A variety of problems—ranging from process overmanagement to enterprise-wide changes in E-mail systems—threatened to delay the program, but the Thaad project is on track, and TIMS, its support system, continues to perform above expectation.

Partnering for Real

Another important selection criterion was the vendor's willingness and ability to support the needs of the Thaad development effort—tested many times during the procurement process. "At the beginning of the program, not all of the technology was available to do what we needed," Kadrich said. While Formtek's software supported a design-review process, its support wasn't optimized for the IPD processes at LMSC or for the Thaad-style review the project required.

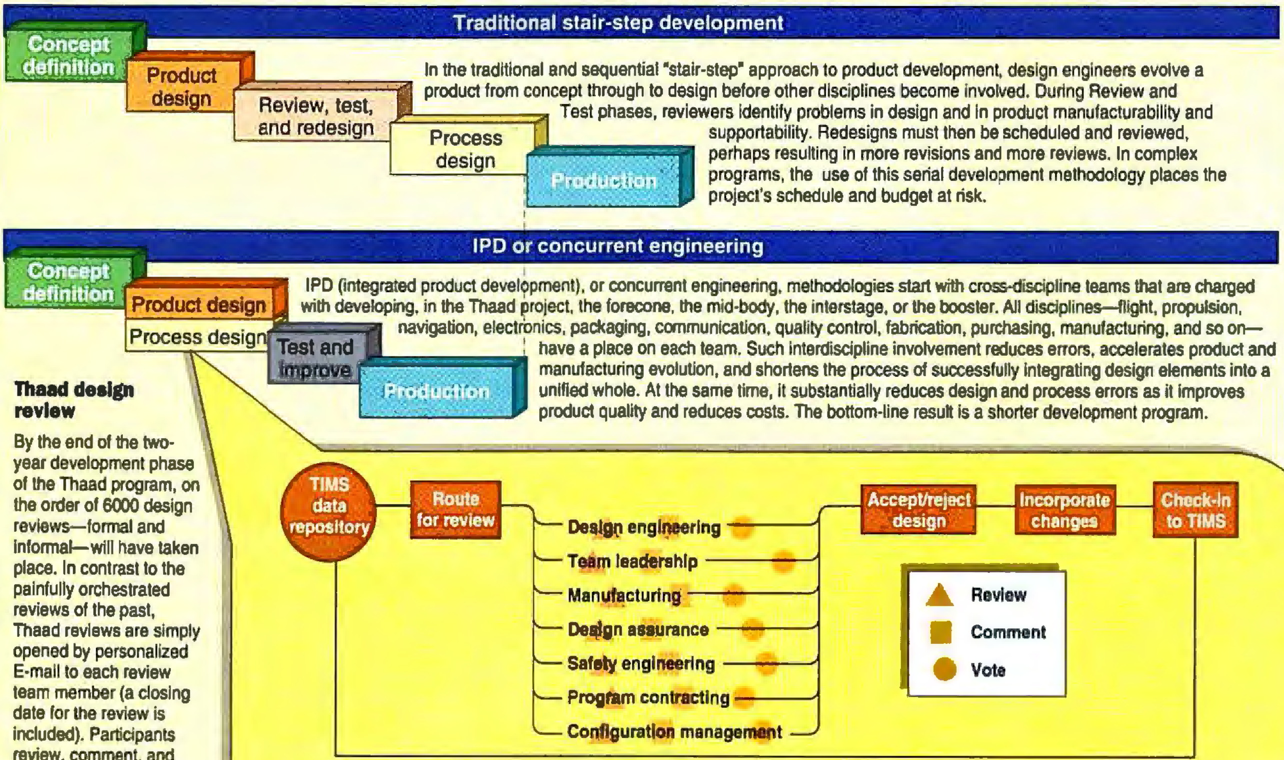
That wasn't the only vendor issue on this fast-moving, highly adaptive program. "For us, requirements are going to change; we honestly believe that the implementation should be iterative. We knew that as program requirements changed and user requirements changed and the users began to really understand the system, we were going to have to go back and retool," said Kadrich. User acceptance—from a community ranging from computer illiterates to computer masters—was critical. "We felt that by getting the users to buy in from the very beginning—finding out what they thought was important, changing the system, and feeding it back to them—we would be more successful."

How could LMSC go about getting the vendor support it needed when it was needed, if the nature of that support kept changing? "We decided to make the vendor part of the team," explained Kadrich. "We really had to work together in an environment that includes just about every discipline you can imagine. So we sat down and from scratch, developed a module that allows people to check in, review, mark up, and circulate a document in an integrated product development environment."

To do this, LMSC selected one of the program's four product development teams to help. "We chose the interstage product development team as a model," said Barbara Victorino, Thaad system administrator. The *interstage* is a complex portion of the missile and would present broad challenges to the review effort. Victorino adds, "We went to them and asked what would help them do their job better and faster; what would help them communicate more efficiently with each other?" Based on these iterative discussions, the design-review module specification was completed.

Formtek played an active support role during the design-review module requirements analysis, but followed LMSC's lead when it came to specifying the system. "The Thaad program provided a solid opportunity for us to make enhancements in our system—enhancements driven directly by customer requirements," said James A. Bole, vice president of engineering at Formtek. During this development effort,

IPD Uses Teaming and Technology to Compress Time



In the traditional and sequential "stair-step" approach to product development, design engineers evolve a product from concept through to design before other disciplines become involved. During Review and Test phases, reviewers identify problems in design and in product manufacturability and supportability. Redesigns must then be scheduled and reviewed, perhaps resulting in more revisions and more reviews. In complex programs, the use of this serial development methodology places the project's schedule and budget at risk.

IPD (integrated product development), or concurrent engineering, methodologies start with cross-discipline teams that are charged with developing, in the Thaad project, the forecone, the mid-body, the interstage, or the booster. All disciplines—flight, propulsion, navigation, electronics, packaging, communication, quality control, fabrication, purchasing, manufacturing, and so on—have a place on each team. Such interdiscipline involvement reduces errors, accelerates product and manufacturing evolution, and shortens the process of successfully integrating design elements into a unified whole. At the same time, it substantially reduces design and process errors as it improves product quality and reduces costs. The bottom-line result is a shorter development program.

Thaad design review

By the end of the two-year development phase of the Thaad program, on the order of 6000 design reviews—formal and informal—will have taken place. In contrast to the painfully orchestrated reviews of the past, Thaad reviews are simply opened by personalized E-mail to each review team member (a closing date for the review is included). Participants review, comment, and vote item-by-item electronically, whenever they wish and from their workstations—without the overhead of traveling or synchronizing schedules. The Thaad program could not have been supported without such substantial improvements in the review process.

REVIEW During design document review, team members receive an E-mail alert that review materials are pending. At their convenience, the users review materials (supported by a full gamut of desktop tools including the ability to "redline"), drawing and commenting on design documentation without affecting the original. The Thaad system relies on Formtek software to provide a common user interface to raster viewing and support services on a broad range of platforms, including SGI, HP, DEC, Sun, Mac, and PC workstations. This permits the reviewer to call up any design documents—from "tiles" (or single-screen subsections) of J-size engineering drawings to text addenda to manufacturing specifications.

COMMENT As a part of the overall design-review process, users are able to enter comments (associated with a particular document element) that become a part of the design-review record. These can be substantive comments stating objections to a design or describing problems likely to occur, or they can be references to resources or other findings. This repository of comments turned out to be a rich and readily mined vein of highly focused information.

VOTE After considering and commenting on materials, reviewers vote to approve—or disapprove and revise—each design. The tabulation process is automated, and status of the review—who read and did what when—is instantly available.

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F760i-W	21"	0.28mm	H:30-78kHz V:55-90Hz	1280x1024
F560i-W	17"	0.26mm	H:30-82kHz V:55-90Hz	1280x1024
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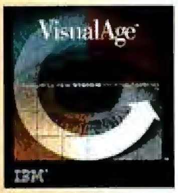

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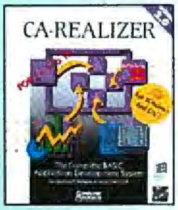

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PRODUCT OF THE MONTH

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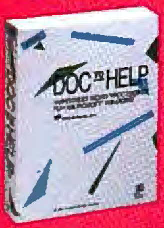

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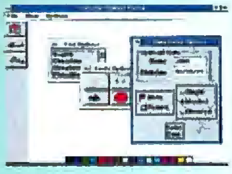

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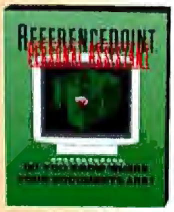

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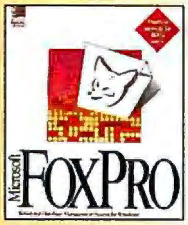

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Formtek extended its platform support and enhanced its user interface—efforts designed to better support Thaad design-review requirements.

Design Review: Old and New

In development efforts preceding Thaad, a set of engineering drawings would be posted on a sign-off board and engineers from all disciplines would review it and mark it up. Over a two- or three-week period, designers representing six disciplines would "redline" the drawings with their comments and corrections. Then, the principal designer would incorporate those changes into the original design, post the drawings on the sign-off board, and the process would start again. When a drawing set was reviewed without change, it was accepted. Typical duration for a design review was two weeks.

Under the Thaad program, a new review regimen was instituted. (And a good thing, too, because the program has completed more than 4000 design reviews since October 1992.) Because the TIMS design-review system was built around workstations, networks, and electronic documents, it supported on-line review, making it possible to route the drawings to the people, rather than the other way around. Furthermore, reviewers could request and review design documentation from their own terminals when they wanted. The net result, according to Kadrich and his staff, was a dramatic shortening of review duration (to as little as three hours in some cases) and a dramatic improvement in review—and design—quality.

> **"The Thaad program provided a solid opportunity for us to make enhancements in our system—enhancements driven directly by customer requirements."**
>
> —James A. Bole

The TIMS design-review process has three basic steps: review, comment, and vote. Design reviews can be *formal* or *informal*. If the design review is formal, it includes a binding "vote," during which each reviewer registers his or her judgment as to whether the design is "flight ready" or not. If the review is an informal gathering of opinion and comment, voting is not required.

At the beginning of a review, users receive an E-mail alert that materials are staged and awaiting review. On request, reviewers are presented with raster images of documents on their workstations and use redline tools to mark up the documentation—from J-size engineering drawings to standard-size pages of text.

During the comment phase, users enter their comments concerning the drawings, specifications, and so on, for inclusion in the formal record of the review. This repository of comment information turns out to be very valuable for two reasons. First, it enables the historical capture of information that is driving the design, rather than capturing just the end-states of the review process. This makes it easier to identify improvements—and problems—and trace them back to their origins. Second, it enables LMSC to enhance and improve the Thaad review process itself. "One of the challenges we have is to develop a better way to do business," said Victorino. "TIMS is helping us take each step of the process, analyze it, and gather data." The result is ongoing improvement in the design-review process.

Wisdom Archive

Maintaining a complete and comprehensive log of review, comment, and vote activities does more than simply "record" the project, it enables the project to be "played back in reverse." This has some interesting benefits. "We went through a design cycle a few months ago that appeared to be a dead end: It looked like we had to go back to square one," Kadrich said. Before reengineering a major portion of the missile system, staff members "replayed" the engineering process, reviewing the considerations and decisions that had been made along the way. This convinced LMSC personnel that they were, in fact, on the right track and the design was resubmitted to the customer. "They were more comfortable with the idea this time round. Rather than weeks and weeks of redevelopment, it took a couple of hours to reload the data files on the server."

For project managers, design-review status reporting is like a finger on the day-to-day pulse of the program: It gives them a detailed understanding of the current state of the project and creates the opportunity to take corrective action early, if necessary. Accurate, up-to-date project status is particularly critical to informed decision making on a crash program like Thaad, where a task slip of two weeks would prove disastrous to the entire project.

Finally, by archiving the review process and the comments registered during it, the TIMS captures for perpetuity a substantive and previously short-lived knowledge base. The design-review module stores information concerning why certain changes were made—or not made—so that, should team members retire or otherwise be unable to help reconstruct the logic of certain decisions, the knowledge base is there, and the process that transpired to result in that knowledge can be reviewed.

Because of the IPD structure of the project, this knowledge base has a great deal of applicability (see the figure "IPD Technology"). "A given team is responsible from concept to design to flight," noted Victorino. "[It] has the authority to make design, schedule, and budget commitments. This is very different from the way we did business in the past." Because of the novel structure of the program and the new E-mail format of project communication, tracking these details is critical both to ensure schedule and budget commitments are met and to understand how they were met.

Platform Issues

There are nearly 800 LMSC employees involved in the Thaad program, slightly more than a third of whom TIMS supports locally. The bulk of the user workstations are Macs running System 7, but Unix and Windows are also supported. The most common TIMS platform is a Mac IIci. The program uses over 220 Macs, typically with 8 MB of memory, an 80-MB hard drive, and either a 13-inch or 16-inch monitor (some are monochrome, some color).

Another popular platform is the SGI Indigo II Elan—typically configured with 64 MB of memory, 1.3-GB hard disks, and 19-inch color monitors; SGI platforms account for over 30 workstations. There are eight HP workstations dedicated to the Thaad project, typically model 750 systems with 128 MB of memory, 2.4-GB hard disks, and 19-inch color displays. Six IBM RS/6000 platforms and a mix of PCs round out the workstation population that is dedicated to the Thaad project. Other, more casual users have a similar mix of platforms.

Initially deployed only on the secure side of the information fire wall, TIMS will soon support access to the unclassified side as well. This is to be accomplished by a security system that safely penetrates the fire wall. Today, a prototype connection has been tested in one direction: Data can move from the unclassified side to the classified side only. A secure, bidirectional channel is in the analysis and planning stage. "We use a Motorola Network Encryption System that has been approved by the National Security Administration

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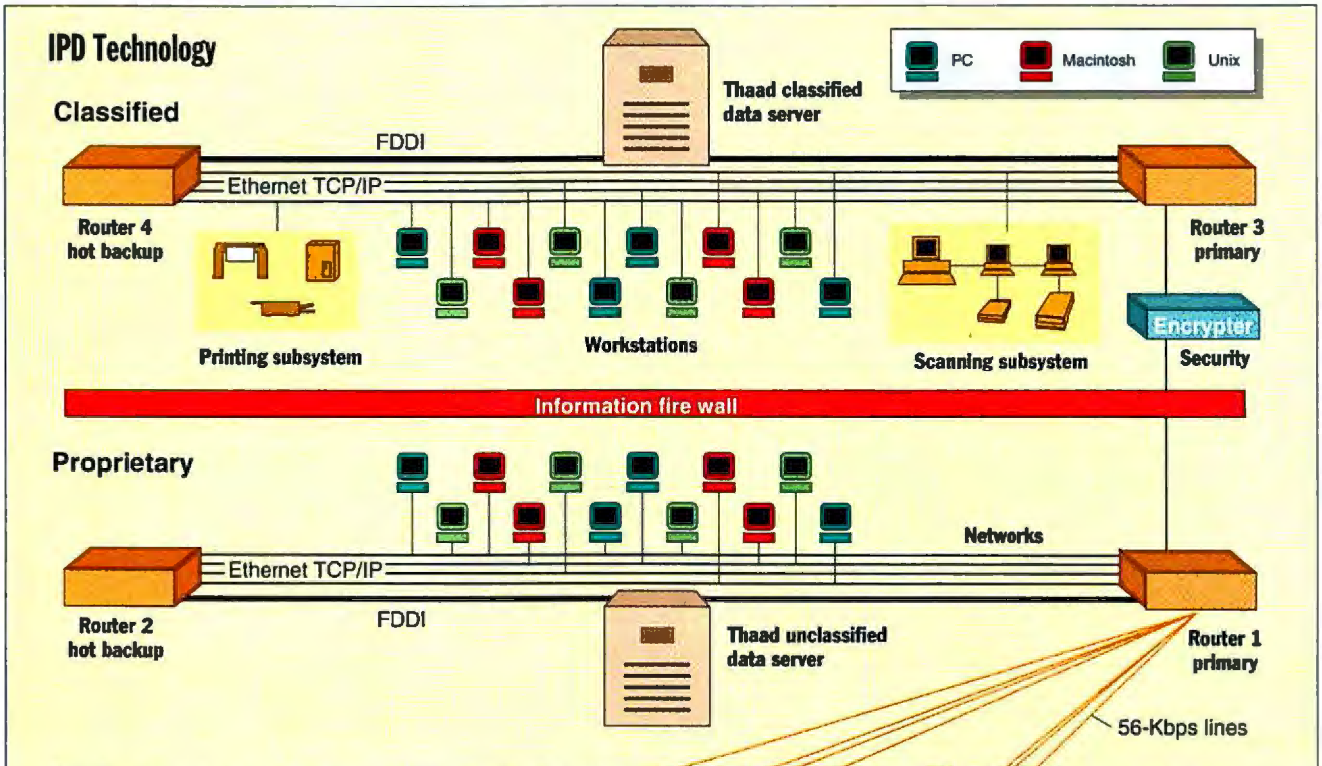


Networks: There are two systems within TIMS: one classified and one unclassified. Each has four 10-Mbps copper Ethernet 802.3 TCP/IP networks with an FDDI backbone (100 Mbps) to support weighty file exchanges. Today, the unclassified system has few users, while the classified system supports nearly 300 workstations. As the project moves into manufacturing and flight-testing phases, the unclassified system is expected to grow substantially.

Servers: A pair of Hewlett-Packard 9000/827 servers—one on each side of the fire wall—are configured with 128 MB of memory and two or three 1.3-GB hard disks; servers are upgraded as needed.

Telecommunications: The Thaad program involves close coordination among more than 30 key subcontractors or suppliers; 56-Kbps lines connect them to the program.

Security: National Security Administration–approved encryption systems from Motorola enable the unclassified and the classified systems to be linked securely. Today, a prototype system provides unidirectional transfers—from the unclassified to the classified system. In the future, a two-way link is planned.

Routers: Both systems—classified and unclassified—are supported by a pair of Cisco routers—one primary and one hot backup.

Scanning: The scanning subsystem enables hard-copy materials that come from outside LMSC to be scanned and converted to raster image files. A pair of NEC 386/33 systems act as servers: one supporting a Fujitsu A and B size scanner and one supporting a Vidar Quickscan LDS, which handles up to J-size engineering and manufacturing drawings. A Sun Sparcstation 2 is used for image quality control, as well as to index and commit images to the TIMS database.

Printing: Three printers in a restricted-access plot room provide hard copy for the Thaad program. A QMS model supports A and B size requests; a 3M printer handles C-size tasks; and a Versatec plotter supports drawings through J-sizes.

Workstations: TIMS directly supports over 220 Macs, 30 SGIs, eight HPs, six RS/6000s, and a mix of PCs.

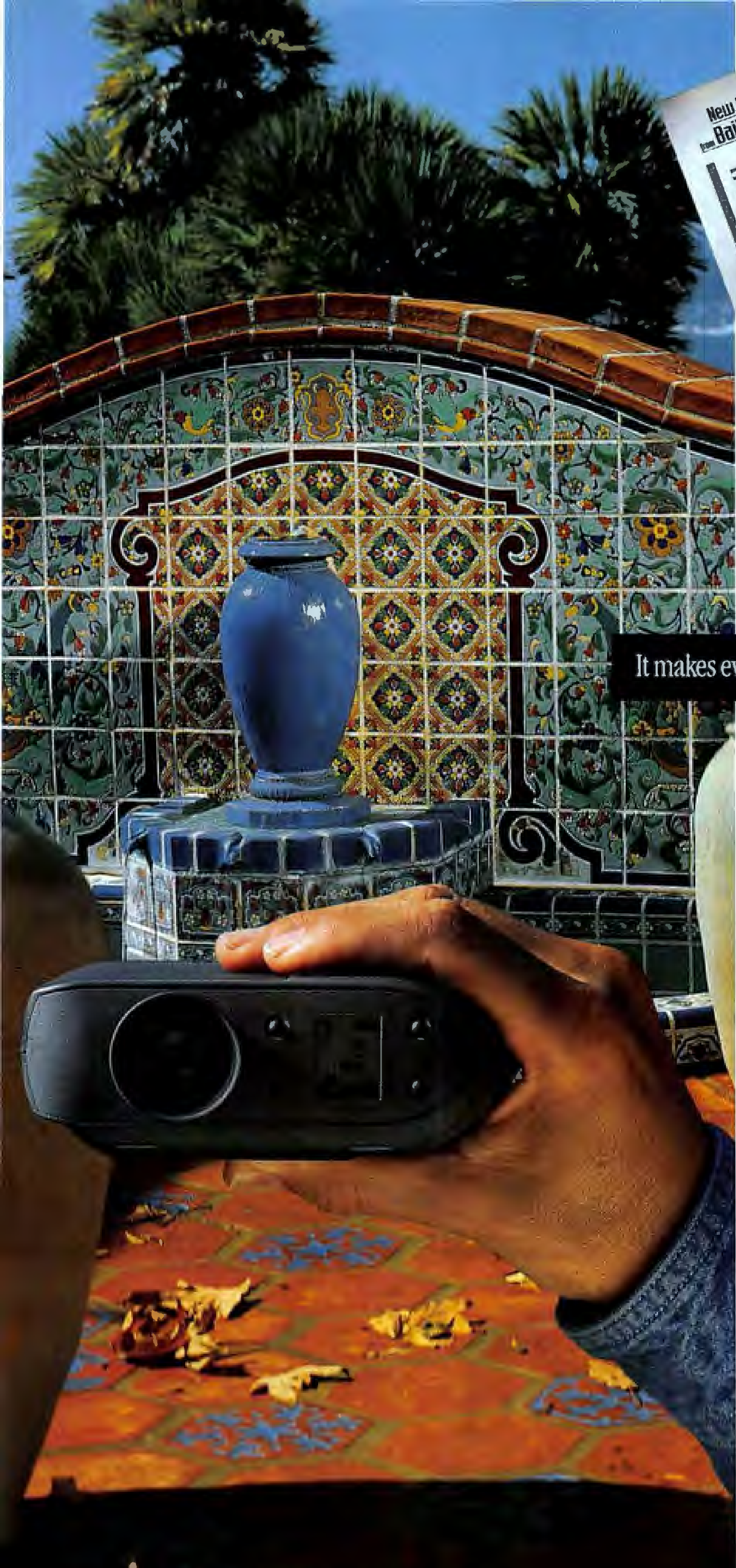
for processing information classified all the way up to 'top secret' level," said Kadrich. A Sun Microsystems NFS link supports secure connectivity to networks on both sides of the fire wall.

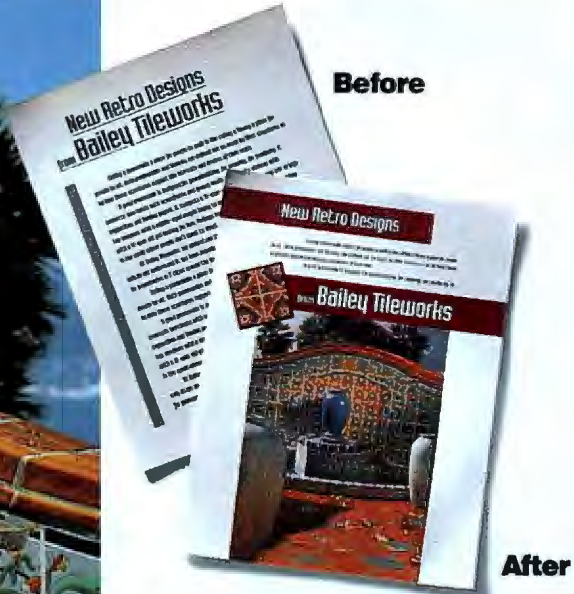
A pair of HP 9000/827 servers (both have 128 MB of memory; one has two 1.3-GB disks and one has three) support users, one in the classified and one in the unclassified domain. Two FDDI backbones are connected to two sets of four Ethernet LANs by hot-redundant routers. Because engineering drawings of 8 or 10 MB are common, keeping this weighty traffic on the FDDI backbone and off the Ethernets improves the response of the user-network segments.

Originally, TIMS included an optical jukebox for bulk storage. But users found the 15- to 30-second response time to be unworkable, and the jukebox itself proved to be the least reliable piece of equipment in a program that required better than 99 percent uptime. As a result, the optical jukebox was scrapped in favor of additional magnetic storage, most of which was installed at the server level.

Of the on-line TIMS data, about 20 percent is text: contract documentation, design commentary, product or process specifications, or other word processed materials stored in both native and PostScript formats. Approximately 75 percent of the TIMS data is engineering drawings saved in raster format. The remaining 5 percent of on-line data consists of scanned images derived from hard copy that Thaad contractors—who are unable or unwilling to electronically deliver drawings and support materials—provide.

Data-conversion routines are critical to supporting the wide variety of platforms and applications within the Thaad program. While engineering drawings are developed and archived in their native application formats, drawings are distributed (for review and commentary) in their raster versions, ensuring they can be viewed from a combination of platforms. Conversion between file formats, such as ASCII, CCITT Group IV, CALS (Computer-





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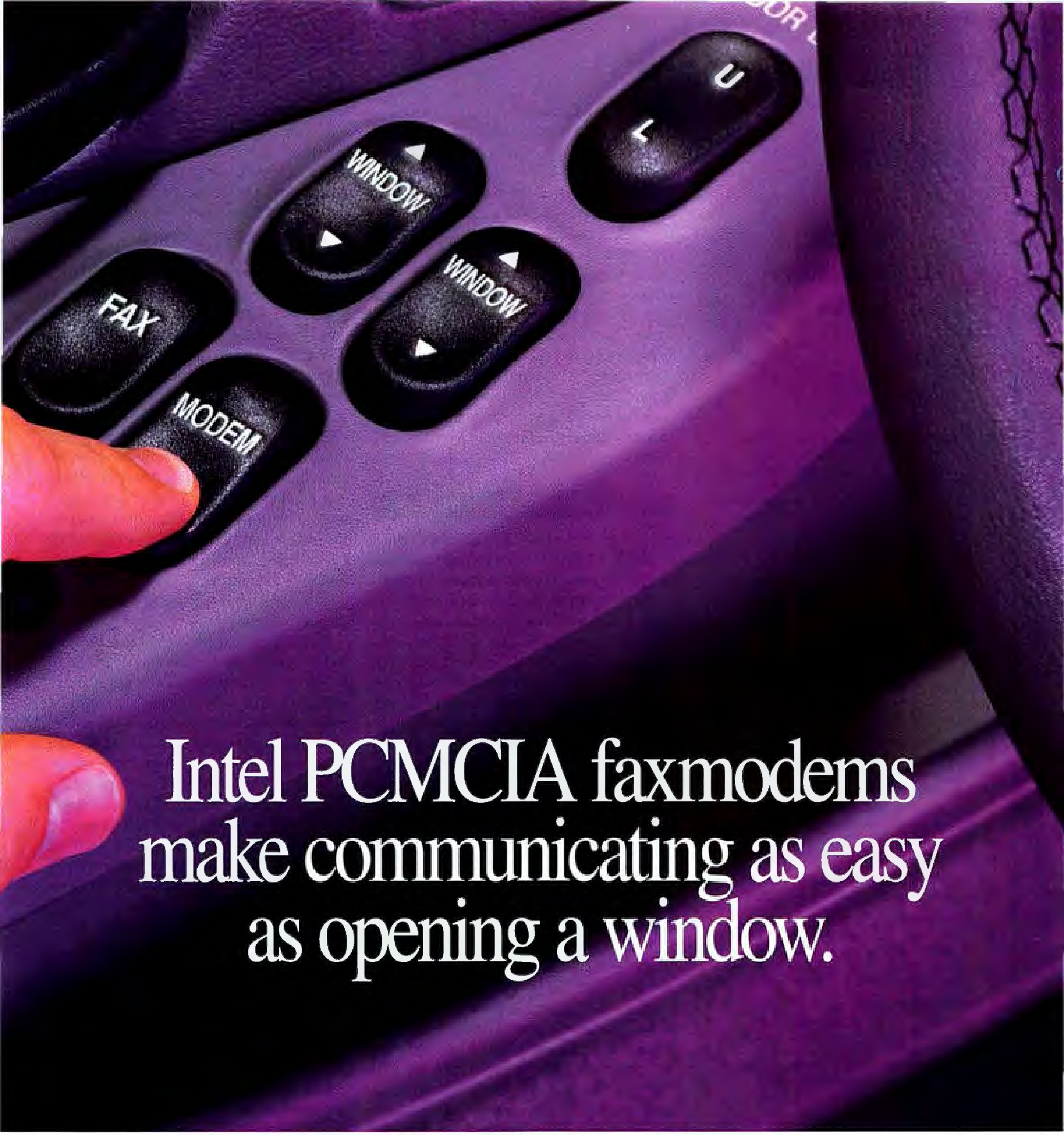

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CAPTURE: Information must be acquired before it is used. Hard-copy or microfilm records can be scanned; engineering drawings and models can be captured in native or raster file formats; text data, spreadsheets, and presentations can be incorporated in application format or as ASCII data; graphics and figures can also be included in native or standard formats (e.g., TIFF, PCX, or CCITT Group 3).

STORE: After being acquired, engineering information must be stored. Typically, organizations use a mix of storage technologies—each with its own price/performance characteristics—to support fast on-line, near-line, and off-line storage. Hierarchical storage management systems support the migration of data from high-speed magnetic disks to slower speed optical jukeboxes to tape subsystems as needed.

QUERY: Queries against the engineering database can be based on structured query approaches, full-text searches, or product data management schemas for data organization.

DISTRIBUTE: Engineering data can be distributed in hard-copy format, in electronic form (as viewable files, revisable files, or standards-based files), or as fax images.

REVIEW: Documents, drawings, and other information can be reviewed and edited.

MANAGE FLOW: With a viable engineering data management system in place and a clear model of the processes being supported, work flows can be implemented to automate the routing of engineering documents and data.

PRODUCT FOCUS: Automated support of the engineering work flow provides the infrastructure to support the layering of a product data management orientation on the existing information infrastructure. This enables the support of product- and process-specific data, such as manufacturing bill of materials.

Aided Acquisition and Logistics Support) type I, HPGL (Hewlett-Packard Graphics Language), and PostScript, enable document interchange and flexibility at the application level.

Document scanning takes place on a scanning subsystem. A pair of NEC 386/33 machines are scan servers for a large-format scanner from Vidar and an A/B size scanner from Fujitsu. A Sun Sparcstation 2 is used to review scanned images, to make any corrections or edits to the images, and to index and commit the images to the TIMS database.

As might be expected, printing Thaad documents comes with its own overhead and headaches. "Classified document generation brings up a lot of problems," confirmed Kadrich. "We control printing through a central location." Documents are output on a QMS printer (for A/B size documentation), a 3M Model 689 printer (C-size drawings) or a Versatec plotter (for roll printing and up to J-size drawings). Once printed, Thaad documentation is registered and checked in and out of the "plot room." This cumbersome, if secure, procedure is mitigated by the ability of users to review documents on their workstations screens, rather than in hard-copy form.

Staff Skills and Applications

For many Thaad employees, TIMS has not required a major skills ramp-up. Rather, it relies on applications already in use like word processing (e.g., Microsoft Word), spreadsheets (e.g., Microsoft Excel), and presentation packages (e.g., PowerPoint). Technical and engineering applications include Pro/Engineer by Parametric Technology (Waltham, MA), I-DEAS by SDRC (Milford, OH); and a variety of Formtek software modules that support process control, application access (at both the network and applications level), as well as document indexing, annotation, viewing, redlining, scanning, plotting, format conversion, and printing.

During the two-year development phase of the Thaad program, TIMS is focused on engineering design work. But the system will also be used for the follow-on manufacturing and support phases. "We are using [TIMS] for prereleased data: design specifications, ECRs [engineering change requests], and so on during the design and test phases," said Victorino. "As we progress through the program, we will be developing more product data, more constructions, inspections, and test data. All of this will be coming back into the database."

Managing Engineering Data

Any organization wishing to effectively manage its engineering data—LMSC included—must come to grips with seven base processes that support design and engineering information and its use. These seven key EDMS (engineering data management system) processes are data capture, storage, query, distribution, review and markup, workflow management, and product focus (see the figure "Engineering Data Management Services"). Most organizations today have these processes in place; the degree to which they are managed and organized depends on the maturity of the enterprise and its management systems.

At a recent Kalthoff EDMS Users Forum (an educational conference for EDMS users and would-be users), Tom Arant, president of Technology Management, a consultancy in Winston-Salem, North Carolina, addressed the issue of EDMS maturity. "Most discrete manufacturing organizations come at an EDMS implementation in three stages or phases," he said. "Phase 1 puts in place the basic engineering data support services: capture, store, query, distribute, and review. Phase 2 expands the scope of Phase 1 and adds work flow to support routing of documents for review and approval. Phase 3 expands basic support services to the enterprise as a whole, extends work flow to all appropriate users, and begins to add product data structures."

In this context, the TIMS can be seen to be squarely in the middle of Phase 2. Engineering support services are in place and work flow is being used on a limited basis. "Today, all engineering data, analysis, design specs, and textual data change information is collected and routed appropriately," noted Victorino. "Eventually, all of the product data—all the way down through logistics and information required to support [Thaad] out in the field—will be included." Phase 3 data management, in Arant's terms, will incorporate bill of material and purchasing information, as well as other data required to support the overall manufacturing life cycle.

Close Encounters

The Thaad project had a variety of skirmishes with failure, the first even before LMSC was awarded the contract. "We had a requirement for the proposal to be only so many pages in length," said Kadrich. "When we went from System 6 to System 7 on our Mac base, System 7 dealt differently with fonts. As a result, the spreading out of characters inside the proposal meant that we were about five and a half pages too long." Having spent nearly three weeks cutting the proposal back to its maximum permitted length, Kadrich and his staff were not about to prune further. "We went back to System 6, delivered the proposal, and subsequently won the contract."

Early in the program, a good deal of effort was spent analyzing the processes

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within the Thaad development program with an eye to both optimizing those processes and developing optimized support systems. "I sat through a number of meetings with my friends in IS [the information systems department] and spent a lot of time trying to analyze the business processes," Kadrich said. On the face of it, this made good sense. But after careful examination, Kadrich and his peers concluded that because LMSC was changing its development approach to reflect its new IPD orientation, as well as implementing a new system that would evolve over time, and because users were not familiar with either IPD or the new system, the basic business processes would be changing, possibly dramatically. As a result, the idea of "reengineering operations" was shelved until a clearer image of what operations should look like was developed.

A critical component of the Thaad system was an easily mastered interface. "Our user interface is real simple: big buttons, self-explanatory lists," explained Kadrich. Much of the interface was structured to resemble LMSC's E-mail system and users appreciated this commonality. "We were requested in the middle of the program to change our entire E-mail system and our resource scheduling system." Kadrich balked and took his case to LMSC senior management, asking for an exemption to the enterprise-wide mandatory upgrade on the basis of its impact on the project's schedule. His request was granted. "The users did not want to sit down and learn a new E-mail system or how to reschedule resources; they just wanted to do their jobs," he said.

A minor issue that surfaced had to do with voting during design reviews. All members of a review team are required to conclude their examination of documents and vote by the closing date of the review. If one or more members fail to do so, the review cannot be formally closed. But what happens when a team member is out of town or otherwise unable to vote in time? In practice, someone else reviews the materials and votes for the missing person, and the TIMS was modified to support that.

By allowing reviewers to designate an alternate person in those situations where the reviewer is absent, the problem of absenteeism was handled efficiently and effectively. Designated alternates were properly supported by the routing and voting applications.

The Future

While the Thaad program—being geographically distributed and managed more through electronic conferencing than face-to-face encounters—is a bit unusual for LMSC, it's likely to become the norm. Partnering among previous competitors, increasingly decentralized development efforts, and collaborative programs that push the limits of schedule brevity are going to require systems like TIMS that permit engineering teams to be virtually collocated on a global basis.

This means some big changes. "At LMSC's Fleet Ballistic Missile program, we've pretty much done things the same way for 35 years," commented Victorino. "Because of the short Thaad schedule, we had to think up new ways to do the same good job [as before]." Today, indications are that the TIMS system is doing a better job not only supporting a compressed schedule but also improving product and process quality and cost—improvements that are likely to keep customers coming back. ■

Scott Wallace is a BYTE technical editor. You can reach him on the Internet or BIX at swallace@bix.com.

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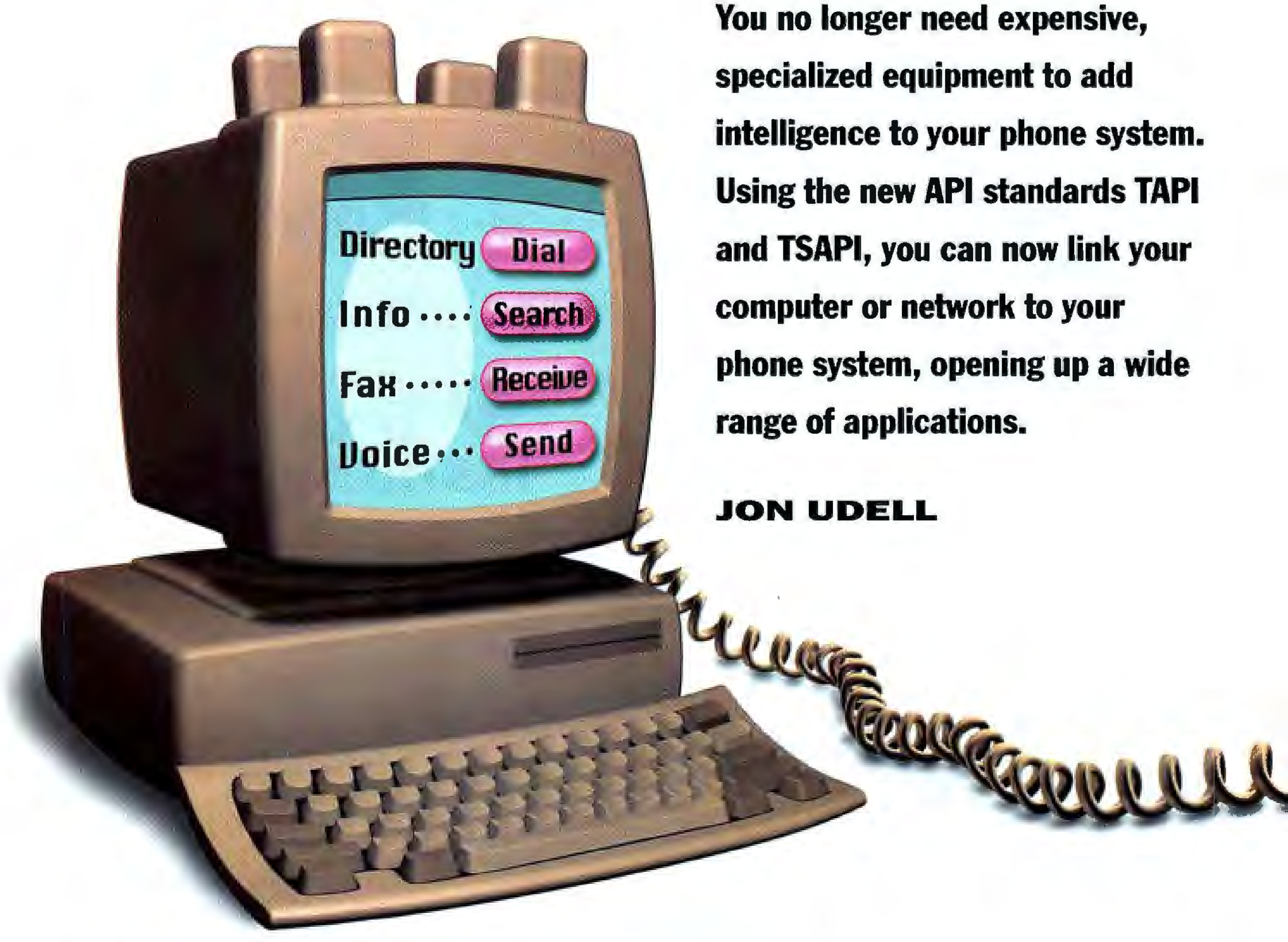


You no longer need expensive, specialized equipment to add intelligence to your phone system. Using the new API standards TAPI and TSAPI, you can now link your computer or network to your phone system, opening up a wide range of applications.

JON UDELL

When the starting time of a high-school football game changes at the last minute, administrators must issue a flurry of phone calls to the sports community. In Denver, Colorado, a DOS-based PC running Dialogic telephony hardware and Telephone Response Technologies software largely automates the chore. It can even negotiate scheduling alternatives, according to Paul Kulas of Interactive Information Systems, whose partner ASO created the custom IVR (interactive voice response) system. "When an official gets a call from the IVR system about the change," says Kulas, "he can agree to the new time or, at the touch of a key, decline but volunteer for a different game—causing the system to make still more calls."

Computer telephony unites the two most essential business instruments—PCs and telephones—and it can't come a moment too soon. Work-flow automation isn't just about routing documents, it's about handling phone calls, too. Today you're probably working with the computer telephony equivalent of stone axes—voice mail, and maybe a PIM (personal information manager) outdialer if your company's PBX doesn't get in the way. Soon, thanks to efforts by Novell, AT&T, Intel, Microsoft, Apple, and a host of smaller vendors, you may enjoy much more powerful forms of CTI (computer/telephone integration). It's not a new idea. Corporate call centers have for years relied on intelligent telephony. Now call-control and voice-processing technologies are moving down to departmental LANs and individual office and home PCs.

No progress occurs in the computer industry without a standards battle, so it's not surprising that computer telephony manifests itself to many observers as a war between TAPI, the Intel/Microsoft telephony API, and TSAPI, the AT&T/Novell telephony services API. In reality, the two are closer than partisans care to admit. Moreover, neither can directly support the kind of intelligent voice messaging used in the Denver sports program.

Both TAPI and TSAPI focus on *call control*. They enable computer control of dialing, answering, transferring, and conferencing. In PBX environments, they also support control of advanced features of digital telephones (TAPI) and the switches to which those stationsets connect (TSAPI).

Call-Control Applications

The most basic application of call control augments the 12 buttons on your phone with a PC keyboard and a GUI screen. Why? Most of the features of PBX systems lie dormant because no one can remember the button sequences used to activate them. "Every transfer in the world begins with the same four words: if I lose you," says Richard King, executive vice president and general manager of Novell's NetWare Systems Group. In the case of BYTE's AT&T Definity G3i PBX system, the description of its feature set fills two fat volumes.

In an increasingly cutthroat PBX business, switchmakers are highly motivated to ensure that the features they compete fiercely to provide are in fact accessible to users. On the other hand, users actually depend on relatively few of these features and aren't likely to invest in computer telephony just to simplify transfers and conference calls.

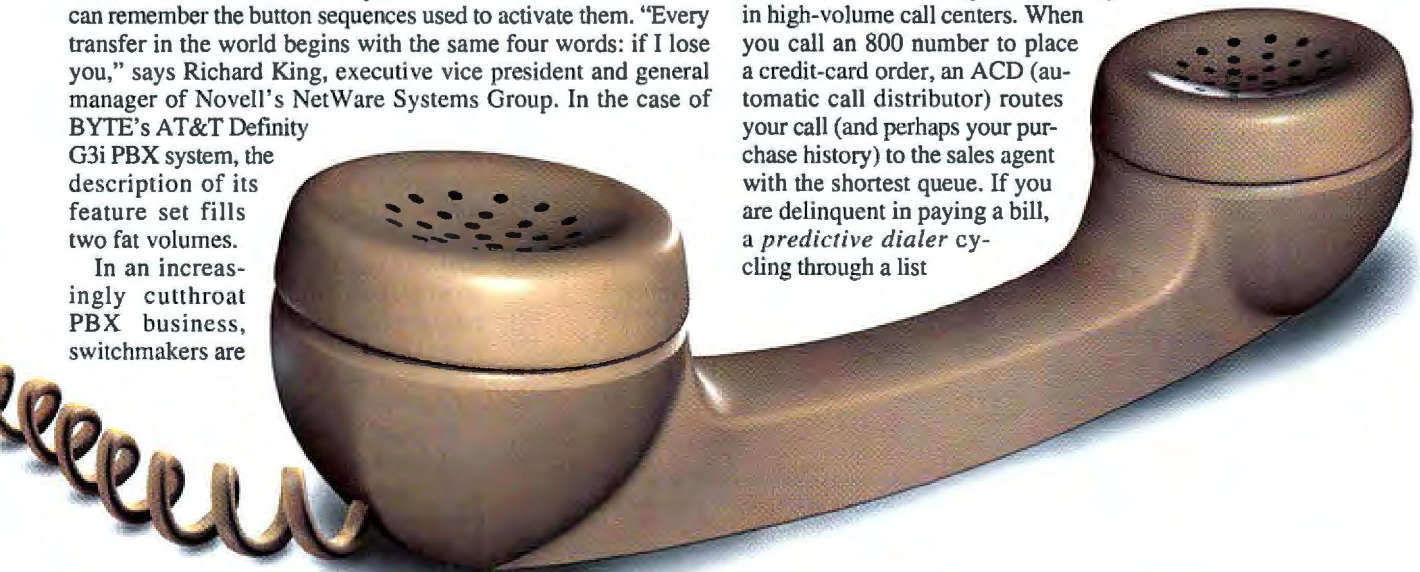
Call control becomes much more interesting when the computer can detect the called or calling number and react appropriately. In the classic application of Caller ID, an incoming call triggers a *screen pop* that launches the application or loads the document needed to handle the call. "You just can't appreciate how great this is until you see it work for you," says Gary Andresen, principal telecommunications analyst for Dataquest (San Jose, CA).

Now that the FCC has ruled that long-distance and local carriers must exchange Caller ID information—the deadline to comply is April 1995—screen pops are ready to move beyond the 1-800 call-center environment into the realm of personal productivity. "The FCC decision will give small businesses the ability to use calling-number information that used to be available only to large companies in the form of ANI [automatic number identification] carried only on T1 lines," says Ellis Hill, a cofounder and director of Rochelle Communications (Austin, TX), a leading provider of Caller ID detection hardware, software, and development kits for DOS, Windows, OS/2, Macintosh, and Unix.

Will carriers meet the April 1995 deadline? It won't be as hard as you might think. "When I called a fellow in Canada the other day," says Hill, "he picked up and said, 'Hi, Ellis.' I called Sprint's product manager to congratulate him for passing the CPN [calling party number], and he said, 'We're doing what?' Two weeks later, they shut it down." Major carriers already operate the hardware and software needed to transmit Caller ID information, and, as Hill discovered, that feature can sometimes be enabled by accident.

Other applications that cry out for call control are whiteboard products such as Fujitsu Networks Industry's DeskTop Conferencing and IBM's Person to Person. These applications, which enable a group of users to annotate shared documents across LANs and WANs (wide-area networks), assume that those users will also be connected through the phone network in a parallel voice conference. When these applications are enhanced with call control, users will be able to set up the voice and data layers of the conference in a single step.

The most advanced call-control applications are power tools for sales and collection agents working in high-volume call centers. When you call an 800 number to place a credit-card order, an ACD (automatic call distributor) routes your call (and perhaps your purchase history) to the sales agent with the shortest queue. If you are delinquent in paying a bill, a *predictive dialer* cycling through a list



of deadbeats may call you. Only after you pick up and establish to its satisfaction that you're not an answering machine will it connect you to a collection agent and send information about you to the agent's screen. As these tools find their way into the hands of smaller, more mainstream businesses, you can expect better service in some cases and more efficient harassment in others.

Ultimately, the richest applications of computer telephony blend call control with media control—that is, the ability to send and receive voice, fax, digital data, and perhaps video through a telephone connection once it's established. There's a lively debate about how the new call-control APIs, which don't directly support media control, will intersect with the rapidly evolving voice-processing industry. To understand the terms of that debate, though, it's helpful to review the architectures of TSAPI and TAPI.

NetWare Telephony Services

In the late 1980s, products from DEC (CIT) and Rolm/IBM (CallPath) pioneered the use of a *CTI link* between a PBX and a host computer. Charles Jolissaint, now chief technical officer of Edify (Santa Clara, CA), holds a patent on the CallPath technology he developed while employed by Rolm. "The switch knew about the call," says Jolissaint, "and the host knew about the caller, so by marrying the two you could keep the call context displayed through a series of interactions with VRUs [voice-response units] and various agents."

NetWare Telephony Services, which shipped May 16, recapitulates this theme, substituting a NetWare server for the traditional mainframe and NetWare clients for the traditional terminals. Initially, telephony applications will run on two platforms: NetWare servers and Windows PCs. Additional clients will include UnixWare (now in testing), Macintosh, OS/2, and DOS. "You want to have the same API available to server and client applications," says Gerry Plummer, applications development manager for software ACD vendor Teloquent Communications (Billerica, MA), "and that's a nice feature of the Novell architecture."

AT&T's Definity was the first PBX supported in this way, but Comdial, Fujitsu, NEC, and other switchmakers (the notable exception at press time being Northern Telecom) signed onto the plan as well. AT&T claims that together these partners account for 70 percent of the U.S. PBX-connected business phones and 50 percent of the international ones. To support NetWare Telephony Services, a PBX vendor provides a physical link between switch and server and supplies one or two drivers (NLMs, or NetWare loadable modules) to control the link and map client requests to the PBX protocol. The requests that clients send to the telephony server NLM and that it passes along to the PBX driver conform to the CSTA (Computer-Supported Telecommunications Applications) standard defined by the ECMA (European Computer Manufacturers Association).

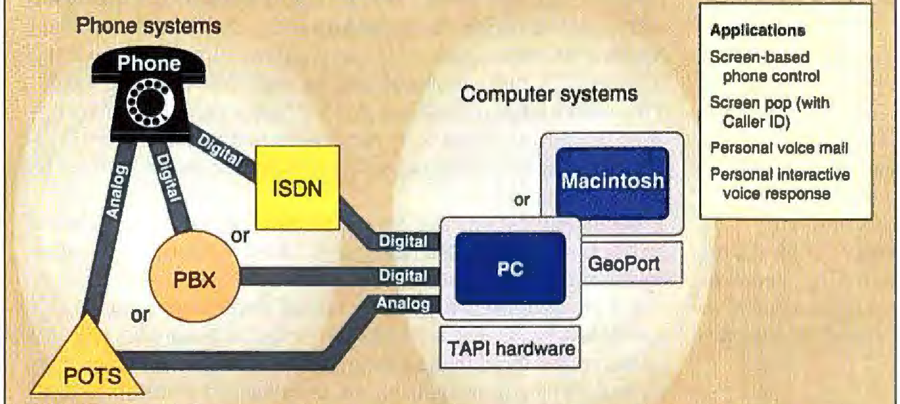
The CTI Link

The nature of the critical switch-to-server link varies from switchmaker to switchmaker. Comdial requires no hardware (its DXP switch uses an RS-232 serial interface) and gives away the drivers, but it charges for the "key" that turns on the telephony services/CTI commands in the switch. AT&T, on the other hand, charges $1500 for the communications board for its Definity system. That's a fraction of what you'd have paid just a year ago. Throughout the PBX industry, formerly prohibitive CTI link prices are in freefall, signaling the eagerness of switchmakers to attract PC-based telephony applications.

Novell says you'll pay $75 to $200 per seat for NetWare Telephony Services, depending on the number of users (and not including the cost of the link). If you're not running current PBX hardware and software, though, you'll need to upgrade, and that can be painful. "I have an AT&T System 75; it does a great job, but there's no migration path," says Dave Straitiff, executive vice president of Voice Technologies Group (VTG; Buffalo, NY). "Stepping up to the Definity can be a $30,000 forklift upgrade."

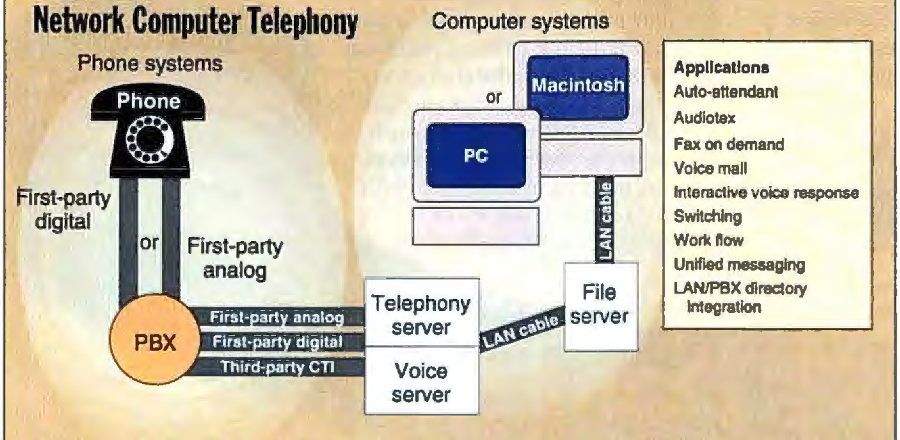
Even so, Novell argues, deployment of NetWare Telephony Services is a centralized, manageable exercise, and the costs can amortize over a large population of PCs. There's no telephony hardware on

Personal Computer Telephony

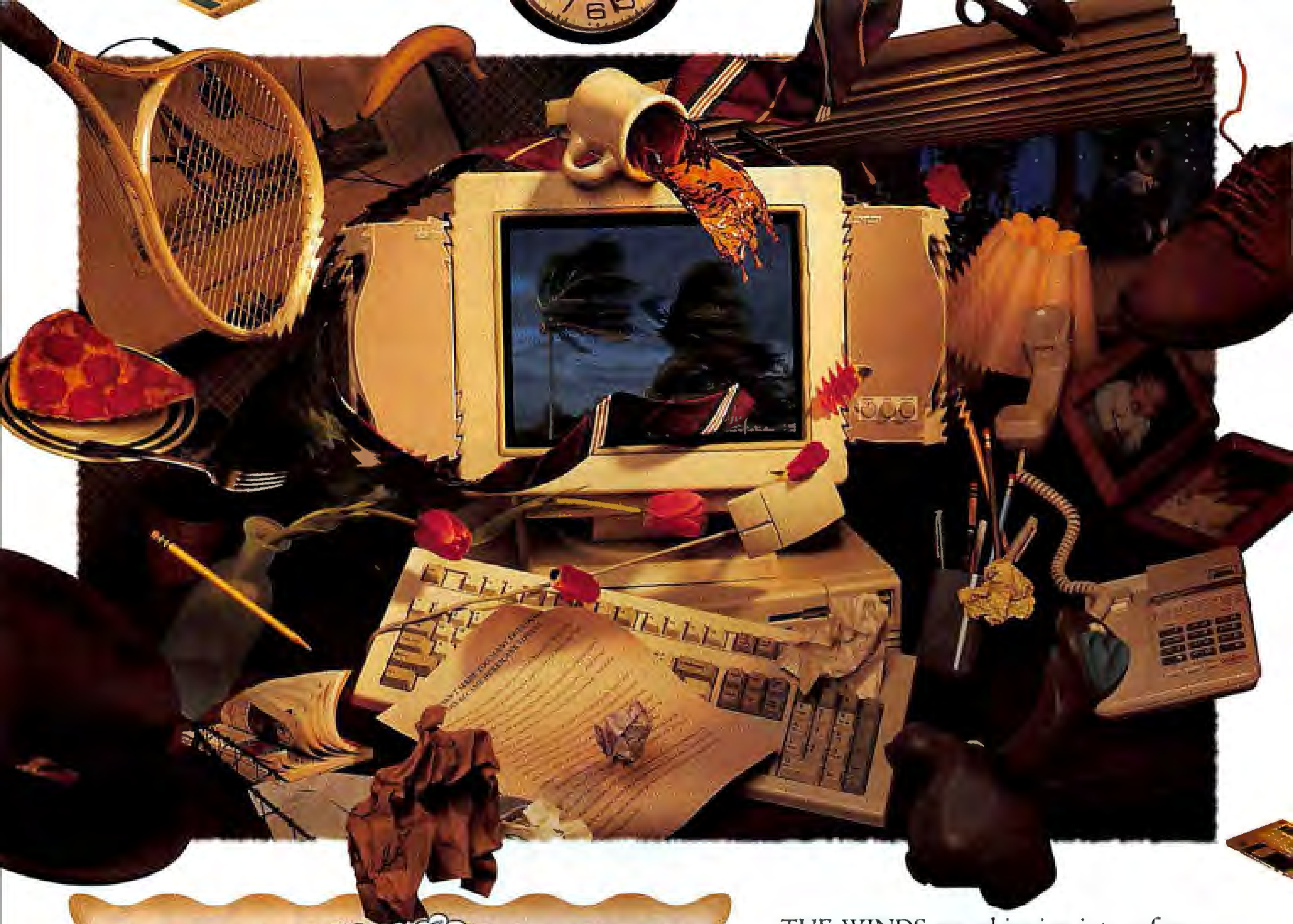


TAPI (or GeoPort on the Mac) allows a single user or small business to integrate the phone and computer systems. This can be done using digital PBX or ISDN or analog POTS (plain old telephone system). The benefits of personal computer telephony include user-controlled installation and personalized service.

Network Computer Telephony



In a network environment, there is no direct phone/PC link. Instead, the two systems are linked via a telephony or voice server. Telephony servers with digital connections to a switch can offer more sophisticated call control than those with analog connections.



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the desktop, as is typical of TAPI, so you avoid the cost and considerable hassle of installing that hardware. "During our beta test, we just E-mailed users the client software and instructions they needed to get up and running," says Novell product-line manager for NetWare Services Scott Wells.

With TSAPI, the connection from phone to PC is logical, not physical. When you log in, you create a mapping between your Ethernet and phone addresses. That association synchronizes CSTA traffic flowing on the LAN with telephony traffic flowing on the PBX. When you log in from elsewhere than your desktop PC, you can supply the extension of the closest phone and so preserve telephony services.

What about remote users dialed in to the LAN? Off-premise PBX extensions exist, but they're expensive and not mobile. Art Schoeller, AT&T's market director for client/server telephony, recommends instead that the remote user dial in to the PBX using a feature that enables the phone to appear as a station on the switch. "It's analog, so you don't get all the goodies," says Schoeller. But standard features are available, and he points out that when you need to set up a conference call from a hotel, you'll save money by using the services of your own PBX rather than those of the network. Note that with TAPI, you'd need a digital telephony driver for the office and an analog or ISDN one for the road. A TSAPI client doesn't need a telephony driver at all, because it shares the one that's in a NetWare server.

The Novell/AT&T approach supports *third-party* call control. That means a third party—a human or software agent—can establish connections on behalf of two or more other humans or software agents. TAPI, by contrast, emphasizes *first-party* call control, which means that the initiator of a call is also necessarily a party to the call. Third-party call control flourishes in production call centers, where software agents often initiate and control calls.

How important is this technique for ordinary office environments? That's the subject of another lively debate (see the text box "First-Party vs. Third-Party Call Control"). What is clear is that, given direct access to the state machine that the switch uses to represent call progress, connections, and other events, programmers can endow third-party call-control applications with sweeping supervisory power. With that power comes responsibility. A malicious TSAPI client could be a formidable wiretapper. Novell therefore extends NetWare security into the telephony services realm, defining new call-control privileges and supplying an administrative tool to manipulate them.

continued


CHRIS SPOLLEN © 1994

Home financial services **Citibank has joined forces with Philips Home Services to deliver financial services via a screen phone. Home customers can use the pull-out keyboard and menus shown on the Philips phone's LCD to perform bank transactions.**

First-Party vs. Third-Party Call Control

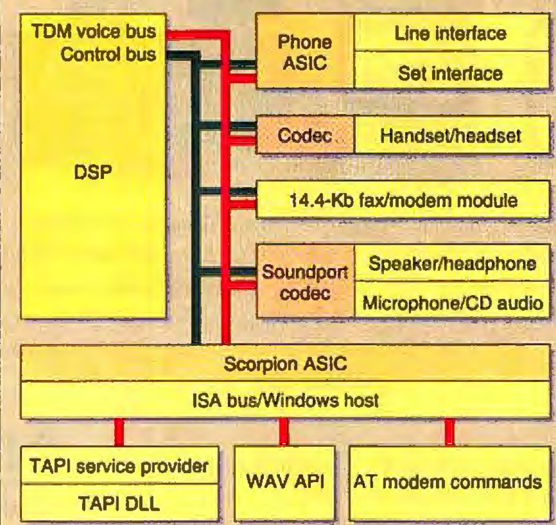
While developers of voice-processing servers generally agree that first-party call control can do almost everything third-party call control can do, they prefer the third-party method when it's available. Until recently, because of the high price of CTI (computer/telephone integration) links, it hasn't been. PC-based voice servers such as those from Active Voice, Applied Voice Technology, and Simpact have traditionally connected to PBXes in the same way that analog phones do.

Asked to connect two parties together, these voice servers do what you would have to do—they dial one party, then they dial the other, and then they make the connection. This procedure ties up costly dial-out ports, and it can take a number of seconds to accomplish. With third-party control such as TSAPI affords, you spare the ports and can make the connection in a fraction of a second.

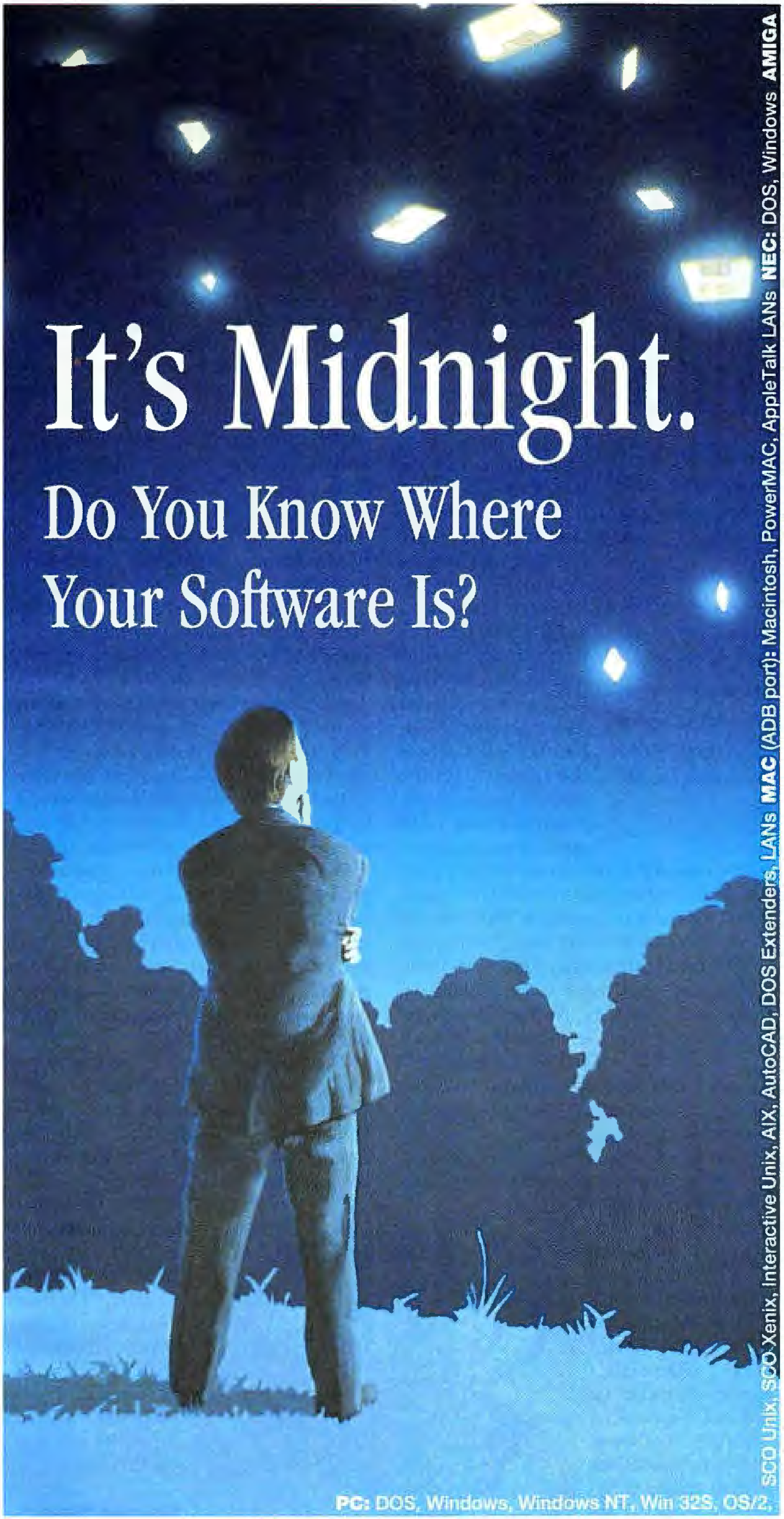
Superior monitoring of call progress is another advantage of third-party call control. Telephony servers operating from a first-party perspective analyze the status of calls indirectly, by listening for DTMF tones, and they lose control of the calls that they transfer. Servers that have a CTI link can know everything that the switch knows about the status of a call, and they can stay in the loop after connecting two parties, awaiting further instructions.

This conventional wisdom may be changing. The messaging protocols spoken between digital phones and PBXes can be fairly rich. With Voice Technologies Group's digital phone emulator, a telephony server running TAPI (perhaps a Windows NT machine) could effect a fair bit of control over the switch. Installing such a telephony server would be as simple as adding a digital phone—and a lot less scary than putting in a CTI link to the PBX. However, consultant Jim Burton, president of *C-T Link* (Boston, MA), points out that switchmakers have reason to be wary of opening up to VTG. "If you took the top four phoneset interfaces and put them on a Dialogic board," he says, "you'd have four PBX vendors with good reason to worry about their voice-mail business."

VTG's Scorpion Platform Architecture



VTG's Scorpion digital phone emulator makes use of the TAPI architecture. It combines a phone, a fax modem, and a sound device on one card. Three key APIs—TAPI, WAV, and the AT modem command set—are supported.



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This central administration is an advantage. However, while it clearly invites various kinds of directory synchronization, none is automatic. TSAPI clients running on NetWare 4.x, for example, will likely want to use the NDS (NetWare Directory Service) as a company dialing directory. The clients can be programmed to do so, but the TSAPI client library doesn't natively support NDS or any other directory service. Nor does it provide a standard address-book mechanism like those supplied by VIM (Vendor-Independent Messaging) and MAPI in the E-mail world. Neither does TAPI, by the way. Both telephony APIs can, of course, call VIM, MAPI, or other address-book services, but these mechanisms aren't standard, as they are with the E-mail APIs.

Healthcare

Aetna Life & Casualty (Hartford, CT) sets up voice-response lines for small businesses, whose employees can call to get claim or spending-account status. The company also manages pension funds for other businesses. Employees in those businesses can call a voice-response line to check the status of the fund or select other investment options. Aetna's own employees use voice response to enter time-card information and for benefits enrollment.

Another interesting possibility is joint administration of the PBX and NetWare directories—potentially a major timesaver. Applications can be written to synchronize the two, but that's not a standard feature of the system today. It probably couldn't be, given the diplomatic gulf that can separate administrators of voice and data networks. "Depending on who's carrying the keys to the closet, you tie the phone to the LAN or vice versa," says Jeff Hafer, telecommunications manager for electric utility company GPU Service (Reading, PA). "In some cases, it'll be like Iran and Iraq."

Windows Telephony

Jointly developed by Intel and Microsoft, TAPI uses the now-familiar WOSA (Windows Open Services Architecture) formula. A system extension, TAPI.DLL, presents a common telephony API to applications developers. The TAPI layer, in turn, talks to one or more service providers that translate common requests into the protocols used by various flavors of telephony hardware. The sample service provider that comes with the TAPI SDK (Software Development Kit; released in late November 1993) controls Hayes-compatible modems using AT commands.

A variant (which Microsoft made available on CompuServe) works with so-called AT+V modems like Zyxel's U-1496E. Like the more powerful and sophisticated Dialogic and Natural MicroSystems boards, these modems can receive and transmit voice and the DTMF (more commonly, Touch-Tone) signals used in analog telephony. The *+V* refers to the ISO extensions to the Hayes AT command set used to control the modems' telephony features.

PBX vendors and third parties are also working to develop TAPI service providers for devices that emulate the digital phones that connect to PBXes; in these cases, transparently to the TAPI application, call-control messages are out-of-band digital signals instead of in-band DTMF tones. Other products for which TAPI service providers exist or are being written are DSP-based (digital signal processor) multifunction boards such as Sierra Semiconductor's WaveFax, National Semiconductor's TyIN 2000, and IBM's MWave.

Novell argues that TAPI is limited by a requirement for local telephony hardware and a restriction to first-party call control. In principle, that argument is wrong. Nothing prevents a TAPI service provider from sending requests across a network to a call-control server that talks to telephony hardware, perhaps even on a third-party basis. "We proved that at the Computer Telephony show," says Microsoft's product manager for TAPI, Charles Fitzgerald. "We showed TAPI applications front-ending Q.Sys International's CallProducer [a LAN-based telephony server]." In practice, however, Novell's claim is largely true. TAPI, like the Macintosh Telephone Manager, focuses more on the desktop or small office than on the enterprise (see the text box "Macintosh Telephony" on page 89).

Will TAPI integrate with TSAPI? Virtually everyone interviewed for this story expects that it eventually will. Clearly, if TAPI can be made to talk to a Q.Sys server, it can be made to talk to NetWare telephony servers as well. Until then, TAPI and TSAPI will tend to gravitate toward opposite poles. "We see TAPI serving the home user or small business, or maybe providing personal voice mail within a larger corporation," says Rod Kuhn, lead software engineer at Active Voice (Seattle, WA), a vendor of voice-processing servers and applications. "At about 25 users, though, people will start to look at justifying costs by using [Novell's] telephony services."

Note, though, that TSAPI won't be an option in all PBX environments, nor is it yet supported on any Centrex system. Switchmakers typically offer a family of products, including low-end *key systems*, various PBXes, and possibly Centrex systems as well. Because only the top-of-the-line PBXes will initially support NetWare Telephony Services, PBX vendors are looking to TAPI as a way to bring the other members of the product family into the fold. "With a service provider that makes the PC look like one of our digital stationsets," says Michael Gough, director of marketing for Comdial Enterprise Systems (Charlottesville, VA), "we'll have a solution from our basic 408 (four lines, eight stations) key system all the way up to our 224-port DXP switch."

The technology Comdial needs to deliver TAPI support is coming from VTG, developer of the Scorpion platform, a family of board-level products that will emulate a variety of digital stationsets and natively support others, the first being Comdial's. "We've taken that work and put it into a TAPI context," says VTG's David Straitiff. "The base design gives you TAPI integrated with Microsoft sound and 14.4-Kbps fax/modem capability on a single ISA board."

Phones are becoming optimized for interaction with computer systems. The Philips P100 screen phone, for example, provides an LCD and a pull-out keyboard.

Lines and Phones

Two abstractions are central to TAPI: the *line* and the *phone*. Line devices (e.g., AT+V modems, PBX interface modules, and ISDN cards) supply one or more communications channels. Much of TAPI is concerned with call control, so most of the functions operate on line devices. But unlike TSAPI, TAPI applications can also wield considerable control over feature-rich phone devices. Functions that operate on phone devices can control the volume and muting of speakers or the gain of microphones (in handsets, headsets, and speakerphones), read and write the display of a phone equipped with one, and even reprogram a phone by downloading instructions or data into its memory. "It's very complete. I was surprised to see how thoroughly they're supporting all the things you find on the various feature phones," says Edify's Jolissaint.

One consequence of the TAPI approach is that the phone can serve as a WAV audio I/O device and can be used for a variety of purposes. "For example, I can ring your phone independently of the PBX to announce an incoming message," says David Straitiff. Phones are ubiquitous and private. If you're sitting in an open cubicle, you'll probably want to play back your voice mail through your phone handset or headset, not a pair of Labtec speakers hooked to a SoundBlaster. Alternatively, you might dispense with the phone entirely and attach a headset directly to the TAPI board, although that means that your phone won't work if Windows isn't running.

How can TAPI call-control functions play voice-mail messages? They can't, but the Windows wave audio functions can. TAPI does offer a function, `lineGetID`, that you can use to extract a handle to the wave device associated with a line device—for example, the sound component of a Zyxel modem or a VTG Scorpion board. The API of choice for data or fax media streams is, at the moment, the admittedly inadequate Hayes AT command set. Microsoft says that the improved communications driver forthcoming in Chicago (Windows 4) will offer a superior API for data and fax modems. Radish

Customer support

Compaq Computer customers can get faster, better on-line support by typing in their customer IDs using their phone's keypad. The IDs are routed to a customer database on the network, which tells the PBX which customer-support agent it should route the call to. That agent can then immediately call up on his or her computer screen all the appropriate background on the customer.

Macintosh Telephony

Apple began developing its vision of personal computer telephony in the mid-1980s and released the MTA (Macintosh Telephony Architecture) in 1991, long before TAPI or TSAPI surfaced. One piece of MTA, the Telephone Manager, offers call-control services; another, the Telephone Tool, maps call control onto various kinds of telephony hardware. The crown jewel of MTA, though, is a suite of telephony Apple Events that abstract the Telephone Manager APIs and radically simplify the development of telephony-aware applications.

All this should have led to an explosion of telephony applications for the DSP-equipped (digital signal processor) AV Macs, which also come with PlainTalk, Apple's well-regarded text-to-speech and speech-recognition technologies. But while Telephone Tools have long existed for modems, ADB-based (Apple Desktop Bus) analog phone adapters, and even the InteCom switches in use at Apple, the AV Macs shipped without Telephone Tool support for the GeoPort Telecom Adapter, or *phone pod*, that connects these machines to analog phone lines. Lacking that support—which is now imminent, according to Michael Bayer, Apple's personal communications evangelist—AV Mac developers couldn't exploit the Telephone Manager APIs or the telephony Apple Events in POTS (plain old telephone system) environments.

Also imminent are PBX-oriented GeoPort phone pods, which will unlock the telephony capabilities of the Power Macs now flooding into corporate settings. Applications such as screen-based phone control, screen pops, database-driven dialing, IVR (interactive voice response), and fax on demand will become increasingly common on individual Mac systems.

What's less clear at the moment is how Macs tap into server-based telephony. "Apple has created very slick, powerful APIs for desktop telephony," says Peter Durlach, vice president of product development for Articulate Systems, developer of Voice Navigator and Power Secretary, "but the classic voice telephony applications—voice processing, IVR—are inherently server-based, and there's been no good way to connect to PC voice hardware sitting on the network." That situation may change soon, however. Apple's Bayer says that a forthcoming Telephone Tool will connect Macs to Dialogic's AppServer via Ethernet.

GeoPort Architecture

Each adapter vendor creates its own adapter handler—a software device handler—for its own hardware. Although the adapter hardware might be the same across platforms, each platform will require its own driver. The GeoPort serial driver handles all data streams and is specific to a given host. Real-time services require a real-time engine, usually a DSP in non-PowerPC Macs.

Apple's biggest contribution to computer telephony may turn out to be GeoPort, a 2-Mbps serial interface that can handle dozens of simultaneous data streams. "Think of it as a turbocharged version of Apple's existing serial port implementations," says Mark Orr, Apple's GeoPort business manager. "There's considerable headroom above 2 Mbps. The speed of implementation is really up to the host. GeoPort has the intelligence to negotiate the fastest host-supported transfer."

GeoPort seems likely to become a standard telephony interface not only on Macs but also on 80x86 PCs. That's great news for PBX vendors who want to create desktop telephony hardware. The same GeoPort phone pod will be able to support TAPI applications on a Windows PC and Telephone Manager applications on a Mac.

Communications Systems' VoiceView technology, which enables alternate voice and data exchanges on a single line, is widely expected to become another important transport that TAPI applications will use to exchange data.

Another TAPI function, `lineMonitorMedia`, enables an application to distinguish among incoming voice, data, fax, and other types of calls. (Service providers will also classify incoming calls.) This ability to classify calls supports a model in which multiple telephony-aware applications may be active concurrently. A well-behaved TAPI answering machine might, for example, register interest in voice calls. When it detects an incoming fax, it passes the call along to a registered fax application; the fax program, in turn, passes voice calls to an application that wants them—in this case, the answering machine.

Although Novell plans to add an arbitration mechanism for workstations in the future, TSAPI presently lacks an analogous concept of multiple cooperating applications. Is that a problem? Not according to Paul Gasparro, CEO of Aurora Systems (Acton, MA). Aurora's FastCall is middleware that sits below applications but above various telephony APIs, including TAPI, TSAPI, AT&T's PassageWay, and Northern Telecom's Visit. "We link the API to the application," says Gasparro, "and we route calls according to rules you specify—if it's my stockbroker, do one thing; if it's my wife, do another." TAPI's model for cooperating applications is somewhat anarchic. Gasparro argues that users will inevitably elect one application or middleware component to impose systemwide order.

What is Intel's relationship to TAPI? The codeveloper of the standard has dropped off the radar screen for the time being. Widely rumored to have been developing a line of PC telephony hardware whose potential TAPI would unlock, Intel is now running deep and silent. "Look at the products we already have [ISDN videoconferencing, fax modems]," says Intel public-relations manager John Jackson. "Clearly these will benefit from TAPI."

Real-World Computer Telephony

While people in the computer telephony business invariably applaud the arrival of TAPI and TSAPI and pledge to support them, the fact is that neither has yet to make much impact on an industry that was already thriving rather nicely without them. Telephony hardware from Dialogic, Natural MicroSystems, Rhetorex, and others has been finding its way into a variety of PC-based applications.

Mail order

Gateway 2000 is looking into the possibility of using CTI (computer/telephone integration) to automate order-status queries. Richard Birkenbeuel, MIS director for Gateway, is examining a voice-response system that asks the caller for his or her order number, ZIP code or other confirming information, and any other required information. No human would need to be involved at Gateway's end to check order status. Where interaction with a person is required, the system would first get the necessary information from the customer and route it with the connection to the agent. That information would then "populate" the agent's screen so that he or she could immediately deal with the customer.

The InfoLine audiotex system recently installed by my local small-town newspaper, the *Keene Sentinel* (Keene, NH), is one example. I can call for weather or sports information and, more interestingly, the public library's children's story of the week or the humane society's narration describing the animals available for adoption. A 486-based DOS PC with a 525-MB drive and a pair of four-line Dialogic cards manages 42 hours of voice files. There's also a priority line so the school superintendent can record announcements on snowy mornings. A linked PC provides Associated Press stock quotes.

Speech-recognition capability means that rotary callers can make selections by speaking at a prompt. This humble use of speech recognition (along with slightly more sophisticated ones that, for example, allow data entry) is currently one of the most practical, of benefit to the 10 percent to 20 percent of U.S. phones with rotary dialing and to the much higher percentages of rotary phones in many other countries. "We can also forward calls, collect messages, and conduct surveys on behalf of information providers," says InfoLine audiotex manager and account executive Jon Foster.

What's in it for the *Sentinel*? It sells the ads that callers must listen to before hearing most selections. Evidently, that's not a major deterrent. In a local exchange area with a population of 70,000, the system handles 1000 calls a day.

IVR—essentially database lookup using Touch-Tone input—is increasingly a method of choice for companies that need to transmit information to their employees or to customers and vendors. Need the CMOS drive table settings for a disk drive? If you're lucky, the vendor runs an IVR system that can speak the information to you seven days a week, 24 hours a day. A variation on this theme is fax on demand. In this case, your Touch-Tone input yields a fax, perhaps one that illustrates jumper settings on a board. Nowadays, customer service is almost entirely delivered through the telephone, and the quality of that service is a key competitive factor. Companies that thoughtfully and effectively deploy computer telephony will have happier customers.

We're only beginning to tap the potential of computer telephony to streamline business operations. At General Electric, another application built by Interactive Information Systems (using Telephone Response Technologies' tools) automates work flow in GE's property management division. GE, which owns thousands of properties around the country, had been requiring realtors and contractors to file reports and completed work orders by mailing or faxing them back to the central office for data entry. "We changed it completely," says Paul Kulas. Now the field workers do much of that data entry themselves via Touch-Tone input. "And they love it," says Kulas, "because they get instant confirmation that they've started the process that cuts their paycheck."

Edify's Electronic Workforce is another toolkit that puts voice and fax response at the service of work-flow automation. Server-based agents, coded using a visual programming language, can process Touch-Tone E-mail and fax input, look up information in databases, send faxes and E-mail, and pump information into DOS-, Windows-, and OS/2-based applications. In a typical application, a customer calls in and places an order via Touch-Tone input. The agent running on the OS/2 server might check the availability of the ordered item via an Oracle query, fax a confirmation to

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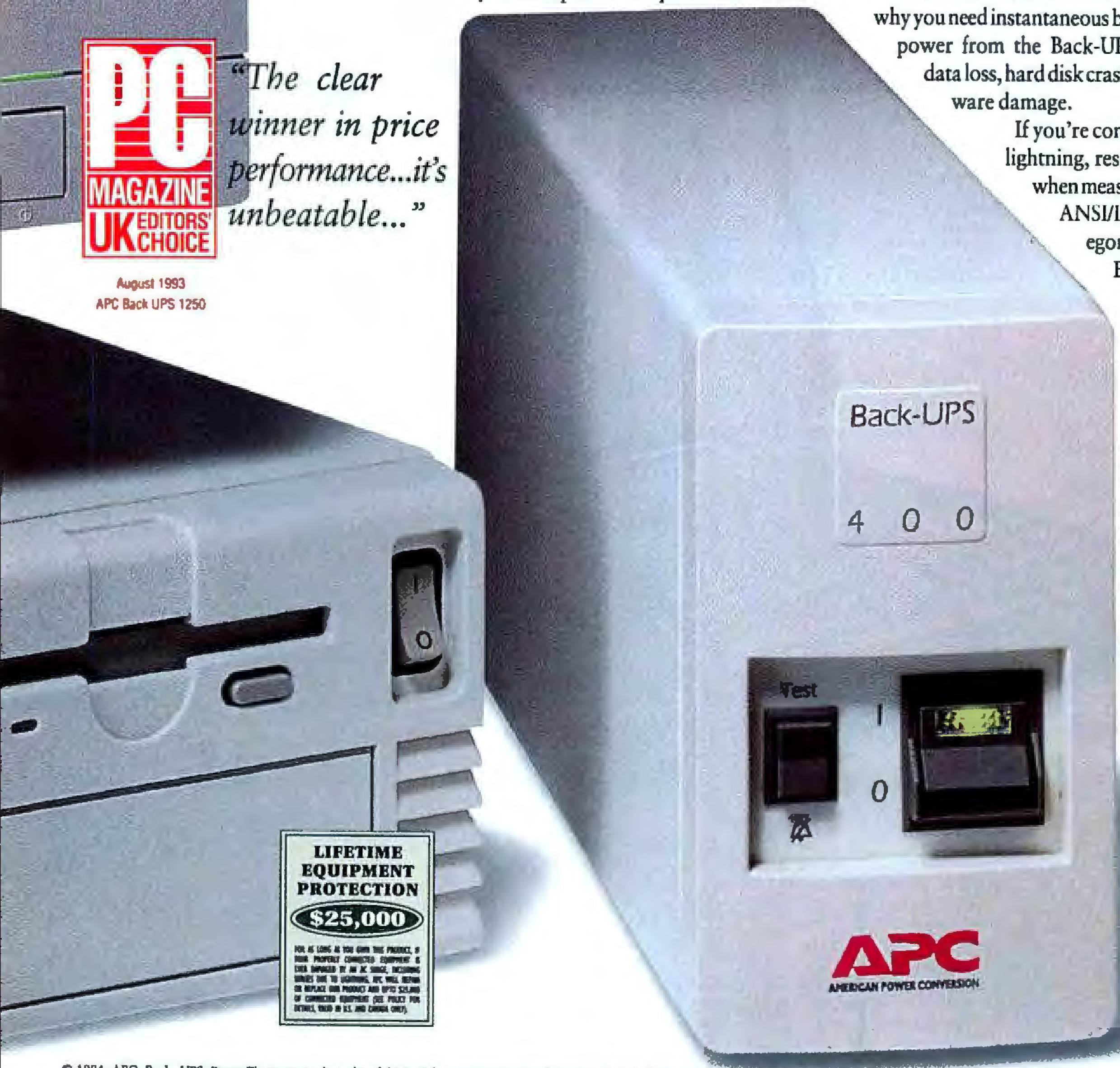

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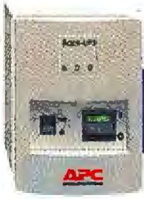

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the customer, send a Notes mail message to the product manager, and insert a record describing the caller into a telemarketer's Act! lead-tracking database.

Still another platform for developing telephony applications is Lotus Phone Notes. A joint effort of Lotus Development and Simpact Associates (San Diego, CA), Phone Notes evolved from Simpact's Remark LANClient and PhoneClient, which integrate voice into Notes documents. LANClient uses the phone as a convenient I/O device and the isochronous PBX system as an effective transport. When you begin recording an annotation, LANClient signals the Remark Voice and Telephony server, which instructs the PBX to ring your phone. The voice server then records what you say in files that it controls or, for portability, in Notes databases.

With Phone Notes, further integration between Notes and the Remark server enables the development of true voice processing applications. Phone Notes, the toolkit Notes developers use to create those applications, is a Notes database with 17 forms that work like an IVR scripting language. You use some forms to create and manipulate Notes documents, and others to perform telephony functions like dialing or text-to-speech output. PhoneClient, which was the first engine capable of executing Phone Notes applications, enables the telephone to function as a limited Notes client. Callers can access Notes databases, enter voice and numeric data, and retrieve voice, numeric, and (with the optional text-to-speech module) textual information.

How's the quality of the text-to-speech output? "It's improving," says Simpact's vice president of marketing, Steve Adams. "You can have the fields read out of a sales-order database, but you probably don't

Report filing

General Electric's property management division has automated report filing for its realtors and contractors. These agents now call in and enter their reports using Touch-Tone input.

Distributed Computer Telephony

Paralleling the move to distributed computing is a move to distributed computer telephony. It starts with the hardware. Both Dialogic and Natural MicroSystems define telephony buses. Developers have long used Dialogic's PEB (PCM Expansion Bus) or the GO-MVIP consortium's MVIP (Multi-Vendor Integration Protocol) originated by Natural MicroSystems to combine voice-processing, speech-recognition, and switching resources into custom telephony systems. More recently, Dialogic has advanced SCSA (Signal Computing System Architecture), which currently defines a telephony bus that can span multiple computer chassis and which also aims to define a software framework in which telephony applications can dynamically acquire and release sets of hardware resources.

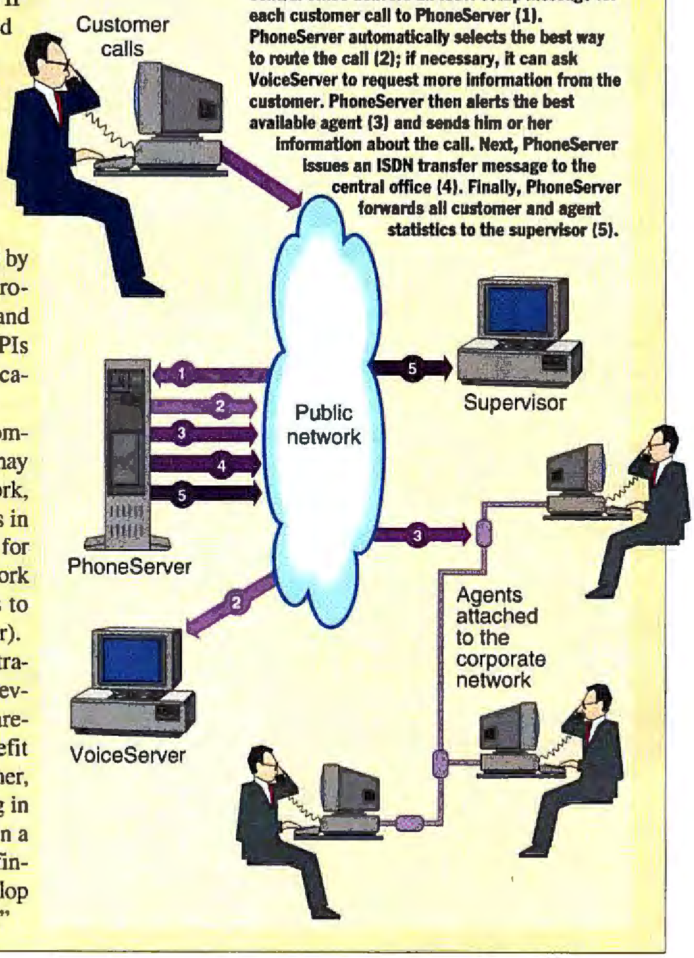
A parallel effort called DCT (Distributed Computer Telephony), led by InterVoice, VoiceTek, and Centigram and involving Natural MicroSystems and others, is also under way. Both Natural MicroSystems and Dialogic are moving to the NetWare platform and plan to offer APIs complementary to TSAPI that can be used to add voice-processing capabilities to the Novell/AT&T telephony services product.

At the extreme end of the spectrum is the notion of distributing computer telephony throughout the phone network. That it isn't so already may not be obvious. But despite the worldwide reach of the phone network, its value-added services tend to couple tightly to individual switches in telephone company central offices or corporate basements. You can't, for example, build a virtual call center that mobilizes agents who may work in various locations, perhaps even in their homes, if everyone has to connect to the same switch to use its ACD (automatic call distributor).

Teloquent's DCC (Distributed Call Center), in an elegant demonstration of a concept that Bellcore calls the *advanced intelligent network*, severs the umbilical cord that connects the ACD to the switch. Its software-based ACD can float freely in an ISDN network. Another major benefit of this approach, says Teloquent's development manager Gerry Plummer, is that developers of such network-based applications aren't working in the rather archaic development environment of the PBX, but rather in a more modern, productive one. "There's no Borland C++ on the [Definity] G3, and no Visual Basic," says Plummer. "We've been able to develop advanced intelligent network services in days, not weeks or months."

Distributed Call Center

With Teloquent's DCC, the phone company's central office delivers an ISDN setup message for each customer call to PhoneServer (1). PhoneServer automatically selects the best way to route the call (2); if necessary, it can ask VoiceServer to request more information from the customer. PhoneServer then alerts the best available agent (3) and sends him or her information about the call. Next, PhoneServer issues an ISDN transfer message to the central office (4). Finally, PhoneServer forwards all customer and agent statistics to the supervisor (5).



want to listen to the text of a Dow Jones report." Developers are building systems to support help desk, event registration, human resources benefit selection, and sales support applications, according to Phone Notes product manager Loretta Jones.

In some cases, computer telephony applications are so strategic that people won't even discuss them. "We're continually surprised by the visionary ideas integrators come up with," says Bob Edgar, president of Parity Software Development (San Francisco, CA) and author of *PC-Based Voice Processing* (Flatiron Publishing, 1994). Edgar describes Parity's VOS Development System as "the Clipper of voice," a common language for developers of turnkey voice-based systems. Edgar won't say what kinds of applications Parity's best customers are building: "They trust me not to give away their competitive advantage."

Customer service

Federal Express (Memphis, TN) has installed voice-response systems in its call centers. Customers can call an 800 number over an ISDN connection. Using ANI (automatic number identification), the system routes the call to an agent and automatically displays the appropriate information on the agent's computer. The customer can also choose automated voice response to get the status of a package, shipping rates, or pickup schedules.

CHRIS SPOLLEN © 1994

Unified Messaging

An application of computer telephony that will grab virtually everyone's attention is unified voice, fax, and E-mail messaging. Everyone would like to be able to randomly access these different message types from a single inbox. Some solutions are here today. Applied Voice Technology's CallXPress3 Desktop presents voice and fax messages in a single inbox, with future support planned for E-mail. The same holds true for Active Voice's TeLANophy (ViewMail and the forthcoming E-Mail Notify/Delivery). Centigram Communications also plans to integrate E-mail into future releases of its OneView. For now, OneView handles voice and fax in a single inbox and lets you combine the two in compound messages, according to Ben Tang, manager of product marketing. Centigram's TextMemo lets you listen to your E-mail over the phone. VMX (now the Octel Client Server Software Division) unifies voice and E-mail today; its VMX-mail puts voice mail directly into Microsoft Mail and cc:Mail (and soon Lotus Notes) inboxes.

While these first implementations of unified messaging are intriguing, most observers agree that truly robust solutions are yet to come. For voice- and call-processing vendors such as Active Voice and Applied Voice Technology, delivering GUI control of the voice mailbox was an obvious way to enhance their products. Expensive, fixed-function voice-mail systems like AT&T's Audix are now being challenged by more flexible, PC-based third-party systems, not only for reasons of cost, but because the new systems can do some very interesting and powerful things.

When you play a voice message, for example, you're likely to want to reply. Active Voice's TeLANophy initiates the return call with a mouse-click. A caller who transmits a fax may be prompted by the voice server, Repartee, to attach voice annotations to the fax. Repartee also supports dynamic, real-time message handling. "Suppose you call me at 1 p.m.," says Active Voice's Rod Kuhn, "and I'm expecting an important call from my boss around the same time. With ViewCall (due in the third quarter), I can be alerted that my boss is holding for me at the auto-attendant while I'm talking to you. If multiple calls are stacked up there, I can view them and choose which to connect to." Voice servers wielding a combination of call-control, IVR, and voice-mail technologies are increasingly able to add intelligence to the basic switching provided by the PBX. That's a fascinating development, with far-reaching implications, but it doesn't in itself lead to the unification of voice mail and E-mail.

Dennis King, executive vice president of market development at Applied Voice Technology, believes the future of unified messaging lies with messaging engines such as those forthcoming from Lotus (Lotus Communications Server) and Microsoft (Enterprise Messaging Server), built to handle large binary objects as well as text. To integrate voice and E-mail today, you have to cross-reference separate message stores. These links, which can be fragile enough to maintain in a single location, can become unsupportable in a distributed environment. "If I have my E-mail and voice-mail systems tied together in Chicago," asks King, "and Chicago connects to New York on the corporate WAN, how do I replicate the voice functionality over in New York?" It can be done, counters Bob Greco, vice president of product development for Active Voice, and it has to be, because even when voice and message stores consolidate locally, there remains the hard problem of distribution.

Anywhere, Anytime

Phones achieve a kind of invisibility. They melt into the woodwork. You use phones unconsciously (unlike PCs), and while that's a great thing for most people, it's a problem for those pushing computer telephony. Harry Newton, publisher of *Computer Telephony* and *Teleconnect* magazines and promoter of the annual Computer Telephony show in Dallas, likes to point out that with 99 percent of the world's phones, you can't even backspace to correct a miskeyed entry. What's even more amazing is that the average computer user never thinks to complain about the lack of a feature that, if missing from a software application, would raise instant howls of protest.

Computers can help phones become much smarter than they are now, in ways that both subtly and dramatically change how we live and work. The rate-limiting factor isn't technology, but imagination. Because people don't see phones for what they really are—ubiquitous, user-friendly terminals that connect anywhere, anytime—it's hard to envision computer telephony applications, and harder still to cost-justify them.

"It's great to have Harry Newton out there evangelizing," says Paul Kulas, "but he's the only one who's making money. It's tough to sell a bean counter on intangibles. They say 'that's really neat.' They don't ask 'how much is it?' " That's a healthy skepticism. It can change quickly into technology lust, though, as more early adopters demonstrate real competitive advantages. ■

Jon Udell is a BYTE senior technical editor at large. You can contact him on the Internet or BIX at judell@bix.com.

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SCOTT WALLACE

Process analysis and modeling are at the core of a wide variety of workgroup support applications.

Work flow is a topic that increasingly captures the attention of technologists and operations people alike. This growing interest in work flow is an acknowledgment that while the primary platform for contemporary computing is the individual's desktop, a group usually gets work done, not someone working alone.

In most organizations today, groups are supported by an often eclectic combination of leading-edge and ancient services. Couriers, postal delivery, and phone and fax communications are mixed with LANs and desktop computers supporting applications ranging from E-mail and office productivity suites through work-flow and document management to desktop videoconferencing and intelligent information-gathering agents (see the figure "Workgroup Support Applications"). The goal of each is to support the detailed and diverse flow of information and services throughout working groups within and across enterprises.

At the core of these working groups—and of all groupware, for that matter—is a model, implicit or explicit, of the workings of the group. Effective use of any kind of group-support service requires a clear, unambiguous understanding of what the group is trying to do and how it goes about doing that. And tools that analyze and document the group's purposes, processes, interactions, and information needs are critical to developing an explicit understanding and a model of work and its flow.

BPA and Reengineering

In most organizations, BPA (business process analysis) and modeling tools have been introduced either through work-flow applications or reengineering initiatives. Historically, work-flow vendors were pioneers in routing electronic objects around the office, and many have built on their experience to develop strong process-analysis and modeling offerings.

Reengineering—often associated with work-flow implementations—is also driving interest in process analysis and modeling. A recent survey of Business Week 600 companies showed that reengineering is on the corporate IT (information technology) agenda and that process-modeling tools are playing a critical role in focusing reengineering efforts and making them effective. Many organizations reengineer without using process-analysis tools, but adding process modeling to the reengineering effort nearly doubles the probability of success (see Thornton May's "Know Your Work-Flow Tools").

Reengineering initiatives, while often driven by new systems or functions, must effectively leverage old equipment and software investments and legacy skill sets. (Meichun Hsu and Mike Howard address work-flow-legacy integration in "Work-Flow and Legacy Systems.") In many enterprises, contemporary analysis and modeling tools provide a bridge between the old and the new, supporting efforts to reengineer legacy systems with new GUI-based software running on relatively open Unix, DOS, and Windows platforms. This happy coincidence means that legacy tools are not necessary to reengineer legacy systems and that programming and support staff can gain experience with desktop operating environments as they maintain and link legacy systems to newer applications.

New Tools, New Benefits

Newer, more graphics-oriented BPA tools help to smooth gaps between applications by supporting the capture, depiction, and detailed modeling of these relationships. Indeed, process repositories that describe in comprehensive operational terms the interaction of process, data, and system elements are rapidly becoming one of the most important information assets of an enterprise. These process repositories are today at least as critical to effective return on IT resources as data repositories were in database development efforts. Some would argue that work-flow and reengineering initiatives are more instrumental to increasing productivity than modernized data repositories.

All this may sound suspiciously like the kind of talk one heard five years ago concerning upperCASE tools. The difference is that, today, process-analysis and modeling tools support the kind of interprocess and cross-operations analysis and modeling that was missing before. Process has become a first-class citizen, rather than a second-class cousin to data.

New Experiences

What about organizations using these new tools; are they finding tangible improvements in their analysis and modeling and in the systems that result? The answer is yes; they are also finding that such systems cannot be engineered in a glass house. To generate appropriate and robust systems, analysis must be guided by the details of daily operations and the hands of business managers, not IT managers. Systems analysis disciplines alone cannot ensure success, in part because many of the obstacles to success are to be found in business operations, not in the IT department or the systems it develops or supports.

Many enterprises are concluding that leadership of work-flow and reengineering initiatives, and the analysis and planning that is found early in such efforts, must come at least as much from line management as from IT. Contemporary modeling tools, in contrast to earlier analysis and CASE products, offer sufficient user-friendliness that operations managers, rather than systems analysts or IT professionals, can take advantage of them. As a result, more process-related information is captured and accurately modeled, and the resulting applications and systems more effectively serve the organization. ■

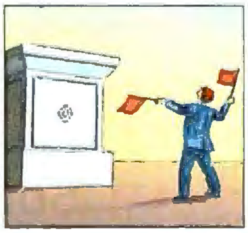
Scott Wallace is a BYTE technical editor. You can reach him on the Internet or BIX at swallace@bix.com.

Know Your Work-Flow Tools

Four classes of tools support work-flow analysis and modeling. 103

Work-Flow and Legacy Systems

Systems optimized for transaction processing need work flow, too. 109



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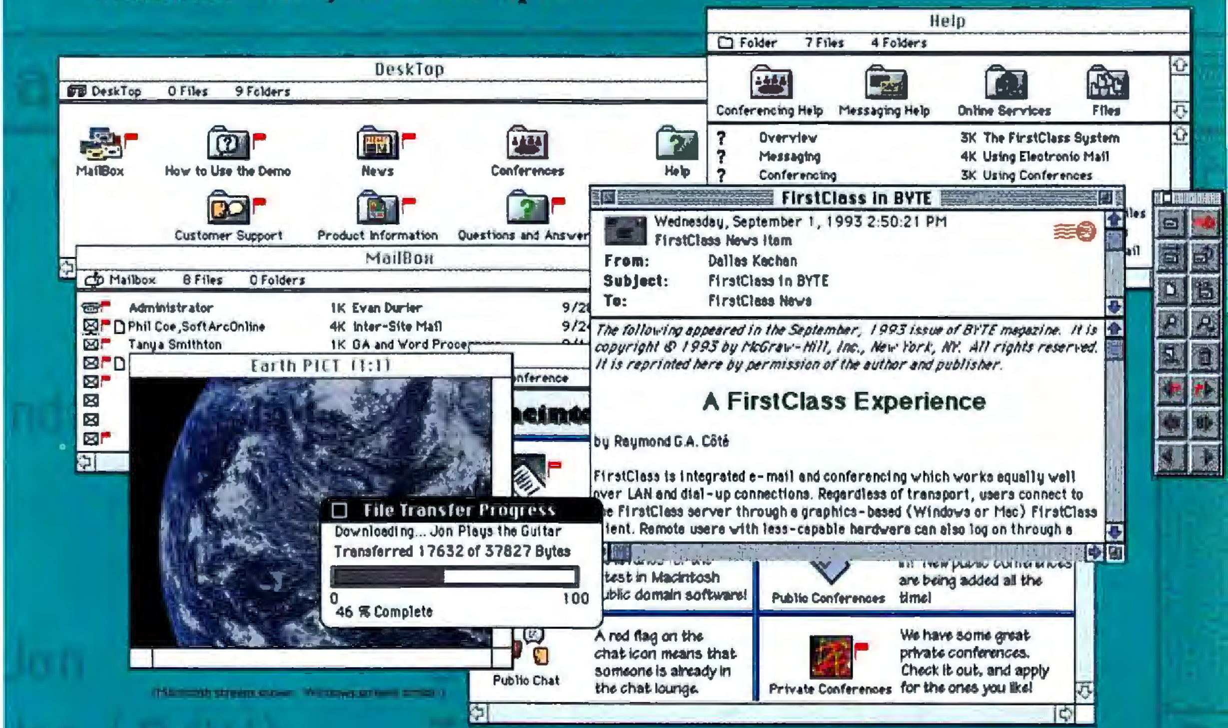

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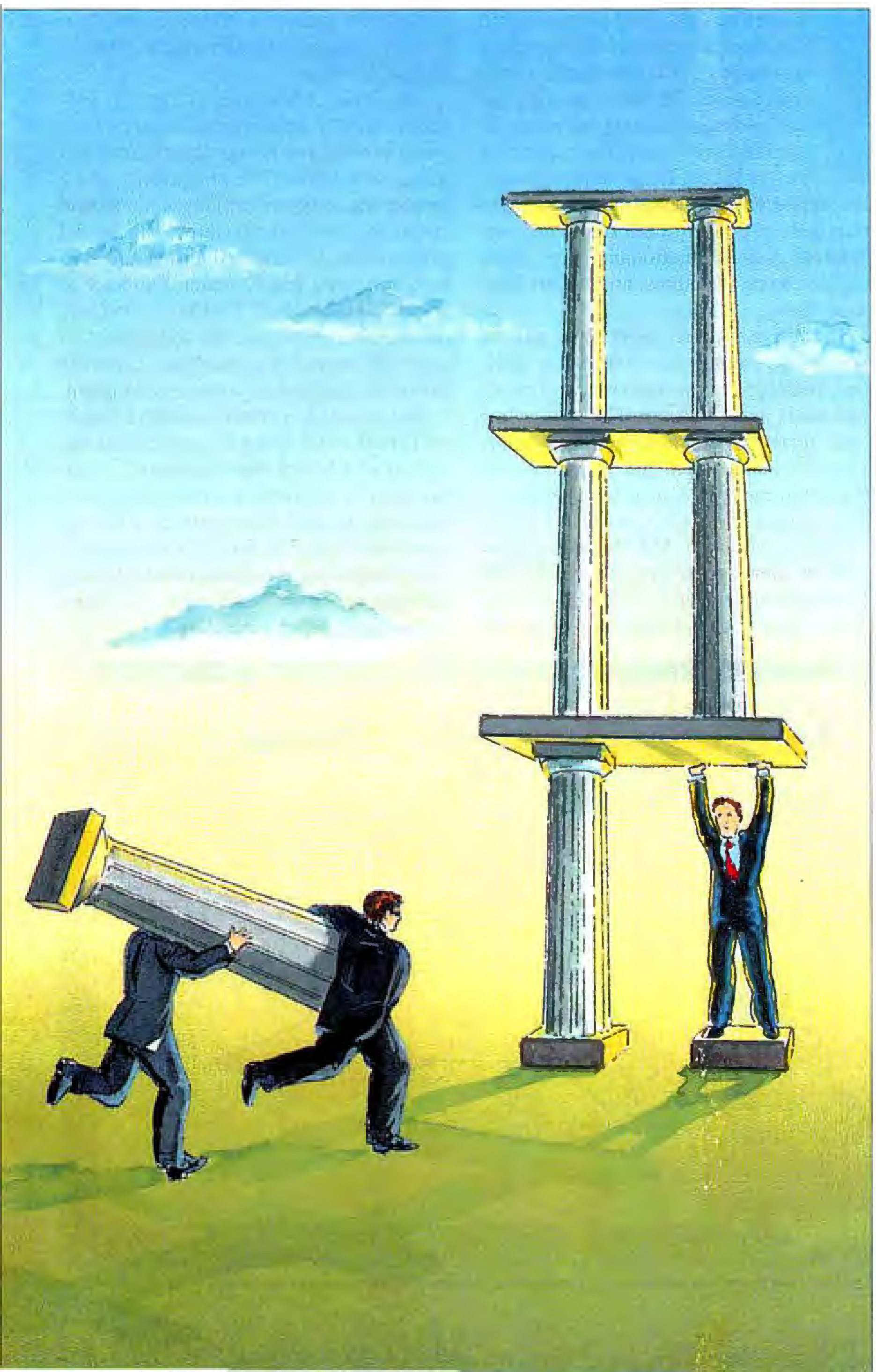


ANDREA BARUFFI © 1994

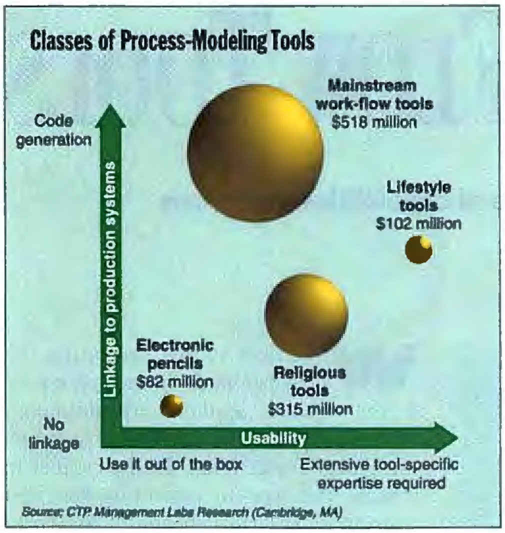
Work flow is fast becoming the glue that binds segmented client/server computer applications into a continuum of processes capable of supporting group work. What's most critical in making this work is providing the right support at the right times in the right places. Here, effective use of process-analysis and modeling tools could be the difference between a successful work-flow implementation and a disaster. Whether the goal is to reengineer operations, to add work flow to existing applications, or to lay the foundation for groupware applications, process-modeling tools provide a variety of support functions.

Analysis and modeling tools can be broken into four basic classes. First, at the low end are diagramming or drawing tools that help you depict work flows and link text descriptions of work processes to the drawings. Next come traditional work-flow tools that analyze and model using a variety of process templates and routing rules. Then, more sophisticated CASE and industrial-engineering software provides analysis and modeling support for systems designers and engineers skilled in the tools and their underlying methodologies. Finally, "religious" tools are similar to the CASE class of tool, but you have to buy into a conceptual framework for tool application and use.

Work-flow tools help break apart existing business processes and depict the individual processes using "maps" or other graphical aids. Next, they provide run-time statistics on processes and the resources the processes use. In other words, these tools help quantify productivity and quality for each connected user.

Modeling tools also help you develop new processes and provide a means of simulating the new processes and understanding the operational and technical implications of each revised process. Finally, process-analysis and modeling tools let you see how new processes fit with older processes, applications, and platforms.

continued



Work-flow tools differ widely in terms of ease of use, functionality, and popularity. Each class is represented proportionally according to its 1993 sales revenue.

Ideally, these tools will support the development of prototype applications that can be scaled into production. The problem is that it is not a simple matter to design easily mastered tools that enable you to take the abstract concept of empowerment and focus it on a specific work environment and the processes within.

Electronic Pencils

Diagramming or drawing tools, sometimes called *electronic pencils*, are products designed to support the drawing of "as is" and "should be" pictures of the processes and work flows. These products require few specialized user skills and in most cases, are not nearly as full-featured and functional as the technologies that systems analysts and design professionals typically use.

Consulting firms that practice reengineering are heavy consumers of electronic-pencil products, which are used behind the scenes to render the whiteboard scribblings "pretty enough" for presentation to senior management. As such, much of their value is cosmetic in nature. A number of internal reengineering departments use electronic pencils to graphically enhance their drawings of processes and work flows. This market subsegment is characterized by "shrink-wrap" pricing, typically $99 to $350.

HavenTree Software's (Kingston, Ontario, Canada) EasyFlow for Macintosh and EasyFlow for DOS are popular electronic-pencil packages. HavenTree plans to release a Windows version this summer. Other examples include Macflow from Mainstay (Camarillo, CA) and FlowCharting 3 from Patton & Patton (Morgan Hill, CA). Featurewise, most electronic-pencil packages are similar. People tend to choose the ones that best fit their preferred method of drawing.

Mainstream Work-Flow Tools

FileNet, IBM, Sigma Imaging Systems, and Wang lived through the early days of process modeling when the only way people could purchase proven work-flow engines was to buy a total electronic-imaging package. Then, image digitization and manipulation were considered the more valuable aspects of the packages. These vendors fought the architectural battles as they struggled to unbundle expensive (and frequently unwanted) optical functionality (e.g., optical jukeboxes, scanners, and so on) from work flow.

In the near future, work flow will be unbundled from process-modeling utilities, enabling customers to mix and match functions and products. The work-flow tools market is characterized by vendor-specific channel strategies with attractive high-volume, per-seat pricing going to high-impact reference accounts.

DEC's (Maynard, MA) LinkWorks defines the new age of work-flow software. It was designed with multiple users in mind, didn't arrive with a lot of legacy baggage, and never let the total life cycle cost (i.e., maintainability and expandability) get far out of sight. The DEC offering lets you customize the flow of information among database, spreadsheet, word processing, E-mail, and graphics applications. The LinkWorks application integration framework supports Microsoft Windows, Macintosh, OS/2, and Motif clients; DEC OSF/1, OpenVMS, SCO Unix, Ultrix, Hewlett-Packard HP/UX, and IBM AIX servers; TCP/IP and DECnet network protocols; and relational databases including Informix, Ingres, Oracle, and DEC's Rdb.

The Bank of Montreal in Toronto, Ontario, recently implemented a work-flow environment for its credit applications using LinkWorks. The first priority of the project was to organize information around corporate client relationships. The second priority was to start delivering information in a more timely manner directly to people who needed it. LinkWorks became the technological glue for the project. It gave the project a unified and centrally managed, multiuser system environment.

The prototype system involved 25 users in Toronto. All desktop applications are run off of a Novell NetWare server. Connectivity is provided via token-ring connections on each floor with an Ethernet backbone tying the floor-LANs together. The post prototype rollout involved linking Chicago operations with users in Toronto by means of a 128-Kbps line.

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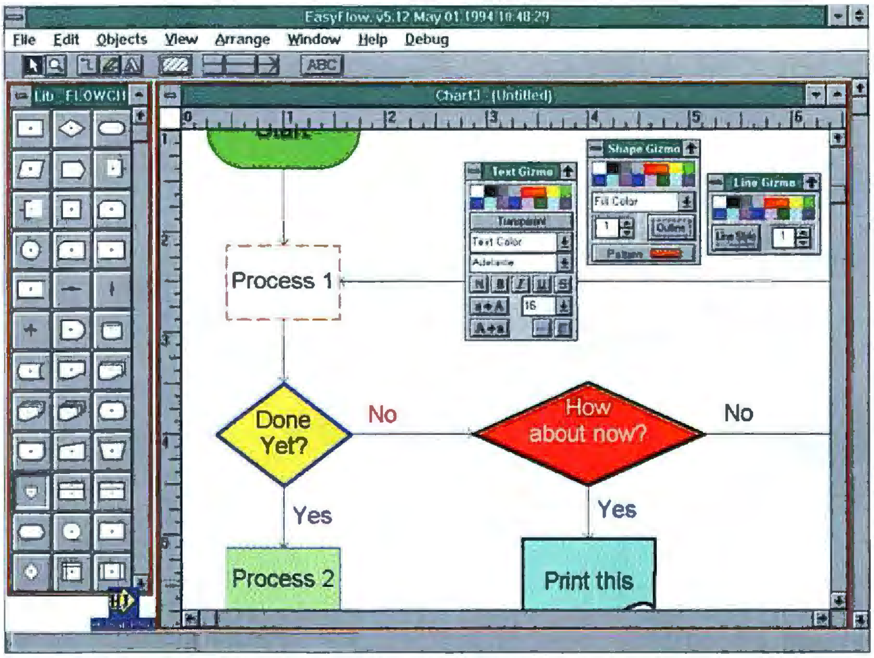
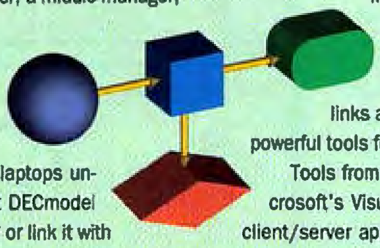


EasyFlow from HavenTree Software allows you to draw flowcharts of processes and work flows.

DEC AND WANG PUT IT ALL TOGETHER

DEC (Maynard, MA) has assembled a suite of work-flow, modeling, and groupware products that astutely address the needs of organizations going forward with reengineering and work-flow initiatives. The process modeling part of the product line is DECmodel, a slick piece of modeling code that tracks process-related activities across multiple dimensions, including cost, time, transactions, or whatever the business unit manager wants to monitor. An interesting feature allows you to look at the process from multiple perspectives (e.g., from that of a senior manager, a middle manager, or a technician).

The product allows the modeler to test, verify, and validate ideas for improving business operations, answers "what-if" questions on the work process being mapped, builds working simulations, and runs on standard MS-DOS-compatible PCs or laptops under Windows 3.1. Perhaps most noteworthy about DECmodel is that you can use it as a stand-alone modeling aid or link it with a new product from DEC, code-named RFM (Reliable Flow Manager), which actually generates code. At the time of this writing, RFM just emerged from external field tests. The product has already been incorporated into the RAELS (Rapid Access Electronic Library System), an integrated document management system that Loral Space and Range Systems designed.



RFM separates processes from applications that are separated from data, which are then separated from organizational issues and considerations. RFM takes a graphical view of the business and, in real time, converts that view to a script language that is uploaded to the server. Early installations have used OSF/1 on DEC Alpha machines. The originating graphical view does not have to be created on DEC's DECmodel product. You can create a translator for any process-modeling package. RFM's product manager estimates that on average, it takes about 30 to 60 days for DEC staff to do a translation from scratch.

Wang Makes It Open

Wang Laboratories (Lowell, MA) is aware of the importance of letting customers select and integrate the components they want. Wang's Open/workflow allows organizations to create and manage work-flow procedures. It lets you organize, automate, manage, and fully integrate work processes with new or existing PC, LAN, Unix, and legacy applications. Wang links a world-class front-end modeling capability with some powerful tools for people who actually build systems.

Tools from Wang such as Open/image Custom Controls for Microsoft's Visual Basic product provide easy, low-cost, interactive client/server applications design with image creation, storage, and manipulation. Open/image User Objects for PowerSoft's PowerBuilder 3.0 product allows developers to integrate document management and routing capabilities. Open/image Connect is a set of software products that enables end users, VARs, and professional services personnel to easily and quickly add image and work-flow functionality to host applications running under terminal emulation windows on PC workstations, to MS-DOS applications running in Microsoft Windows, and to supported Microsoft Windows applications.

Wang has also formed a tight relationship with Lotus Notes. Wang is one of the few Premium Resellers of Lotus Notes and has been involved with the product since 1991 and offers a variety of Notes-specific services.

The current client architecture is based on Windows 3.1, DOS 6.2, and Intel-based PCs (with 12 MB of memory) connected to token-ring LANs. Each workstation supports the network protocols required to connect to the NetWare-based servers (IPX), as well as the LinkWorks and Sybase servers (via TCP/IP). This protocol coexistence relied on the standard Novell environment using ODI (Open Data-Link Interface) software drivers as well as Novell's LAN Workplace for DOS 4.1 for TCP/IP support. Fast DEC Alpha servers run Oracle or OSF/1. The power of the LinkWorks framework is evidenced by the fact that the platform and database migration (historically a major source of trauma to end users) is transparent. End users' interface to the machine remains unchanged.

The bank didn't want to be tied to a particular system or a particular vendor. It needed to accommodate Unix, Macintosh, and PC platforms—both at the front end and the back end. LinkWorks provided the framework to accommodate all the disparate servers and connectivity needs. A variety of servers emerged in the production rollout. A Sybase server is a gateway to the DB2 databases; a videotext server provides access to a repository of procedures and customer service information; and an OS/2 server running NewsEdge from Desktop Data (Waltham, MA) provides access to real-time news and events.

CASE-Style Tools

Products in this category come from two primary sources—CASE vendors and specialized purveyors of industrial-engineering software. These products make no bones about ease of use. They're meant for experienced professionals to use.

Unlike electronic pencils or an increasing number of analysis and modeling tools with origins in work flow, CASE-style tools are probably inappropriate for use by individuals outside the systems design and development domain. If would-be users don't understand industrial engineering or structured programming disciplines or if they do not have process modeling or reengineering expertise, the tool will prove frustrating, and its results will be less than optimal.

CASE-style tools have developed strong followings among business analysts working in the headquarters of corporate planning departments. The reengineering projects in these corporate planning departments are characterized more by their significant role stratification (i.e., corporate planners create the models, another set of people verify the models, and still different people implement them) than by their ability to generate order-of-magnitude process improvements or other business benefits. Further, CASE-style analysis and modeling tools wielded by headquarters planners do not typically produce results quickly, because they are hard to learn and take a long time to execute. Much of the vendor activity in this niche market has been confined to refocusing, repackaging,

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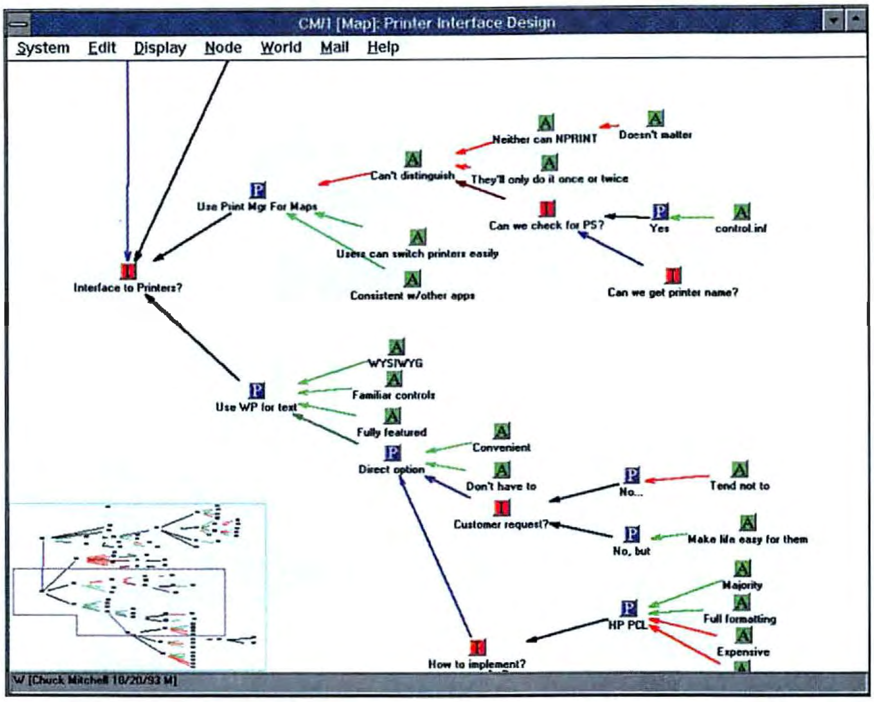

Corporate Memory Systems' CM/1 lets you visually analyze strategic problems that occur over multiple time periods.

and remarketing older products.

CASE-style tools exhibit a wide range in pricing. Tools evolving from traditional CASE product sets define the top of the market, $10,000 to $40,000. These prices, however, are subject to negotiation. PC-based CASE-style tools are more attractively priced in the $1000-per-seat range.

Examples of CASE-style tools include SIMfactory from CACI (Arlington, VA), which features animated work flows, and Business Design Facility from Texas Instruments (Plano, TX), which features extensive training support. TASC-Flow from TASC (Reading, MA) is used extensively by systems integrator GTE Vantage Solutions (Chantilly, VA). One of the reengineering teams at the Bank of Boston has recently chosen Workflow Analyzer from Meta Software (Cambridge, MA) as its process-modeling tool.

Dictionary Software's (Sydney, Australia) InCASE is an easy-to-use PC-based CASE tool for Windows or Windows for Workgroups. It supports entity relationship diagrams, business-process reengineering, data-flow diagrams, and SQL table generation. In addition, InCASE provides an open repository (accessible from ODBC [Open Database Connectivity] databases, PowerBuilder, or Visual Basic), a report writer, and a query facility. InCASE offers a lot of functionality for its $1000 price.

Religious Tools

These tools could be placed in other categories if they did not require the end user to go through a religious conversion to the assumptions and beliefs of the products' architectures. While Lotus Notes is probably the best-known groupware product and is clearly a "convert-creating" kind of tool, it does not include work-flow analysis or modeling functions. Third-party products like Clear Software's (Canton, MA) allClear (which is stronger on analysis, weaker on development support) and Reach Software's (Sunnyvale, CA) WorkMan for Lotus Notes (which is weaker on analysis and stronger on development) are starting to fill that gap.

Most religious tools reflect the efforts of social scientists to impose their conception of how work should happen in real-world operations. For example, when Action Technologies (Emeryville, CA) created its Coordinator product, Stanford University computer-science professor Terry Winograd and management consultant Fernando Flores categorized group activity using models drawn heavily from linguistics. (Coordinator is now sold by DaVinci Systems in Raleigh, North Carolina.) Coordinator postulates a finite number of interactions or conversation types between workers. Their tool forces workplace communications to become very explicit, but it does not necessarily force the desired action to occur.

Consequently, what is being sold is not so much software as it is cultureware. Additionally, because the insights generated by these tools are not linked to code-generating utilities such as DEC's Reliable Flow Manager, the economic power of the ideas are not implemented (see the text box "DEC and Wang Put It All Together" on page 106). The models or maps that these tools generate might tell you what is wrong or how the work flows, but they don't fix the problem.

CM/1 from Corporate Memory Systems (Austin, TX) and OrgMap from NetMap International (San Francisco, CA) are two other examples of religious tools. CM/1 provides a fascinating visual method of working out complex, multifaceted, multi-time-period strategic problems. It is based on a social-science methodology known as Issue-Based Information Systems. OrgMap redraws the organization chart based on the hidden power structures revealed in person-to-person and department-to-department interactions.

The program queries top executives about whom they have regular contact with. The executives then rate the importance of that contact on a scale of 1 to 10. Both sides of the contact must confirm the significance of the link. For instance, if one party assigns a 10 and the other a 2, then OrgMap lowers the overall rating of the link to reflect the disparity. Once all the links are rated, OrgMap groups employees into networks according to where they have the most significant contacts. Each network is represented as a circle, and within that circle, employees are linked by lines according to confirmed links.

Which analysis and modeling tools you use depends on the task at hand, the hardware and software infrastructure of the organization, and the skill sets of the personnel involved. Ideally, organizations will aggressively manage a portfolio of tools and competencies, having developed broad and deep expertise on multiple products. Organizations able to do this will be in a position to mix and match products for "best of breed" performance. ■

Thornton A. May is vice president of Research & Education with Cambridge Technology Partners (Cambridge, MA), a global consulting firm. He is a recognized leader in the designing and delivery of internal management development programs for senior executives and CIOs at Fortune 500 companies. He can be reached on the Internet or BIX at tmay@ctp.com.

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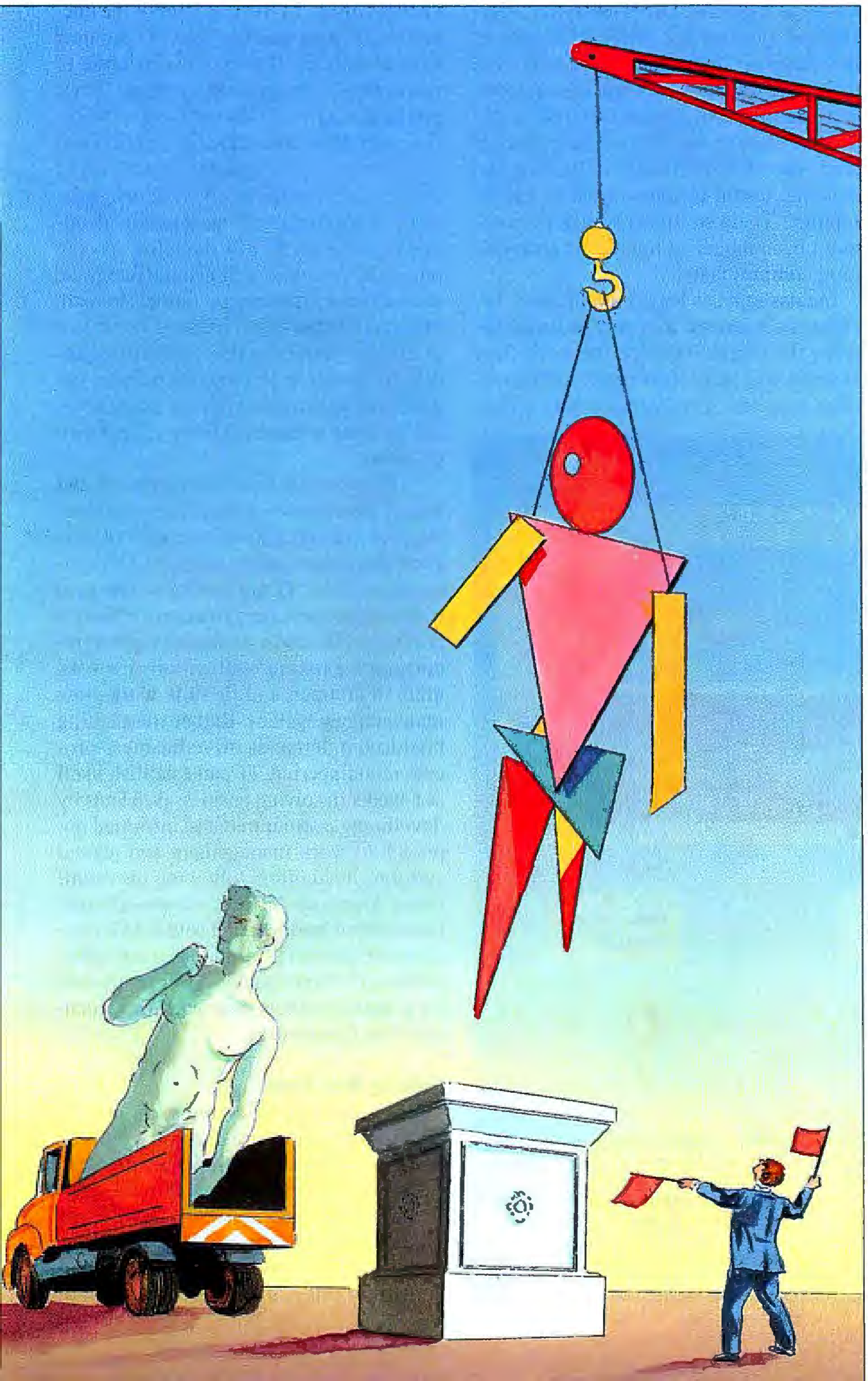
WORK-FLOW AND LEGACY SYSTEMS

Adding work-flow support will become critical to legacy transaction-processing applications

MEICHUN HSU AND MIKE HOWARD



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There are many reasons why a company would want to link complex, mainframe-resident legacy TP (transaction processing) systems with a work-flow system. TP systems are sharply focused on processing structured data for a particular purpose, such as entering a customer's order or accepting a bank deposit. Such systems, many of which are old enough to vote, are accurate and reliable, but they have certain shortcomings in today's world of inexpensive desktop processing cycles and even less expensive storage.

Moreover, most companies are changing the way they do business—pushing decision-making authority farther down the hierarchy, as middle management positions are eliminated; making work more interesting by assigning multiple responsibilities to teams of people, each of whom performs any or all tasks that the workgroup handles collectively. Companies that are embracing globalization often establish ad hoc project teams that are geographically dispersed so that work can proceed around the clock. Semistructured or unstructured information is no longer considered unfit for business use; companies expect that systems will make allowances for data that is less than well organized. Developers—and, increasingly, end users—need an enterprise-wide view of the business processes that keep things humming.

Linking Work Flow to TP

For more than a generation, legacy TP systems have done a superior job of handling the transactions that result from discrete business events. Typically, one event triggers a cascade of others, each carried out by an application that calls, and is called by, other applications. By one estimate, a typical large bank may have from 2000 to 20,000 interconnected applications. However, many of these connections represent business policies and practices that may or may not be relevant to today's way of doing business. Often, no one can evaluate these practices—let alone modify or maintain the interconnected applications—because the linkage among related applications is encoded in the applications themselves or documented in operational manuals. Such manuals tend to become part of the oral history of the company, with all the invention, omission, and potential for inaccuracy that verbal transmission implies.

Unraveling the mysteries of current computer-enforced policies and practices is the result of business-process analysis, redesign, and modeling. This is painstaking work that involves inspecting both manual and computer-mediated procedures; identifying those procedures that are unnecessary, redundant, or outdated; and supplanting them with processes that meet today's needs and are flexible enough to be modified as conditions change. According to a 1994 Gartner Group paper, case studies show that companies can reap more than 50 percent of the benefits of business-process reengineering even before they apply new technology to the redesigned processes. But the rest of the payoff depends on automating these processes, and that is the purpose of developing automated work-flow systems.

Work Flow as Integrator

A key role for work-flow management software will be as the integrator of disparate applications—legacy systems from the mainframe days. Indeed, more than 70 percent of reengineering efforts based on IT (information technology) will automate well-understood business processes that are currently paperbound, suffering from outdated or flawed IT systems designs, or just never connected to other important business systems. Order-entry and purchasing systems are prime examples of host-based systems that can benefit from the superimposition of work-flow systems that add processing logic and data to important existing applications and manual processes. It is foolhardy to believe that existing, useful business systems can be scuttled. To do so involves making enormous economical, political, and sociocultural commitments.

Increasingly, as legacy applications become modularized into encapsulated objects, the target audience for work-flow systems will be professionals and knowledge workers, who typically rely on paper, telephones, desktop applications, and perhaps E-mail. Work-flow systems will let these end users hold more power and work with more flexibility by combining application components in new ways for ad hoc response to key business events.

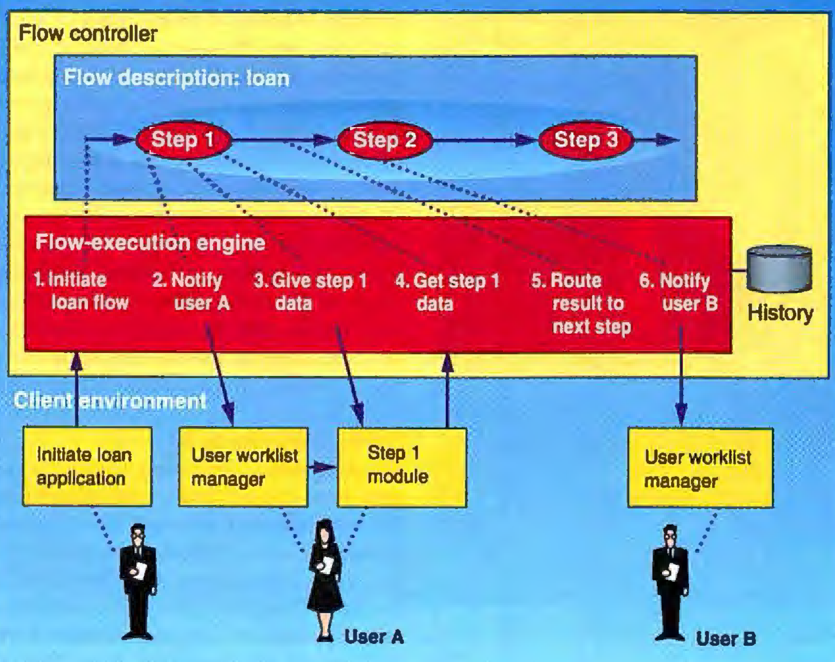
In the immediate future, most work-flow applications will be custom-developed and proprietary to the businesses that use them. In the near future, however, you will see the entry of work-flow system vendors, many of them alumni of the document-imaging marketplace, where they have already cut their teeth on a subset of work-flow management systems. Their products may well take the form of work-flow templates, into which developers and end users will plug specific objects, either encapsulated from legacy systems or developed specifically to meet newly identified business needs, to accomplish specific purposes. Vendors will also differentiate themselves by offering prefabricated work objects. Furthermore, most of the major platform vendors in the marketplace today are building large direct-service capabilities to provide systems integration, not necessarily biased in favor of their own products.

Linking work-flow management and legacy host-based systems presents challenge and opportunity to independent software developers and corporate IT organizations alike. IT organizations can give business-process reengineering efforts a real-world flavor by exploring ways to incorporate existing applications as work units in an open and flexible work-flow management system. Rather than letting boardroom demands drive business-process reengineering, IT can establish itself as a leader in solving business problems by developing a structured and informed approach to work management and related systems. In addition, following the example of American Airlines, whose information-systems business unit sold CASE templates developed for in-house use to other airlines, IT shops may discover profit-center potential in their own work-flow management frameworks.

Defining Work Flow

Today's work-flow systems are largely homegrown; most are currently embedded in or integrated with document management systems—for example, loan application processing systems (see the figure "Execution of a Simple Flow"). More highly evolved work-flow systems treat document images as objects and route

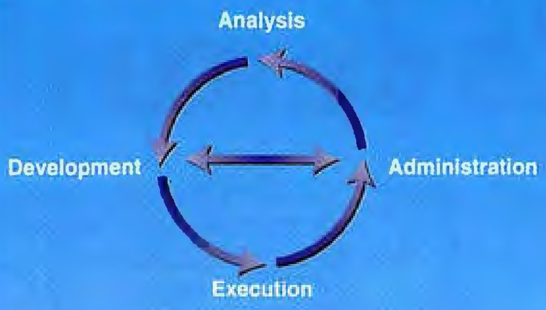
Execution of a Simple Flow



Execution of a simple flow in a loan-processing system proceeds as follows: ❶ The flow controller notifies user A (through user A's worklist manager) that step 1 is waiting to be done. ❷ User A chooses to perform step 1. ❸ The work-flow system's client environment invokes the application needed to perform step 1. ❹ The application interacts with the flow controller and provides the application's initial arguments and then collects its results. ❺ When step 1 is finished, the flow controller routes the result to the next step and notifies user B that step 2 is waiting. ❻ The sequence continues for steps 2 and 3.

As the loan flow progresses, the flow controller writes execution events into the history repository, from which the user can retrieve information relating to the progression of the flow.

Life Cycle of a Work-Flow Application



Phases and associated tasks are as follows:

Analysis—Analyze the targeted departmental or enterprise-wide operations. Identify resources, data objects, policies, and procedures.

Development—Using results of the analysis phase, construct executable work-flow descriptions. Populate organizational databases, develop applications and their data-object managers, or integrate with existing applications and data managers.

Execution—Create and execute work-flow instances.

Administration—Using the status and history information provided by the execution phase, analyze history data and provide feedback to the analysis and development phases.

them through office mail or messaging systems, allowing notification of the end user when work arrives at the workstation. This is all very useful, but the true payoff of work-flow systems will be realized when the abstractions of business processes can be taken to a higher level, where business users can understand and manipulate them to optimize processes for competitive advantage. This requires that work-flow management systems be separated from document management or office systems and that they serve as an umbrella for such systems.

A full-fledged work-flow management system is one that supports the development, execution, and analysis of multistep, multiuser business processes. It manages the flow of work among participants in the system, based on business-specific procedures, constraints, and objectives developed during the process-analysis and modeling efforts. Flow descriptions—not to be confused with data flows, which deal with the movement of data, not work—are the programs that work-flow systems follow in implementing a business process. A *flow* is a compound work unit, composed of modular work units called *steps*, and possibly other nested flows. Each work unit in the flow has its own description. Modular work units are combined according to dependencies among them. Event-driven triggers can cause the modular work units to execute sequentially or in parallel. Flow descriptions and associated process information are stored in a process repository, just as *metadata*—information about the data with which an application works—is stored in a data dictionary.

A *work unit* is an application routine (or a set of routines, if the work unit is a nested flow); each work unit is necessary for accomplishing a single business function. Applications can use different programming paradigms and run on different platforms; they are interrelated by information and control flow. A flow can operate within or across organizational boundaries.

The work-flow system ensures that individual flows execute reliably and continually until they are properly terminated. The system tracks execution events and supports user inquiry and analysis of the flow's current execution status and history. Exception-handling actions, such as retry and compensation, may be programmed in the flow description; alternatively, they may be specified ad hoc by control commands during execution. Exception handling may also require synchronization with applications.

Work-Flow Life Cycle

The life cycle of the work-flow system is similar to that of other application systems (see the figure "Life Cycle of a Work-Flow Application"), recursively moving through the phases of analysis, development, execution, and administration. Each phase requires its own environment. Similarly, those who interact with work-flow systems fall into four categories. Business-process analysts analyze business operations during the analysis phase, using BPR (business-process reengineering) tools and business-process models. They identify objects and their behaviors (or methods) in an abstract manner and provide input to developers. They can use feedback from the execution phase for continuous process improvement.

Developers design and capture flow and applications descriptions during the development phase. Flow developers develop

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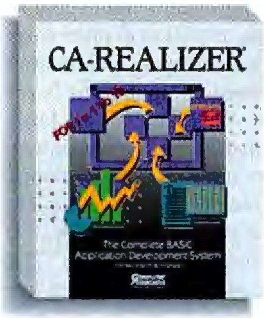

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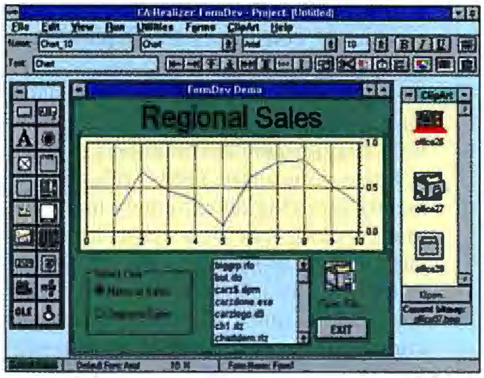

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flow descriptions, using flow development environment tools such as a flow editor and a flow simulator. Applications developers develop the applications that form the bases of steps, using applications development environment tools.

Workers, or users, initiate and carry out the execution phase. These are the people who perform the work in a step, on whose behalf servers perform work, and who handle exceptions when they occur.

Administrators manage the business process that the work-flow system addresses through most of the life-cycle phases. They manage organizational process databases that hold resource descriptions and policies, such as security and resource utilization policies. They may handle flow exceptions, monitor and control execution, alter flow descriptions to react to special situations, and update descriptions. They are different from systems managers, whose tasks fall outside this discussion, in that they focus on business processes and not on the technical aspects of the computer system itself.

Principles of Work-Flow Architecture

Certain principles provide the framework for a work-flow management system architecture. First is the separation of flow control and data management. The work-flow component manages complex events, triggers, and organizational policies and constraints as specified in high-level descriptions. It cooperates with data managers but is not embedded in them. A second principle holds that the work-flow system is composed of open components that are flexible, customizable, and replaceable. The heterogeneity principle allows multiple heterogeneous applications environments to participate in work flow. The reliability principle holds that work-flow systems can use transactional synchronization and recovery services to preserve data consistency when necessary. The principle of scalability declares that a work-flow system can be partitioned into logical areas of independent control called *domains*. A single flow can span multiple domains. The final principle, infrastructure integration, enables the work-flow system to use standard services, such as object-request brokerage, name and transport services, and message and data-interchange protocols.

A work-flow system is not a TM (transaction manager), although it may use a transaction manager for synchronization with database managers. The TM of open TP monitors is typically a separate, open component. Also, a work-flow controller is not a TPM (TP monitor), although it must interoperate with standard, open TM services. Finally, a work-flow system is not intended for coordinating relatively unstructured groupware activities or for monitoring personal agenda and calendar applications. However, these applications and tools can interact with the work-flow system to offer complete work-flow functionality.

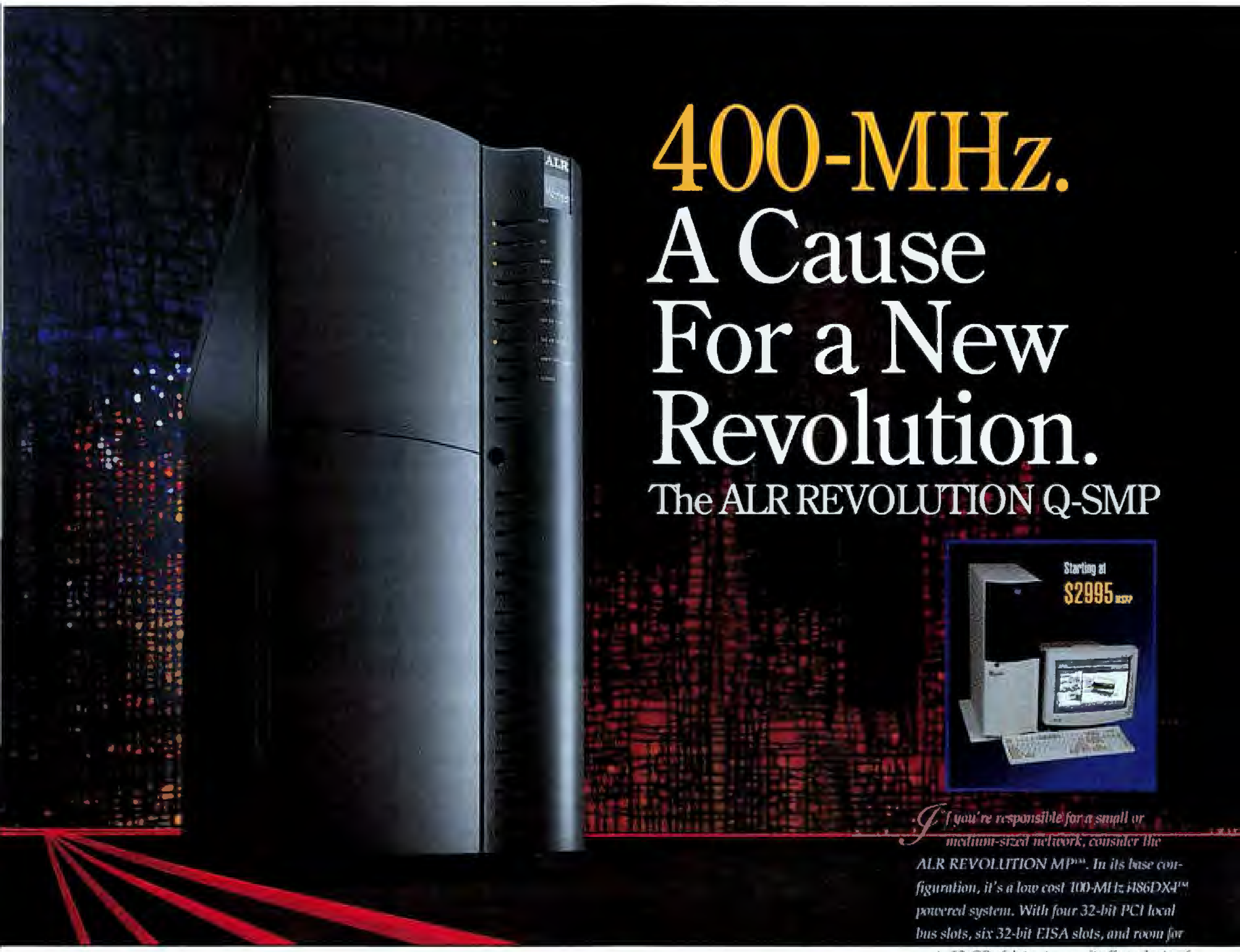
Managing the Evolution

The work-flow approach is applicable to legacy TP systems, as well as in other areas where support for developing and reliably executing long-lived computations is required (e.g., CAD/CAM, electronic business documents, and imaging applications).

TP applications are typically developed using a TPM, which provides a complete environment for supporting integrated database-intensive applications. The TPM funnels requests and results between terminals and applications servers and provides queuing and transaction management services that ensure recoverability and optimize performance. A current trend is to downsize TPMs—to free them of their proprietary constraints and deploy them on open systems, providing client/server interfaces and accommodating open database servers and heterogeneous applications development environments.

Some proprietary TPMs' role in efficiently servicing an extremely high volume of short, specific requests against a large amount of shared data is impossible to replace anytime soon. However, you can off-load many applications that are crowded onto an aging TPM system—although not without pain—and better manage them with an open TM system. Open TP is a critical stage in modernizing TPMs, but further developments are needed to allow next-generation TPMs to accommodate standard and extended-service components.

For example, the CORBA (Common Object Request Broker Architecture) standard, endorsed by the Object Management Group, may provide the backbone for



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MAX 1-GB RAM	512-MB RAM
EDC/ECC Memory	EDC/ECC Memory
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715 WATTs Power	445 WATTs Power
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heterogeneous applications integration. The services of the Object Request Broker allow functions (called *methods* in object-oriented circles) to be organized in an object-oriented framework, enhancing manageability and extensibility of the applications servers that provide them. An extensible transaction manager may support extended transaction models, such as nested transactions and sagas, and allowing new transaction models to be defined dynamically. Application and database servers in the next TPM generation may be active (i.e., they may be capable of monitoring events of interest to other components in the system and providing event notification when these events occur).

If a work-flow management system is to be effective in mission-critical business-process management, then it must be able to integrate TPM-based applications into its modular work units, or *step applications*. The marriage of TP and work-flow technologies is a necessity to make business-process abstractions available on both the development and execution sides of the business.

The marriage of TP and work-flow technologies is a necessity to make business-process abstractions available on both the development and execution sides of the business.

This marriage will probably occur in three stages. In the first stage, the terminal-emulation capability provides the linkage to legacy TP applications on monolithic TPMs. This is happening now. At the user-system interaction level, a step in a work flow appears as an application that a conventional TPM application expects. The work-flow system uses terminal emulation to interact with the TP system, activating TP applications and sending information to and extracting information from the legacy system. At this stage, there is no redevelopment or reengineering of the legacy system: Integration may be laborious, and there is a reliability window with respect to the flow state.

In the second stage, TPM applications are developed with a client/server model. APIs supplant terminal-level interfaces, allowing a step application to invoke the APIs while presenting to the end user a modern user interface. In addition, a step application can leverage services provided by other IT components, such as document and imaging systems, and desktop utilities and tools. This stage requires the existence of both open TP monitors and open work-flow managers—in the sense that appropriately documented APIs are available.

The third stage features an integrated applications development life cycle, in which business-process analysis and reengineering tools, as well as organization resource managers, such as calendar applications and corporate resource-policy databases, are able to work together with work-flow managers and TPMs. At this point, front-end business-process analysis tools produce business-process templates, from which work-flow managers automatically or semiautomatically synthesize and execute work flows.

Work Flow Ahead

The advent of the complete work-flow management environment is not far away. According to a 1993 Gartner Group study of the consultancy's clients, 67 percent currently use E-mail and 90 percent expect to have it in use by 1996. Calendar and scheduling applications are installed in 33 percent of companies, with 63 percent expecting to have them on-line by 1996. Business-intelligence systems, used for near-real-time analysis of marketing, point-of-sale, and other types of data for strategic decision-making, exist in 12 percent of companies today, with 34 percent intending to have them installed by 1996.

In addition, the study found that imaging, document, and work management technologies will reach critical mass by 1995 and will then become fundamental building blocks in the electronic workplace of the future. The broad use, consolidation, and maturation of these and other applications, in conjunction with continued pressure to supplement and support existing legacy systems with desktop systems, will ensure an increasingly critical role for work flow—and for the analytical and modeling tools that support the design, development, and deployment of work flow on legacy systems. ■

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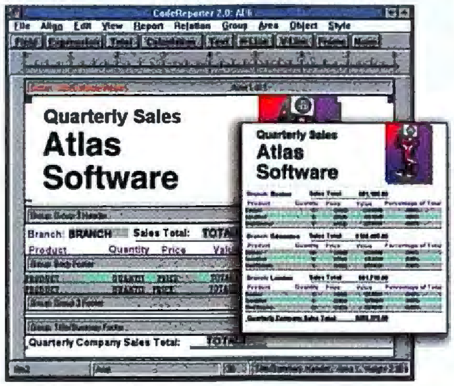

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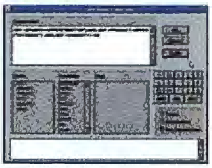

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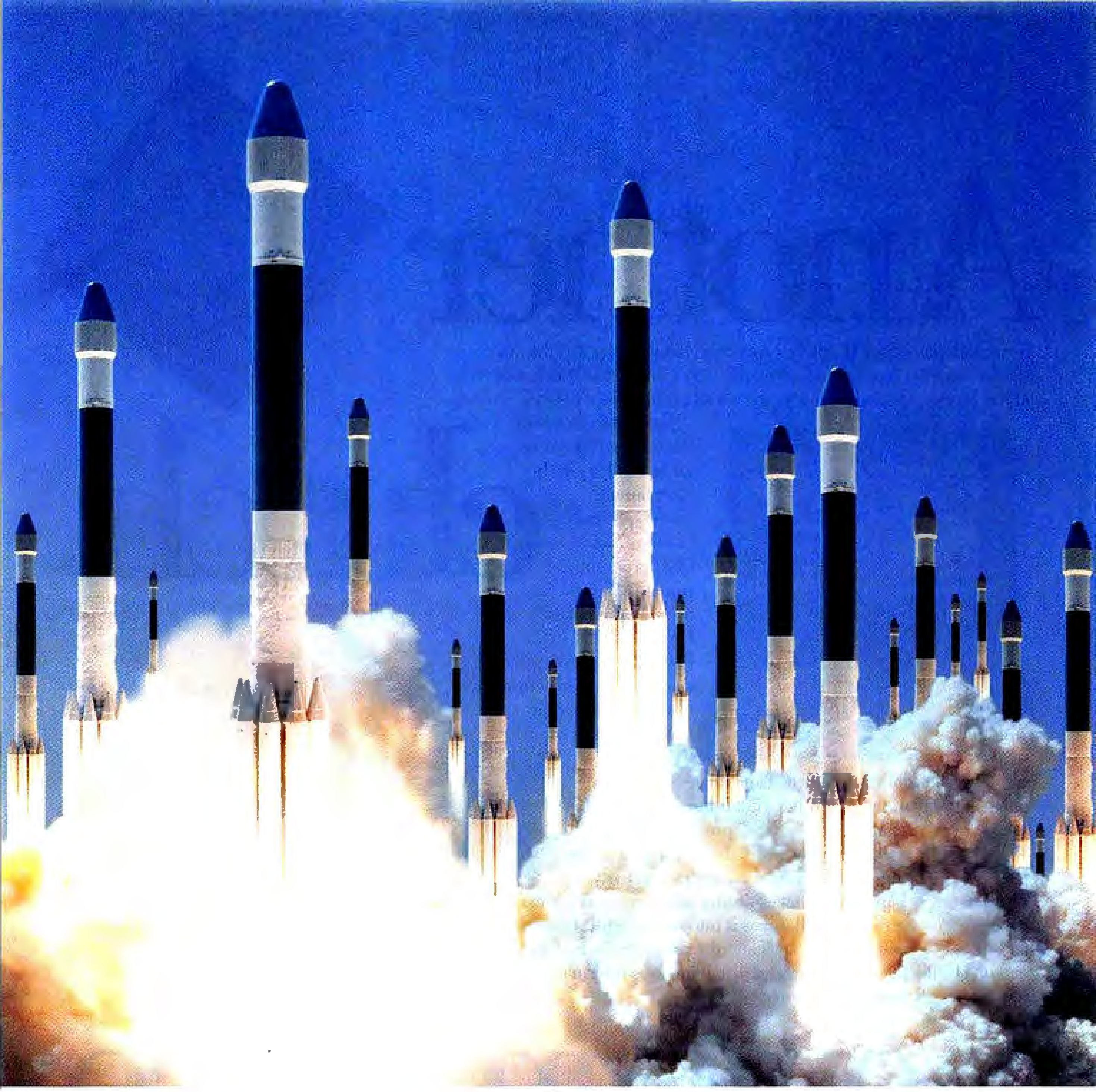


Network Management Systems

BYTE evaluates the most popular tools for testing and monitoring complex LANs

Today's local-area networks (LANs) constitute a collection of highly complex computing devices and systems. Although LANs have proved to be effective computing platforms, their growing complexity without a commensurate advance in management capability has left some organizations ambivalent with regard to large-scale LAN implementations.

The pressure to downsize seems to emphasize the attractiveness of LANs as alternatives to mainframe and minicomputer information systems. Organizations, however, are keenly aware of the offsetting danger posed by committing critical business applications and data to LANs without comprehensive management tools. The solution for some has been to use LANs for less-critical departmental applications while maintaining mainframes and minicomputers as repositories of critical data. A few strong LAN management products based on solid standards will surely alleviate some of the fear.

This month, we evaluate network management and network utility programs that span a variety of capabilities, functions, and categories, from desktop network administration utilities to high-end products with enterprise-wide device management and alarm-reporting capabilities. This review considers only network management products supporting the NetWare environment.

Central Point Software's XTree Tools, Frye Computer Systems' Frye Utilities, and LAN Support Group's BindView NCS are DOS applications, while the management consoles of the rest of the products require Windows 3.x to run. Only Central Point Software's LANlord requires a dedicated management server (running OS/2 1.2 or higher) in addition to a Windows 3.x management console. Only LANlord and Intel's LANDesk Manager are offered as single, integrated products. All the other products require one or another utility module to make them a complete offering. Frye sells all its management utility products as independent modules; they all work together without a hitch.

The evaluated management products do not fit into one or two neat categories. We have attempted to group them into enterprise management/device management products (Novell NMS and VisiSoft's VisiNet) and desktop management products (the remaining seven products). Even after that general grouping, distinctions remain between products in each group in terms of product architecture, functional emphasis, and breadth of features. Among the desktop management products, Brightwork Development's Brightwork Utilities, Frye Utilities, LANDesk, LANlord, Saber Software's Saber LAN Workstation, and XTree Tools are more directly comparable.

We weren't able to evaluate every network management product. Other vendors of these products include Symantec Corp. ((800) 441-7234), Shany, Inc. ((415) 694-7410), and Horizons Technology, Inc. ((800) 828-3808).

Network Management Applications

Network management in its simplest form involves only the administration of network physical and logical resources. If networks functioned without failures and security breaches, the primary tasks of network administration would involve adding and removing users; assigning access rights to network resources; making application and peripheral resources available to users; periodic network backup; and monitoring network capacity and resource usage to plan and carry out expansion.

Real networks, however, are seldom so simple. In addition to the complexity that comes with size and heterogeneity, networks experience breakdowns caused by hardware failures, software bugs, protocol-related errors, and exceeding critical performance thresholds. Good diagnostics software, documentation, and experience may be enough to handle problems associated with hardware failures and occasional software bugs. Other network problems are not as easily diagnosed and corrected and require a variety of management tools, including protocol analyzers, within an integrated management system.

Network Monitors

Network monitors are designed to provide mainly network traffic statistics, performance threshold setting and monitoring activities, and alert notification to critical events in network performance or resource status. Monitors are generally device-

OVERVIEW

NSTL RATING		VERSION	NETWORK MANAGEMENT	VERSATILITY	DIAGNOSTICS	EASE OF LEARNING	EASE OF USE
	DESKTOP MANAGEMENT SYSTEMS						
★★★★	Frye Utilities for Networks	1.5	▲	▲	▲	▲	▲
★★★★	LANDesk Manager	1.51	▲	▲	▲	▲	▲
★★★	Saber LAN Workstation	2.0	▲	▲	▲	▲	▲
★★★	Brightwork Utilities for NetWare	1.0	▲	▲	▲	▲	▲
★★★	BindView NCS	3.12	■	■	■	▲	▲
★★★	XTree Tools for Networks	1.5	■	▲	■	▲	▲
★★	LANlord	2.0	■	■	▲	▲	▲
	ENTERPRISE MANAGEMENT SYSTEMS						
★★★★★	Novell NMS	2.0	▲	▲	▲	▲	▲
★★	VisiNet	2.0	■	■	▲	▲	■

KEY

★★★★★	Outstanding
★★★★	Excellent
★★★	Average
★★	Below average
★	Poor
▲	Good
■	Fair
▼	Unacceptable

independent, software-only products obtained at a lower cost than protocol analyzers.

Based on the specific implementation, some network monitors are dependent on the underlying NOS (network operating system) to obtain traffic statistics, current network activity and status, and other relevant network database information. Most of the NOSes on the market offer some degree of network administration and management services, such as setup management, performance monitoring, security, and accounting.

Although not all of these services are open to applications programmers, a few NOS vendors offer APIs to some of them. The limitation of network monitors dependent on the host NOS is their inability to provide reliable services when the operating system is experiencing problems. Monitors that interface to the network via a MAC (media access control) driver cannot provide node configuration information without some higher-level protocol driver, such as NetBIOS. The monitors discussed here, however, are fully independent of the NOS and thus are not affected by the status of the NOS software.

Protocol Analyzers

Unlike network monitors, which basically identify and count frames and then provide a statistical summary, protocol analyzers are designed to provide more detailed information about the network's inner workings (and therefore are more expensive). Although a few software-only protocol analyzers are available, most protocol analyzers are offered as turnkey systems with specialized hardware. They can not only capture packets traveling over the communications medium, but also decipher and analyze those packets for specific protocol components and data.

Protocol analyzers are similar to network monitors in their ability to count frames and manipulate captured packets for summary view according to filter and trigger conditions. The additional capability of protocol analyzers to dissect a frame into all the protocol layers and embedded data makes them indispensable for diagnosis and problem determination in the event of network failure.

Server and Workstation Monitoring

A server- and workstation-monitoring module is similar to a network-monitoring module except that the focus is on server and selected workstation statistics.

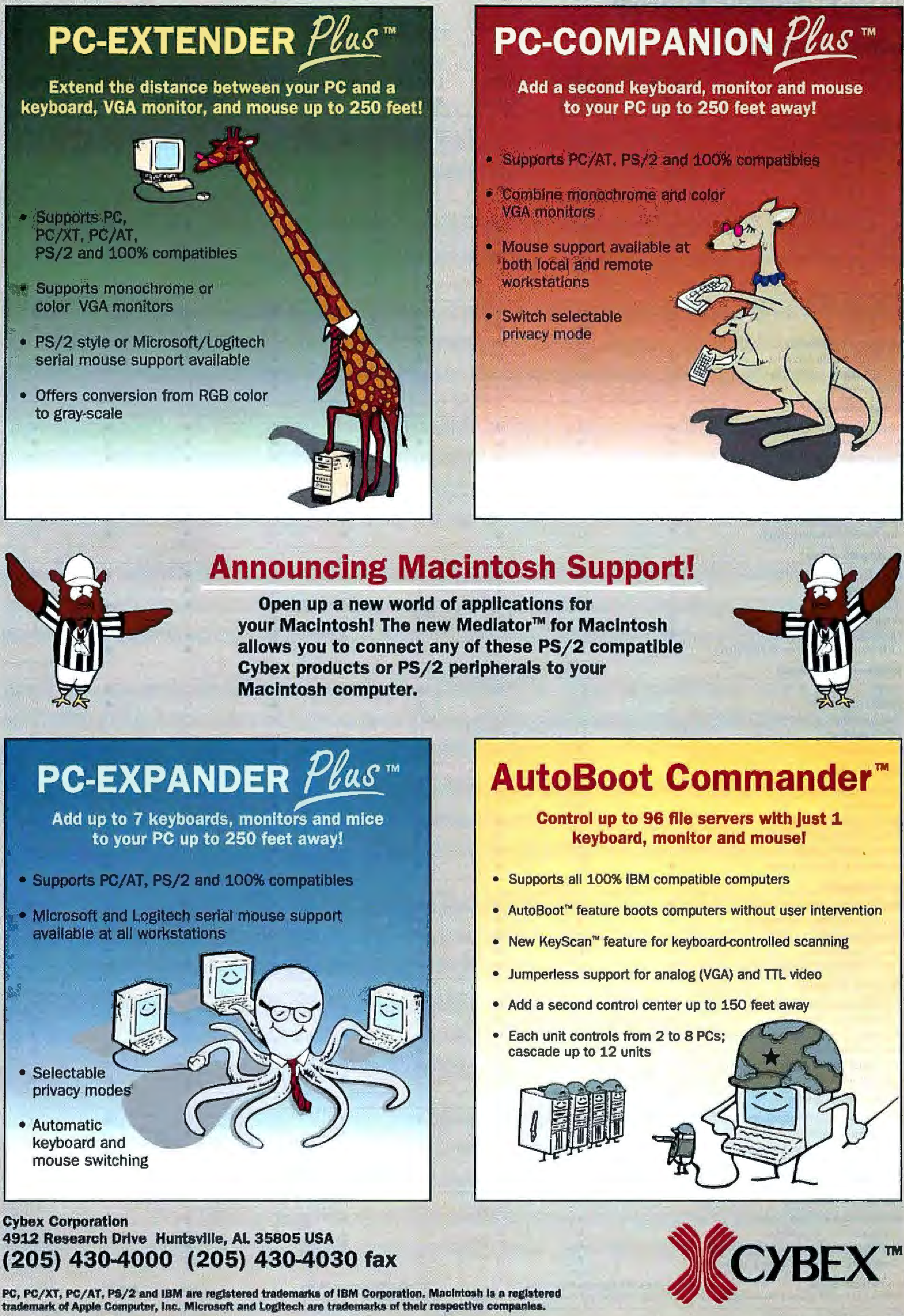
On some management programs, such as LANlord, the workstation-monitoring utility enables the network manager to define alert thresholds and notifications, including automatic alerts triggered by changes to PC hardware and system configuration files. It additionally allows automatic identification and reporting of inactive PCs, lost physical network connections, and monitoring and logging of network client packet statistics.

Inventory Control and Asset Management

This management utility lets the network administrator gather information on a company's computing assets. The inventory-control management module tracks file-server and client-workstation hardware components (including Macintosh computers in some products, such as LAN-Desk Manager and Frye's LAN Directory) and server and workstation configuration

Highlights

	Strengths	Limitations
BindView NCS	Excellent report generation and layout features Very good server and workstation management functionality Very easy to learn and use	No global network monitoring and analysis option No network management standard interface Lacks full Windows support
Brightwork Utilities for NetWare	Good workstation management support Very good printer management features Competitively priced	Limited NOS support No global network monitoring and analysis option No network management standard interface
Frye Utilities for Networks	Excellent file-server monitoring and early-warning module Very robust suite of management utilities for NetWare LANs Very good database administration features Easy to set up and use	Lacks full Windows support No network management standard interface Limited NOS support
LANDesk Manager	Very good user-interface features Very good diagnostics and error-handling features Good management standards support	NOS-dependent Limited system and database administration functions Limited alert notification and response option
LANlord	Very good workstation management functionality for large-scale installations Very good user-interface features Good documentation	No server management capability Limited configuration option No global network monitoring and analysis option
Novell NMS	Superior user-interface features; best on-line help and reference Good management standards support; widest network system and device management support Best database administration features	Limited desktop management functionality Limited network administration utilities (e.g., printer management and virus protection) Limited report generation
Saber LAN Workstation	Excellent desktop environment set-up and management Excellent NOS support Very good usability features	No network management standard interface No global monitoring and analysis option Limited alert-notification option
VisiNet	Excellent visual representations of enterprise network components (across LAN and WAN) Good management standards support Excellent SNMP support	No global monitoring and analysis option No workstation management Limited alert-notification option
XTree Tools for Networks	Very good DOS-based NetWare environment management utility with the best price Good server and workstation management functionality Easy to set up and use	No global monitoring and analysis option No network management standard interface Limited NOS support



Circle 81 on Inquiry Card (RESELLERS: 82).

NETWORK MANAGEMENT FEATURES

	BINDVIEW NCS	BRIGHTWORK UTILITIES	FRYE UTILITIES	LANDESK MANAGER	LANLORD	NOVELL NMS	SABER LAN WORKSTATION	VISINET	XTREE TOOLS
Management console									
Windows application	○	●	○	●	●	●	●	●	○
OS/2 PM application	○	○	○	○	○	●	○	○	○
Unix application	○	○	○	○	○	●	○	○	○
DOS application only	●	○	●	○	○	○	○	○	●
Agent software on clients									
PC client workstation	●	●	●	●	●	●	●	●	●
OS/2 client workstation	○	○	○	○	○	○	○	○	○
Macintosh client workstation	○	○	●	●	○	○	○	○	○
Unix client	○	○	○	○	○	○	○	○	○
Managed device support									
File servers	●	●	●	●	○	●	●	○	●
PC workstations	●	●	●	●	●	○	●	●	●
Macintosh workstations	○	●	●	●	○	○	○	○	○
Communications gateways	●	●	●	●	●	●	●	○	●
Wiring hubs/concentrators	○	○	○	○	○	●	○	①	○
Bridges/routers	○	○	○	○	○	●	○	①	○
Network systems support									
Novell NetWare 2.xx	●	●	●	○	○	○	●	●	●
Novell NetWare 3.xx	●	●	●	●	●	●	●	●	●
Novell NetWare 4.xx	○	○	●	○	●	●	●	●	○
Banyan Vines 4.xx	②	○	③	○	○	○	●	○	○
Banyan Vines 5.xx	②	○	③	○	○	○	●	●	○
IBM LAN Server 2.x and 3.x	②	○	③	○	●	○	●	●	○
Microsoft LAN Manager 2.x	②	○	③	○	●	○	●	●	○
Any NetBIOS-based network	●	○	③	○	●	○	●	●	○
Network protocol support									
Novell NetWare IPX/SPX	●	●	●	●	●	●	●	●	●
Banyan Vines IP	②	○	●	④	○	⑤	●	○	○
TCP/IP	②	○	○	④	○	●	●	●	○
Apple AFP	②	○	③	④	○	⑤	○	○	○
NetBIOS	●	○	○	④	●	⑤	●	●	○
LAN Manager/LAN Server NetBEUI	○	○	○	④	●	⑤	●	●	○
Management standards support									
SNMP	②	○	○	●	⑥	●	○	●	○
RMON SNMP	○	○	○	●	○	●	○	●	○
IBM NetView	○	○	○	○	○	●	○	○	○
HP OpenView	○	○	○	○	○	○	○	○	○
Novell NMS	②	●	●	●	●	●	●	●	○
Diagnostic features									
Adapter diagnostics	○	○	●	●	○	○	○	○	○
Cable faults	○	○	○	○	○	●	○	○	○
Single-station echo test	○	○	●	●	●	●	○	○	●
Transmission errors	○	○	○	●	●	●	○	●	●
Server-specific errors	○	○	●	●	○	●	○	●	●
Workstation-specific errors	●	○	●	●	●	●	○	●	○
Server management									
Server configuration information	●	●	●	●	○	●	●	●	●
Server disk/volume information	●	●	●	●	○	●	●	●	●
Security and user account	●	●	●	●	○	●	●	●	●
Server monitoring	●	●	●	●	○	●	●	●	●
Set up threshhold values	●	●	●	●	○	●	●	●	●
Workstation management									
Client configuration information	●	●	●	●	●	○	●	○	●
System file access/modify	●	●	●	●	●	○	●	○	●
Workstation monitoring/performance statistics	●	●	●	●	●	○	●	○	●
Remote control	●	●	○	●	●	○	○	○	●
Identify/correct application problems	○	○	○	●	○	○	○	○	○
Set up threshold values	●	●	○	○	●	○	●	○	●
Hardware/software inventory									
Inventories client PC hardware	●	●	●	●	●	○	●	●	●
Inventories client PC applications	●	●	●	●	●	○	●	●	○
Inventories OS/2 client hardware and apps	○	○	○	○	○	○	○	○	○
Inventories Macintosh client hardware	○	●	●	●	○	○	○	○	○
Inventories Macintosh client applications	○	●	●	●	○	○	○	○	○
Application software metering									
Applications on network drives	○	●	○	○	●	○	●	○	○
Applications on local drives	○	●	○	○	●	○	●	○	○
Alert when license exceeded	○	●	○	○	●	○	●	○	○
Block execution when license exceeded	○	●	○	○	●	○	●	○	○

① Via the SNMP module
② Planned for second quarter 1994 availability
③ Frye's LAN Directory module only
④ Traffic-monitoring portion of LANDesk Manager
⑤ Novell's LANalyzer agents only
⑥ Via proxy agent
○=no ●=yes

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NETWORK MANAGEMENT FEATURES *(continued)*

	BINDVIEW NCS	BRIGHTWORK UTILITIES	FRYE UTILITIES	LANDESK MANAGER	LANLORD	NOVELL NMS	SABER LAN WORKSTATION	VISINET	XTREE TOOLS
Electronic software distribution									
Automated application installation	○	⑦	●	○	○	⑧	●	○	○
Automated file copy/distribution	●	⑦	●	○	●	⑧	●	○	○
Operating-system installation	○	⑦	●	○	○	⑧	●	○	○
Automated software upgrades	○	⑦	●	○	○	⑧	●	○	○
Scripting for creating distribution lists	○	⑦	●	○	○	⑧	●	○	○
Network monitoring/protocol analysis									
Captures Ethernet-segment MAC frames	○	○	○	●	○	●	○	○	○
Captures Token Ring–segment MAC frames	○	○	○	○	○	●	○	○	○
Captures Novell IPX/SPX packets	○	○	○	●	○	●	○	○	○
Captures TCP/IP packets	○	○	○	●	○	●	○	○	○
Captures AppleTalk packets	○	○	○	●	○	●	○	○	○
Real-time traffic monitoring	○	○	○	●	○	●	○	○	○
Protocol analyzer module	○	○	○	○	○	●	○	○	○
Workstation threshold settings/event tracking									
Disk space free (%)	●	○	○	○	○	○	●	○	○
Changed configuration	●	○	○	●	●	○	●	○	○
All workstation events logged	●	○	○	●	●	○	●	○	○
Server threshold settings									
Server utilization (%)	●	●	●	●	○	●	○	○	●
Disk space free	●	●	●	●	○	●	●	○	●
Cache hit ratio (%)	●	●	●	●	○	●	○	○	●
I/O requests pending	●	●	●	●	○	●	○	○	●
Response options									
Run an external program/batch file	●	●	●	●	●	●	○	○	●
Modify system files and reboot workstation	●	○	●	○	●	○	○	○	○
Adjust system files, shut down, and restart server	●	○	●	○	○	●	○	○	●
Report options									
Report scripts	●	●	●	●	●	●	●	●	●
Script editor	●	●	●	○	●	○	●	○	○
Exports to spreadsheet	●	●	●	●	●	○	●	○	●
Exports to database	●	●	●	○	●	○	●	○	●
Report types									
Global network monitoring	○	○	○	●	○	●	○	○	○
Network utilization	○	●	●	●	○	●	○	○	●
Network inventory	●	●	●	●	●	●	●	●	●
User accounts	●	●	●	○	○	●	●	○	●
Topology display options									
Network components depicted graphically	○	○	○	○	○	●	○	●	○
Bridges/routers	○	○	○	●	○	●	○	●	○
Server	○	○	○	●	○	●	○	●	○
Workstations	○	○	○	●	●	●	○	●	○
Real-time inventory update	●	●	●	●	●	●	○	●	●
Advanced features									
User programming	○	○	○	○	○	●	○	○	○
APIs	○	○	○	○	○	●	○	○	○
External device attachment for alert notification	●	●	●	●	●	●	●	●	●
Other features									
Virus-protection module	⑨	●	○	●	●	○	⑩	○	○
Storage management	⑨	○	○	○	○	⑪	●	○	○
Task-scheduling module	●	●	●	●	○	●	●	○	●
Interface to NetWare utilities	●	●	●	●	○	○	○	○	●

⑦ In Brightwork's Fusion 1.0
⑧ Via Novell's Navigator 3.0, not currently integrated with NMS
⑨ Planned for second quarter 1994 availability
⑩ Scan only
⑪ Via SMS, not currently integrated with NMS

information and applications.

The program automatically tracks applications on workstations and servers by scanning their drives. The inventory-control program collects hardware and software information on a network based on a standard hardware parts list and known-applications software list. In some management programs, retrieved server and workstation hardware information may include data on the CPU, coprocessor, memory, operating system, device drivers, system setup (CMOS) and BIOS information, and configuration files.

In addition to automatic identification of hardware, these management modules allow manual entry of additional information for asset tracking and management.

Network Topology and Mapping

Among the evaluated products, only Novell NMS and VisiNet provide automatic discovery of network topology and logical mapping of the network. LANDesk Manager and LANlord provide a quasi-topology map in the form of a Windows File Manager directory and file tree.

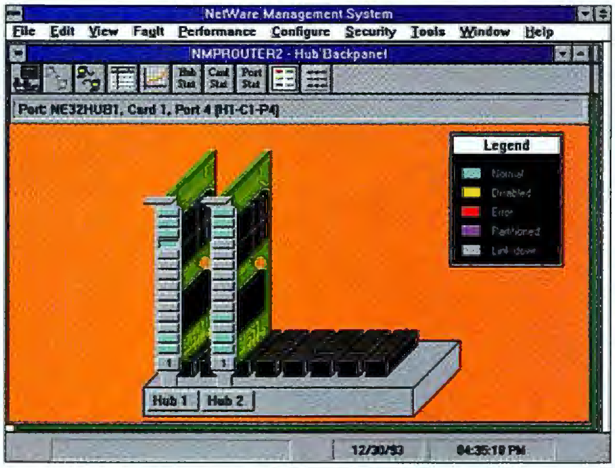
Other management products can automatically discover network components, but they present discovered entities in list form. Discovered topology information may include the network segments, nodes on segments, adapter cards connected to segments, addresses applicable to nodes, and advertised services such as routing, network servers, and hubs.

Some management programs (e.g., VisiNet) allow the network manager to create a graphical representation of the nodes and links in a network segment or an internetwork. Both Novell NMS and VisiNet allow physical (mainly location) and logical (interconnect devices, file servers, and workstations represented by icons) maps of the network.

Help Desk

A help-desk application combines workstation management and remote-control software. It can perform workstation monitoring and gather network and workstation configuration and diagnostic information. This provides the administrator with a valuable database for tracking overall network configuration and isolating network problems.

The help-desk component provides tools for accessing and controlling workstations remotely, to resolve user problems from a management console. When a user calls with a problem, the network administrator can establish a direct connection with the user's workstation and inspect the hardware and software configuration; gain full control of remote Windows and DOS resources, including the user's screen, keyboard, and mouse; remotely view and edit system files; perform file transfers with chat support; execute programs on the user's workstation; and even reboot the workstation, if necessary, to make configuration changes active.



NetWare Hub Services monitors hub performance and attached stations and enables or disables network access to connected stations.

Application Metering

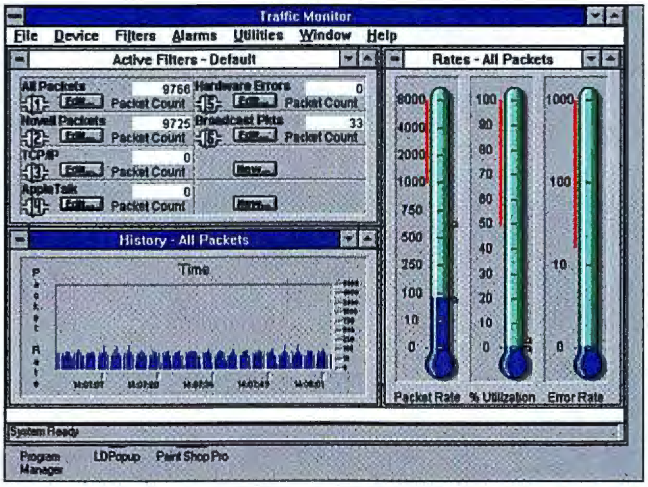
An application-metering module reports on server-based or workstation application (DOS and Windows) usage to ensure compliance with software licensing agreements. Features of such modules include monitoring of concurrent application execution on server and local PC drives; automatic alert notification when license limits are exceeded; creation and maintenance of a registration database for authorized DOS and Windows applications; blocking of options to enforce user compliance with site licenses or prohibit execution of unauthorized applications; and statistical reporting of current and historical application usage.

continued

Electronic Software Distribution

An electronic software distribution utility automates the process of distributing applications, remotely installing applications, installing and distributing operating-system software, and upgrading software on a network. The distribution module may use an executable program, a script file, or a batch file to define distribution criteria and launch the task.

Software distribution is carried out according to a scheduled distribution job, which specifies when the distribution will occur, what files are to be distributed, and when the program is to be run. Some vendors (e.g., Novell) offer optional electronic software distribution programs that can be run from a mainframe to install software on LANs.



The LANDesk Traffic Monitor displays real-time statistics on network traffic, such as packet and error rates, network utilization, and broadcasts.

Other Administration Utilities

Other useful network administration utilities bundled with desktop network management products include printer and queue management, network backup and storage management, and task scheduling. Printer and queue management streamlines general network printing functions. Through storage management services, the network manager and network users can administer the automatic backup and restore of data on servers and workstations and manage backup information exchange between workstations and servers.

Task scheduling involves the execution of programs in an unattended mode to perform specific management functions. As part of a management program, scheduled tasks are automatically launched by the management console, a user-defined script, or a batch file at a specified time to provide maintenance such as doing scheduled backups, initiating an action to correct network problems that have been posted by a management alert, or performing other network management functions.

Recommendations

Novell NMS 2.0 functions as both a network management platform and a network management product family. Although it's designed to manage primarily NetWare LANs (e.g., file servers, print servers, and

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DS1425 Multi Button	X	2K bits	X		X

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gateways) and interconnect devices (HMI-compatible [Hardware Monitor Interface] hubs, bridges, and routers), SNMP support makes it compatible with several other products and SNMP-compliant systems.

NMS excels in network mapping, its user interface, and its on-line reference. It's an excellent choice for managing large, multisegment, multiplatform LANs.

VisiSoft VisiNet's strength is support for a wide variety of NOSes, providing modules for NetWare (including version 2.xx), LAN Manager (and OS/2 LAN Server), NetBIOS, and SNMP. It also works as a snap-on product under a Novell NMS management system. VisiNet is reasonably priced for the types of management functions it provides. Its major management function—providing a visual view of the network (across LANs and WANs)—is weakened by an unusual functional complexity. (Many of the software's limitations have been addressed in version 2.5, which we didn't receive in time to test.)

Among the desktop management products, Frye Utilities surpasses the other products in ease of installation, setup, and use; depth of management functions; versatility of configuration options; robust performance and responsiveness of each program module; and the uncomplicated way its modules interface to the network and the information they collect. Each module is offered separately, and they all work together flawlessly.

Intel's LANDesk Manager places a close second with its comprehensive set of management tools, including an excellent traffic-monitoring module, a good inventory tracking and management component, a good desktop management function with an application monitor, and an effective server-monitor module with good alert-handling features. LANDesk Manager's user interface is among the best of those of the products evaluated.

Central Point Software's LANlord and Saber Software's Saber LAN Workstation are excellent for workstation management in general. LANlord excels in workstation trap (alarm) handling and management, support for very large networks, and multiple NOS support. Its overall functionality is slightly compromised because it lacks server management capability.

Saber LAN Workstation has a rich set of desktop applications and utilities, including advanced DOS and Windows menuing, application metering, and workstation threshold-setting features. It lacks network monitoring and server and global network threshold-setting features. Likewise, Brightwork Utilities' lack of networkwide monitoring, poor diagnostics, limited network and management standards support, lack of network and workstation threshold-setting capability, and average documentation lower its overall evaluation.

Central Point Software's XTree Tools and LAN Support Group's BindView NCS are the most cost-effective DOS-based network management products for NetWare environments. BindView NCS excels in workstation configuration management monitoring, while XTree Tools is better at server management. BindView NCS's report-generation module is its greatest strength; it provides the most extensive reporting and report management options. Because of their NetWare-only support characteristics, BindView NCS and XTree Tools are weak in management standards and network protocol support. ■

This report contains the results of The Software Digest Ratings Report, *a monthly publication from the National Software Testing Laboratories (NSTL). To obtain complete test results and in-depth analysis, contact NSTL (P.O. Box 551, Hightstown, NJ, 08520, (609) 426-7070, fax (609) 426-5434). BYTE and NSTL are operating units of McGraw-Hill, Inc.*

About the Products

BindView NCS 3.12
NCS Console and Server Information Module, $495 (SIM licensed per server); NCS Console and Workstation Auditing Module, $495 (WAM licensed per 100 nodes); additional SIM or WAM, $395; Traveling NCS, $1995 (per auditor)
LAN Support Group, Inc.
2425 Fountain View,
Suite 390
Houston, TX 77057
(800) 749-8439
(713) 789-0882
Circle 1090 on Inquiry Card.

Brightwork Utilities for NetWare 1.0
50-user, $699; 100-user, $1999; 250-user, $2999
Brightwork Development, Inc.
766 Shrewsbury Ave.
Jerral Center West
Tinton Falls, NJ 07724
(800) 552-9876
Circle 1091 on Inquiry Card.

Frye Utilities for Networks 1.5
NetWare Management 1.5, $495 for inital server license, $395 for additional server license; NetWare Early Warning System 1.5, $495/$395 (ISL/ASL); Software Update and Distribution System 1.0, $995 for initial (50-user) license, $895 for additional (100-user) license; LAN Directory 1.5, $495/$395 (IL/AL); Node Tracker 1.0, $149/$149 (IL/AL); NetWare Console Commander 1.5, $395
Frye Computer Systems, Inc.
19 Temple Place
Boston, MA 02111
(800) 234-3793
Circle 1092 on Inquiry Card.

LANDesk Manager 1.51
Base NMS product, $1495
Intel Corp.
734 East Utah Valley Dr.
American Fork, UT 84003
(800) 538-3373
(801) 763-2200
Circle 1093 on Inquiry Card.

LANlord 2.1 (version 2.0 tested)
Server and client software: 50-user, $2499; 100-user, $4299; 250-user, $8999
XTree Tools for Networks 1.5
First server, $795; additional servers, $595 each
Central Point Software, Inc.
15220 Northwest Greenbrier Pkwy.,
Suite 100
Beaverton, OR 97006
(800) 964-6896
(503) 690-8088
Circle 1094 on Inquiry Card.

Novell NMS 2.0
Base product, $2495; Management Agent 1.5: one-user pack per NetWare 3.x or 4.x server, $495
Novell, Inc.
122 East 1700 South
Provo, UT 84606
(800) 453-1267
(801) 429-7000
Circle 1095 on Inquiry Card.

Saber LAN Workstation 2.0
Client software and documentation, $179; additional node license, $39 (no documentation)
Saber Software Corp.
5944 Luther Lane,
Suite 1007
Dallas, TX 75225
(800) 338-8754
Circle 1096 on Inquiry Card.

VisiNet 2.5 (version 2.0 tested)
NetWare or LAN Manager/LAN Server with SNMP, $795 (single-server-restricted version), $1995 (no-server-restricted version); add-on server licenses (sold separately), $395 (single-server upgrade, to monitor one additional server), $1295 (to upgrade from single-server-restricted to no-server-restricted version)
VisiSoft, Inc.
2700 Northeast Expy.,
Suite B-700
Atlanta, GA 30345
(404) 320-0077
Circle 1097 on Inquiry Card.

Easing Windows' Graphics Bottleneck

New 64-bit graphics accelerator cards break Windows performance barriers

GREG LOVERIA

As a graphical operating system functioning on top of another operating system (DOS), Windows places unusually high performance demands on every PC subsystem. While CPU clock speed, hard drive response, and memory size all influence Windows application speeds, the biggest Windows performance bottleneck has always been the graphics adapter subsystem. That's particularly true if you work with 24-bit graphics applications.

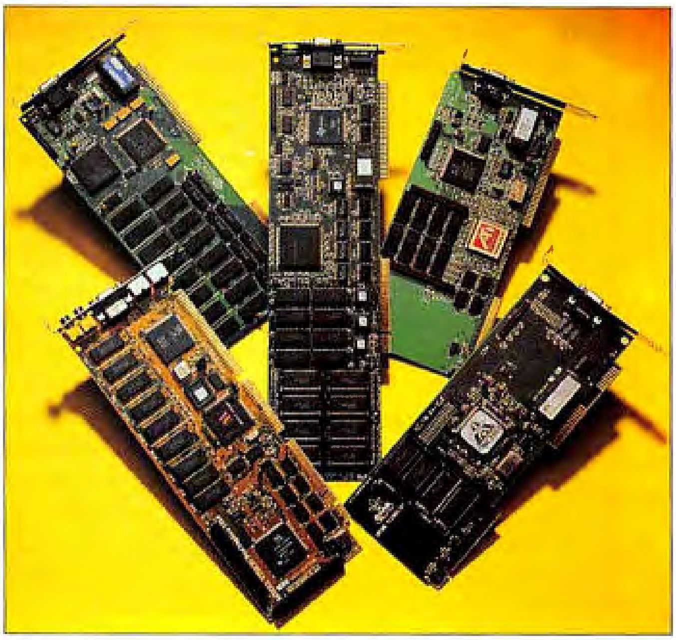
Fortunately, manufacturers of graphics adapter cards have been producing products with on-board graphics accelerator chips, available from manufacturers like S3, Cirrus Logic, Weitek, Texas Instruments, and Tseng Labs, that specialize in handling graphics-intensive duties. Graphics card companies like ATI, Matrox, and Media Vision design their own graphics accelerator chips. The sole purpose of these chips is to relieve the CPU as much as possible from graphics processing chores such as font caching, fills, painting, and raster and vector drawing. The result is increased Windows application performance speeds.

While graphics accelerator chips using 32-bit-wide data paths have been around for a year or so (other wide graphics datapath designs have been around for years, however), the newest trend is to move graphical data between the graphics accelerator chip and the adapter's memory in a 64-bit-wide data path. Widening the data path increases bandwidths and allows the adapter to process and move greater amounts of graphical information more efficiently. Short of purchasing a new and faster PC, adding a 64-bit graphics accelerator card can be an easy and inexpensive way for end users to improve Windows application performance using their current VL-Bus (VESA [Video Electronics Standards Association] Local Bus) or PCI (Peripheral Component Interconnect) system.

New Breed

In this review, I examine some of the first of a new breed of 64-bit accelerator cards that push graphics performance to new levels and are particularly suited to 24-bit graphics applications. Because they are optimized for 24-bit graphics, these cards run nearly as fast in 24-bit color-depth modes as they do with 8-bit graphics. But in all modes they are faster than previous cards.

While many of these products are high-end cards priced for graphics work at high resolutions (e.g., Matrox's card supports 1600- by 1200-pixel resolution with high speed and refresh rates), a few are reasonably priced cards that provide top speed for running general Windows applications that include some 24-bit work. Orchid's card, for example, starts at $249 with 1 MB of DRAM. I also tested 64-bit cards from Media Vision, Diamond, and ATI. Since my evaluation, other cards—both VL-Bus and PCI—have appeared from other manufacturers, such as Acronics, Actix, Genoa, Infotronic, Miro, Number Nine, and STB. All the reviewed cards except Media Vision's support VESA's DPMS (Display Power Management System) specifications, which lets them work with DPMS-compliant monitors and systems in power-saving modes.



Five new 64-bit graphics cards (clockwise from left) from Media Vision, Diamond Computer Systems, Matrox Graphics, ATI Technologies, and Orchid Technology. Whether in the PCI version or the VL-Bus version shown here, any one of these is faster than any PC card you've used before. (Although it's not in the photo, a 2-MB Matrox MGA Ultra was also tested.)

I tested cards that follow the VL-Bus standard, considering them from the point of view of someone looking to upgrade a current VL-Bus system. If you're buying a new system with a PCI bus, the PCI versions of these cards should provide similar performance.

Gauging Benchmarks

In spite of myriad available graphics accelerator benchmark tests, gauging performance differences between such complex products as graphics adapter cards is a daunting task. Any particular benchmark test can slant test results in favor of one product or another.

Also, many of the graphics accelerator tests around can generate confusing mounds of raw performance data, giving timing details on such operations as numerical BITBLT stretches, fills, and line drawing. I have found that poring over mountains of raw data results sometimes tells me little about how much faster my applications will run if I add a particular accelerator card to an existing system.

For this review I chose TI's Wintach 1.0, a tried-and-true graphics benchmark utility that emulates actual Windows with applications functions such as vector draws, font caching, scrolls, and paint fills. It also gives a pretty good estimate of CAD performance in general. Wintach runs four sets of operations, each characteristic of an application type: word processors, CAD/draw, spreadsheets, and paint programs.

Wintach indexes the elapsed time of each application set against the performance of a Compaq Deskpro 386/20 with unaccelerated VGA. It then scales the resulting speed indexes according to resolution and color depth so the final application index reflects the amount of data a graphics system is actually processing over time. The four scaled indexes are then averaged to get the overall RPM (Relative

A Bigger Bus

Generally, an on-board accelerator chip can transfer graphics data between itself and banks of dual-ported VRAM (video RAM) faster than it can with DRAM, and faster over a 64-bit data path than a 32-bit path. The downside is that VRAM is more expensive (at least 1.5 to 2 times DRAM costs). As a compromise, graphics accelerator chip manufacturers such as Tseng Labs and Weitek use interleaving techniques on 32-bit-wide data paths to increase data transfer speeds between their accelerator chips and a graphics card's memory.

In short, memory interleaving is similar to double buffering. That is, while one bank of video memory is sending graphical data, a second bank can be receiving incoming data. Although you can also apply memory interleaving on VRAM-equipped cards, it is more typically used with DRAM because both fit with cost-conscious design goals.

On the other hand, manufacturers like ATI, Cirrus, Matrox, Media Vision, S3, and Weitek (again) have introduced accelerator chips that use a 64-bit-wide data path to move data between the graphics chip and video memory, and even sometimes out to the color DAC (D/A converter) that pumps the analog signal to the monitor. At this writing, controversy is brewing over whether a 32-bit interleaved design is as fast as a straight 64-bit-wide on-board data-path architecture.

Companies such as Tseng Labs that produce accelerator chips with 32-bit interleaved designs contend that a properly designed 32-bit interleaved accelerator card is every bit as fast as a 64-bit-wide accelerator card. My tests with three Tseng-based cards (from ATI, Diamond, and Genoa) show that they just can't keep up with 64-bit cards. The results for the fastest of the three cards, Genoa's Phantom 32i, are included along with the data from the 64-bit cards in the table "Performance for 64-bit Graphics Accelerator Cards" on page 138.

Performance Measurement) index number (as shown in the table "Performance for 64-bit Graphics Accelerator Cards.")

TI originally designed Wintach to exercise the functions of its TMS-34020 and 34040 graphics coprocessors. I picked it for my tests because it matched the results from preliminary tests I ran using actual Windows programs with two cards, an unaccelerated Diamond SpeedStar with 1 MB of DRAM and Media Vision's Pro Graphics 1024 accelerated card with 2.25 MB of VRAM (video RAM).

I timed speed differences between the two cards using four application tests. The first displays a CorelDraw .CDR file with 849 vector objects, to gauge vector and paint/fill screen redraws. The second scrolls a 20-MB TIFF file in Photostyler 2.0, to gauge raster redraws. The third and fourth scroll a 28-page multifont Microsoft Word document and a two-page multifont PageMaker 5.0 document, respectively, to test redraws, font caching, and vector font fills. When I ran Wintach on these two cards, the percentile differences in speed observed between the two cards running my Windows application tests and Wintach's RPM results were virtually identical.

Speed Trials and Tribulations

In testing these cards in three VL-Bus systems and with several monitors, I ran into problems you should be aware of. With two early VL-Bus systems, I ran into compatibility problems. Only one of the new cards, ATI's Graphics Pro Turbo, would work in these systems. With a 66-MHz MIS 486DX2 PC, which had one of the first Micronics VL-Bus motherboards (circa March 1993), I was able to fix the problem by updating the PC's Phoenix flash BIOS with new software from MIS and Micronics.

I'm still working on the compatibility problem with the other system, a home-built unit with an early Diamond VL-Bus FastBus motherboard (circa June 1993) and a Chips & Technologies BIOS. The older motherboards follow version 1.0 of the VL-Bus specification, while the new graphics cards comply with VL-Bus 2.0. The graphics cards are supposed to be downward compatible with version 1.0 systems.

All the cards functioned flawlessly in the newer system I ended up using for the testing, a 66-MHz 486DX2 from Gateway 2000 with 16 MB of RAM, a current-model Micronics VL-Bus motherboard, and a Phoenix BIOS. I tested all cards using DOS 6.2 and vanilla Windows 3.1 configurations. I generated all Wintach test results at frequencies between 60 and 72 Hz in noninterlaced modes (as needed per resolution with each card).

The test monitors were a 21-inch MF-5421A Idek and a 15-inch Optiquest 3000. Caution is the word when working with low-bandwidth monitors and high-bandwidth adapters: I destroyed my 15-inch Optiquest monitor by plugging it into an adapter that was already configured at a 1200- by 1600-pixel test resolution from a prior test with the multisync, multibandwidth Idek monitor.

ATI Graphics Pro Turbo

ATI Technologies' Graphics Pro Turbo 64-bit accelerator is based on the company's proprietary mach64 graphics accelerator chip and 64-bit ATI68860 DAC (D/A converter). I tested the 2-MB VRAM version of the card, which retails for $449. You can upgrade it to 4 MB with ATI's 2-MB VRAM expansion daughtercard ($249) or buy the 4-MB VRAM version for $699. The Graphics Pro Turbo ships with drivers for Windows 3.1, NT, OS/2, AutoCAD 386, Autoshade, 3D Studio, and Intergraph's MicroStation.

The VL-Bus version of the Graphics Pro Turbo is a three-quarter-length card (the minimum size because of VL-Bus slot design). The PCI and ISA versions are half-size cards. The 2-MB version supports resolutions of up to 1280 by 1024 pixels (256 colors). With 2 MB, only 65,536 colors are supported at the 1024-

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by 768-pixel resolution; with the 2-MB VRAM expansion module or the 4-MB version, you can get 24-bit color depth (16.7 million colors) at 1280- by 1024-pixel resolution where the card uses a packed-pixel mode.

Card setup and device driver installations are straightforward and are performed from a DOS utility. The card has only one set of on-board IRQ (interrupt request) jumpers; you set I/O and memory addresses through software. After configuring the card for monitor resolutions and refresh frequencies, you start Windows and then access ATI's control panel to fine-tune your Windows setup using ATI's FlexDesk+ utility. FlexDesk+ allows you to configure color bit depths, screen and virtual desktop sizes, and fonts, after which you must reboot Windows.

ATI's WinSwitch utility allows you to change between most of the above resolutions on the fly without rebooting Windows, while the DeskScan utility implements accelerated panning and zoom features. Another bundled Windows utility accelerates playback of Video For Windows motion video clips, allowing viewing at twice the capture size without pixellation (i.e., without creating a granular effect). Last, a DPMS utility lets any system implement power saving with VESA Green PC–compliant monitors.

In the Wintach tests at 640- by 480-pixel and 800- by 600-pixel resolutions with 24-bit color depth, the 2-MB Graphics Pro Turbo was one of the slowest 64-bit cards tested (which isn't that slow). With ATI's FlexDesk+ utility, however, you can enable a 32-bit-depth mode and increase the card's performance enough to put it in second place at those resolutions. (As with many other accelerator cards, in 32-bit-depth mode, ATI uses the extra alpha channel bits as an additional 8-bit data path to increase transfer rates of graphical information.)

People like me, whose applications need 24-bit color in all modes, will want the 4-MB version of the card, which wasn't available for testing. Because most of my work centers around 24-bit image manipulation, I'd like to know how the 4-MB version performs at higher resolutions. However, at the 2-MB version's lower resolutions and color bit depths, the Graphics Pro Turbo is fast and well worth your consideration.

About the Products

Graphics Pro Turbo (2 MB of VRAM, VL-Bus) ... $449
2-MB upgrade ... $249
4-MB version ... $699
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Thornhill, Ontario, Canada L3T 7N6
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fax: (905) 882-2620
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Kelvin 64 (2 MB of DRAM, VL-Bus) ... $325
1-MB DRAM version ... $250
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Fremont, CA 94538
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(510) 683-0300
fax: (510) 490-9312
Circle 1084 on Inquiry Card.

MGA Ultima (2 MB of VRAM, VL-Bus) ... $499
PCI version ... $449
MGA Ultima Plus (4 MB of VRAM, VL-Bus) ... $849
2-MB VL-Bus version ... $599
2-MB PCI version ... $499
2-MB VRAM ... $250
Matrox Graphics, Inc.
1055 St. Regis Blvd.
Dorval, Quebec, Canada H9P 2T4
(800) 361-1408
fax: (514) 685-2853
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Pro Graphics 1024 (2.25 MB of VRAM, VL-Bus) ... $449
8-bit color version (0.75 MB of VRAM) ... $299
1.5-MB VRAM upgrade ... $149
(same pricing for ISA and PCI versions)
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47300 Bayside Pkwy.
Fremont, CA 94538
(800) 845-5870
(510) 770-8600
fax: (510) 770-9592
Circle 1086 on Inquiry Card.

Stealth 64 (2 MB of VRAM, VL-Bus) ... $399
4-MB VRAM version ... $599
(same pricing for PCI version)
Diamond Computer Systems, Inc.
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Sunnyvale, CA 94086
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Orchid Kelvin 64

Costing considerably less than the other 64-bit cards I tested, Orchid Technology's DRAM-based Kelvin 64 was also the slowest, but not by much. It kept close to the high-end Matrox cards at lower resolutions. The card's Cirrus Logic 5434 chip, a 64-bit graphics accelerator, uses inexpensive DRAM and also functions as the high- and true-color DAC.

For $250, the Kelvin 64 ships with a 1-MB bank of 256- by 16-bit DRAM. A user-installable 1-MB DRAM upgrade kit costs $45. The 1-MB version supports resolutions ranging from 640 by 480 pixels with 16.7 million colors (24-bit) to 1280 by 1024 pixels with 16 colors (4-bit). Upgraded to 2 MB, the card supports 24-bit color at 800- by 600-pixel resolution, and 256 colors at 1280- by 1024-pixel resolution noninterlaced. Drivers bundled with the unit are the same as those that ship with ATI's adapter. I tested a 2-MB card.

The Kelvin 64 is completely jumperless; all I/O addresses are set through software. You first load Orchid's KINSTALL DOS setup utility to select and install drivers for Windows, CAD, and certain word processors. The KINSTALL utility also installs KSCAN, Orchid's advanced monitor setup utility, where you select and test monitor video modes and make screen-centering adjustments. After starting Windows, you use the Kelvin 64 Setup icon from Windows' Control Panel to configure display resolutions, color palettes, and DPMS times, as well as how much memory to reserve for the card's font caches.

Additionally, you can configure virtual screen resolutions and set hardware screen-magnification "zoom-in" and "zoom-out" hot keys. Because it holds only 2 MB of memory, the Kelvin 64 can display only 65,536 colors (16-bit) at 1024- by 768-pixel resolution. Like the ATI card, the Kelvin 64 uses a 32-bit color depth for acceleration, though not as effectively.

Still, Orchid's Kelvin 64 accelerator card is substantially less expensive than the others, and it's one heck of a bargain for the performance I observed. Orchid bills it as "the first affordable 64-bit graphics acceleration solution," and rightly so. Anyone who demands fast graphics speeds for minimal dollars should put the Kelvin 64 first on his or her shopping list.

Media Vision Pro Graphics 1024

Media Vision's Pro Graphics 1024 accelerator card comes in two flavors. The $449 True Color unit with 2.25 MB of VRAM can display 24-bit color at 1024- by 768-

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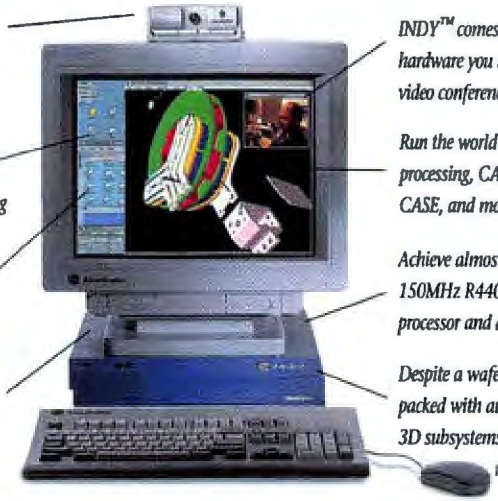

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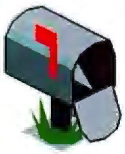

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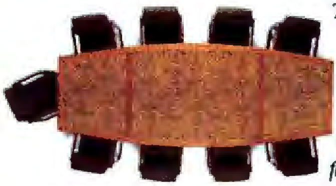

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PERFORMANCE FOR 64-BIT GRAPHICS ACCELERATOR CARDS

Diamond's Stealth 64 was by far the fastest card tested, but other cards have their strong points. Although expensive, Matrox's Ultima cards do well at higher resolutions and reach 1600- by 1200-pixel resolution. For its price, Orchid's Kelvin 64, the only DRAM-based card tested, provides good performance at lower resolutions. The 2-MB version of ATI's card does even better at lower resolutions; the 4-MB version, unavailable at the time of this review, may also do well at higher resolutions. Higher numbers are better; — = not applicable.

	RESOLUTIONS[1]										
	640 × 480 × 16.7 MILLION	800 × 600 × 65,536	800 × 600 × 16.7 MILLION	1024 × 768 × 32,768	1024 × 768 × 65,536	1024 × 768 × 16.7 MILLION	1280 × 1024 × 256	1280 × 1024 × 32,768	1280 × 1024 × 65,536	1600 × 1200 × 256	1600 × 1200 × 32,768
ATI Graphics Pro Turbo	84.73[2]	—	110.48[2]	—	112.87	—	87.25	—	—	—	—
Diamond Stealth 64	143.34	—	176.50	—	—	234.34	—	—	186.96	—	—
Matrox MGA Ultima for VL-Bus	69.18	—	86.88	88.16	—	—	92.41	—	—	84.56	—
Matrox MGA Ultima Plus for VL-Bus	69.63	—	88.41	—	—	113.89	—	119.08	—	—	117.29
Media Vision Pro Graphics 1024	75.80	—	99.86	—	—	133.51	—	—	—	—	—
Orchid Kelvin 64	66.18[2]	—	71.46[2]	—	83.58	—	—	—	—	—	—
Genoa Phantom 32i[3]	26.72	51.71	—	—	63.69	—	50.71	—	—	—	—

[1] In pixels × pixels × colors.

[2] Wintach read this card in this mode as using 32-bit color depth instead of 24-bit and scaled it accordingly. The Wintach RPM value has been adjusted downward (by 0.75) so that it can be compared with the other cards in 24-bit mode.

[3] The fastest of three 32-bit cards tested for comparison. All used a 32-bit interlaced memory design. These cards slowed down with 24-bit color.

Texas Instruments' Wintach graphics benchmark times four sets of graphics operations that simulate word processor, CAD/draw, spreadsheet, and paint programs. Wintach indexes the time results to those of a Compaq Deskpro 386/20 with unaccelerated VGA and then scales the results based on resolution and color depth so that the resulting four application indexes reflect the amount of graphics data involved. The four indexes are then averaged to the single overall index (called RPM for Relative Performance Measurement) that is presented here. RPM values are shown for the highest color depth supported at each resolution. For the 64-bit cards, the highest color mode provides the best Wintach result at a given resolution. Because of the scaling of RPM values for resolution and color depth, numbers at different modes are not directly comparable. An RPM value for 24-bit mode, for example, will be three times higher than the RPM value for the 8-bit mode at the same pixel resolution if both tests take the same time.

pixel resolution, while the $299 8-bit Color unit with just 0.75 MB of VRAM can display 1024- by 768-pixel resolution with up to 256 colors. You can upgrade the $299 unit for the difference in price between the two.

Media Vision ships the units with a full array of drivers for Windows 3.1, Windows NT, and OS/2, as well as Autodesk ADI drivers for AutoCAD, 3D Studio, and Animator Pro. Extra goodies include Kai's Power Tools for Windows (an excellent fractal-generation program) and FastFilm (a Media Vision hardware implementation that allows full-screen playback of Video For Windows clips). The FastFilm feature is made possible by Media Vision's MVV462 Video DAC, part of the company's Stingray24 multimedia chip set.

Media Vision's multimedia plans for this card are obvious. Besides the normal 15-pin SVGA connector, the card has both S-VHS Video and NTSC composite in-and-out connectors. These connectors will become functional when Media Vision releases its 1024 multimedia daughtercard, probably this fall.

The 1024 True Color adapter installs easily, without your having to set any jumpers (a single jumper block disables or enables the on-board VGA). To install, you start Windows in a 16-color, 640- by 480-pixel mode. You choose all Windows drivers, monitor options, and screen resolutions from a Pro Graphics 1024 setup utility icon in Windows' Control Panel and then restart Windows to invoke the new resolutions and color bit depths.

Expanded Pro Graphics 1024 units are not actually 64-bit accelerators—with 2.25 MB of VRAM on-board, the True Color unit uses a 72-bit-wide data path to speed up graphics functions. The Pro Graphics 1024 cards use a Cirrus Logic 5402 accelerator card coupled with Media Vision's own MVV452 graphics accelerator chip. The design moves graphical data via interleaving between the MVV452 chip along three 24-bit-wide data paths to three 0.75-MB banks of VRAM (one path each for the red, green, and blue color channels).

Of the six 64-bit accelerator card configurations I tested, only the Pro Graphics 1024 and two 4-MB adapters can display 16.7 million colors at 1024- by 768-pixel resolution. At this mode and resolution, the Media Vision chip comes in a distant second behind Diamond's card (and it's hard to say how a 4-MB ATI card might do). In 640- by 480-pixel and 800- by 600-pixel modes, the card placed in the middle of the pack.

Although the Pro Graphics 1024 is not the fastest accelerator card, I'm impressed by Media Vision's design and engineering implementations of the present 72-bit acceleration and FastFilm subsystems, and with all the extras that come with the card. If your graphics needs include future plans for capturing video or taping full-screen digital video playback and SVGA computer sessions on your VCR, then you must have a Pro Graphics 1024 in your system.

Matrox MGA Ultima

Since introducing it last year, Matrox has revamped its 64-bit MGA graphics chip, removing some 3-D capabilities to lower the cost and tuning drivers to improve the performance. I tested two VL-Bus versions of the current 64-bit MGA card: the $499 MGA Ultima, a three-quarter-length card with 2 MB of VRAM, and the $599 MGA Ultima Plus, a full-length card that comes with 2 MB but upgrades to 4 MB for an additional $250. I tested the Ultima Plus both ways and found that the Ultima and 2-MB Ultima Plus perform almost identically.

With 2 MB, both cards support resolutions of up to 1152 by 882 pixels in 15-bit high-color mode and 1280 by 1024 pixels in 256-color mode (8-bit). The Ultima

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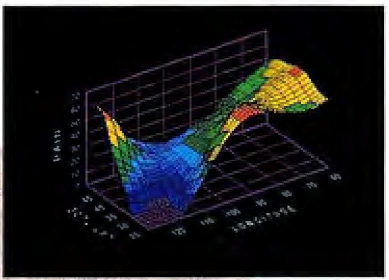

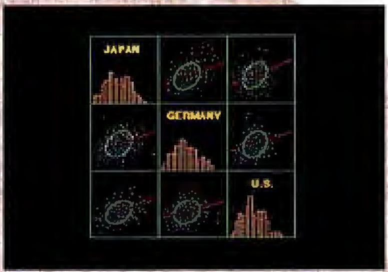

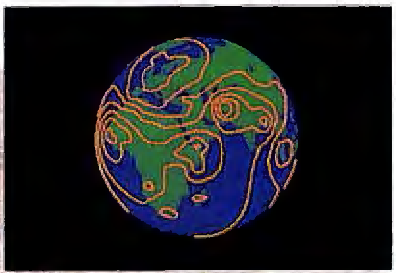

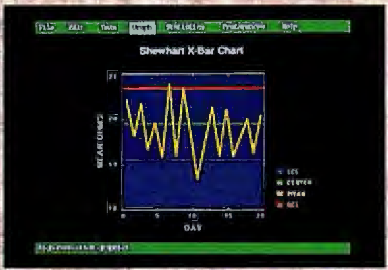

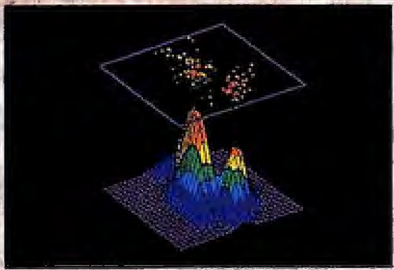

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I tested uses a Brooktree 485 RAMDAC for high- and true-color modes. With 4 MB, the MGA Ultima Plus displays resolutions of up to 1152 by 882 pixels with 24-bit color depth, as well as 1280 by 1024 pixels and 1600 by 1200 pixels with 15-bit color depth.

Installation was easy, although Matrox uses a 10-position DIP switch to set the card's memory addressing and enable or disable on-board VGA. You use a DOS utility to establish and test monitor frequencies, resolutions, and color depths, as well as for installing Windows 3.1, NT, AutoCAD, 3D Studio, OS/2, and MicroStation drivers. The setup program modifies AUTOEXEC.BAT and CONFIG.SYS to set software communication links with the MGA adapter's hardware BIOS.

After rebooting the system and starting Windows, you use Matrox's MGA Control Panel utility to set operating resolutions and bit depths, as well as virtual screen resolutions of up to 1600 by 1200 pixels. The Control Panel also lets you enable Matrox's ModeSWITCH utility, which lets you switch Windows resolutions and color depths on the fly without interrupting your applications. You can also enable or disable Matrox's PixelTouch hardware zoom utilities, which let you instantly magnify images for precision pixel retouching in image editors such as Photostyler.

Surprisingly, the extra 2 MB of VRAM I installed on the Ultima Plus increased Windows speed only marginally, and only in a few applications. Also surprising was that, with or without the extra 2 MB installed, the Ultima Plus ran slightly slower than the lower-cost MGA Ultima in some modes. Although it was once the only 64-bit Windows accelerator card and one of the fastest graphics cards of any type, the MGA Ultima tested slower than most of the other 64-bit cards at lower display resolutions. At higher resolutions, it's on a par with all the cards except the Diamond Stealth 64—and at 1600- by 1200-pixel resolution, it is the only card still in the running.

Using Matrox's QCDP (Quality Color Dithering Process) color mode, both Ultima cards can provide fairly realistic color, with display speeds in between those provided by 8- and 24-bit modes. QCDP is an 8-bit mode that uses the Matrox chip's hardware dithering process to emulate 24-bit color depths using only 8 bits of data. It comes into its own at 1280- by 1024-pixel and 1600- by 1200-pixel resolutions where true color isn't available.

A strong point is that the 4-MB MGA Ultima Plus supports the highest screen resolutions at the highest color depths of any accelerator card I've seen on the market. And particularly at these high resolutions and added color depths, the Ultima cards provide their best performance. A special $999 version of the card, the MGA Ultima 200, has the 200-MHz bandwidth necessary for an ergonomic 76-Hz refresh rate at 1600- by 1200-pixel resolution. In my image-editing applications, I found that the PixelTouch zoom and ModeSWITCH features were a real plus, and for spreadsheets and PageMaker layouts, the 1600- by 1200-pixel modes proved ideal with a large monitor.

Diamond Stealth 64

Diamond's Stealth 64 VL-Bus card, the fastest card I tested, ships in two configurations—a 2-MB VRAM version ($399) and the 4-MB VRAM unit ($599) I tested. Versions are also available for PCI systems. Besides Windows 3.x and NT drivers, the Stealth ships with drivers for Lotus 1-2-3, WordPerfect 5.1, Cadkey, DataCAD, MicroStation, and Panacea's TurboDLD ADI drivers for 3D Studio, AnimatorPro, and AutoCAD releases 10, 11, and 12.

The Stealth 64 VL-Bus unit is a three-quarter-length card with only one jumper (IRQ setting). The half-length PCI version is completely jumperless. The Stealth uses S3's new Vision 964 graphics accelerator chip along with a Brooktree 485 RAMDAC for high- and true-color support.

The 4-MB VRAM unit supports 24-bit color depth at resolutions of from 640 by 480 pixels to 1152 by 864 pixels, and 65,536 colors at the adapter's maximum resolution of 1280 by 1024 pixels. The 2-MB VRAM version supports 24-bit color at 800- by 600-pixel resolution, 65,536 colors at 1024 by 768 pixels, and 256 colors at 1280 by 1024 pixels.

The Stealth installed without a hitch, and driver setup was equally painless. From box to Windows, I was up and running at 1024- by 768-pixel resolution in 24-bit color in less than 5 minutes. With Diamond's DOS-based installation and setup utility, you set and test monitor frequencies, text modes, and DPMS timings. A utility, S64BIOS.COM, loads as a TSR program for systems that don't automatically shadow the Stealth's BIOS into memory on bootup. (The Gateway 2000 test system did auto-load the BIOS, so I didn't test the unit with this TSR installed.)

The installation program next installs Windows drivers and starts Windows itself. Once in Windows, Diamond's In-Control Tools dialog box requests additional information about monitor frequencies, as well as Windows screen resolutions and color bit-depth preferences.

During the Wintach test, the application screen tests really screamed, but I decided the results were a fluke—the RPM index numbers from the Wintach test seemed too fast. I spent almost 3 hours running multiple applications, rerunning Wintach, and performing some AutoCAD redraw timing tests that I had run with the other cards. I also tried a number of other graphics benchmarks, including NSTL's tests, before convincing myself that the Stealth was indeed running as fast as I perceived.

Diamond's Stealth 64 blazes in every Windows and DOS application. It will make your old 486 feel like a double-speed Pentium. I give it two thumbs up for excellence in all categories, as well as for being the fastest graphics accelerator card I've ever worked with.

For Every Need and Budget

Obviously, the top pick for best performance is Diamond's Stealth 64. It's a tad expensive with 4 MB of VRAM on-board, but it's worth every penny. My next choice goes to Orchid's DRAM-based Kelvin 64 as the least expensive 64-bit card on the market. Although a bit slower than most, it should appeal to users on a budget who need faster Windows application speeds but don't need 24-bit color at 1024- by 768-pixel resolution.

Media Vision's Pro Graphics 1024 is a great choice for those who can use 64-bit acceleration performance now but want to do everything with one card in future multimedia applications. The most expensive of all, Matrox's Ultima cards are the only cards in this review that support 1600- by 1200-pixel resolution, and they do it with good performance. The jury's out on ATI's Graphics Pro Turbo until test results with a 4-MB configuration become available.

Other than the initial VL-Bus installation problems, all the cards that I tested worked as advertised, albeit some a bit faster than others. If you're tired of slow Windows speeds with 24-bit graphics, give one of these cards a try. Maybe you don't need a Pentium just yet. ■

Animator, technical writer, and consultant on computer graphics, desktop publishing, digital video/audio, and MPC, Greg Loveria lives in Binghamton, New York. He has written numerous articles for BYTE and is a contributing editor to McGraw-Hill's DataPro books. You can reach him on the Internet or BIX at loveria@bix.com.

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IBM's high-priced PowerPC notebook makes AIX truly portable

BRUCE DAWSON

Although it's not the first RISC-based portable PC running Unix, IBM's RS/6000 N40 is the first using the new PowerPC chip, and it may be the fastest. Built by Tadpole, the N40 is a notebook version of IBM's RS/6000 running AIX, IBM's flavor of Unix. It is a lightweight, color notebook powered by a 50-MHz PowerPC 601 microprocessor with a 32-KB cache. Weighing just over 7 pounds with the battery installed, it has the near-laptop dimensions of 8.5 by 11.8 by 2 inches. The price of the basic system I reviewed, equipped with 16 MB of RAM and a 340-MB hard drive, is $11,995.

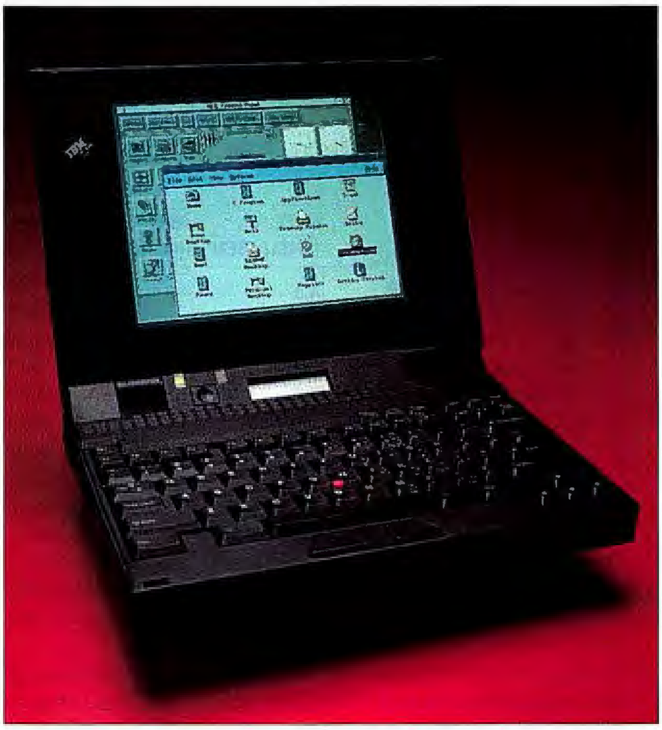
The internal battery lasts only 45 minutes to an hour; it's too bad the power-efficient 603 version of the PowerPC chip wasn't available at design time. IBM extends your road time by shipping the N40 with two batteries, but you must shut down the system to switch them. Using the N40's save-and-resume feature, that process takes around 5 minutes—not bad for a Unix system, but still inconvenient. Another solution is an optional external battery pack that connects to the back of the N40 and extends battery life up to 4 hours.

Packs Power

This rugged little notebook packs a lot of power and features. The lightweight magnesium-alloy case makes it sturdy and doubles as a heat sink. The N40's built-in TFT (thin-film transistor), active-matrix color screen measures 9.4 inches diagonally and provides bright 640- by 480-pixel images and a wide viewing angle. The removable hard drive slides out easily to provide security or to enable different users to each have their own environment. A smaller (250 MB) drive is also available. You can expand the N40's memory from its base configuration of 16 MB up to either 32 MB or 64 MB by replacing the 8-MB modules in its two SIMM sockets with higher-capacity units.

The N40 uses the same TrackPoint II pointing device found on IBM's ThinkPad portables. This mouse alternative proved to be quite a boon to portability, eliminating extra baggage and configuration time. However, unless I turned down its sensitivity, I found it to be more disconcerting than useful in vibration- or shock-prone environments, such as most forms of ground transportation. Old point-and-click habits die hard, and you're just as likely to select Close as Minimize in the X Window System if the vehicle you're riding in should hit a bump at just the wrong moment.

The N40 comes with a full set of external ports. The SCSI, parallel, serial, and audio ports use nonstandard connectors, but breakout cables are provided, so you can use standard cables to connect peripherals. The 15-pin AUI (attachment unit interface) connector requires an additional cable and transceiver for most Ethernet environments. A LocalTalk port provides another networking option. The N40's 8-bit Fast SCSI-2 supports up to six external devices.



IBM's RS/6000 N40 packs most of the power of a full Unix workstation into a notebook-size magnesium-alloy shell. As with any notebook, you give up storage capacity and screen size for portability.

For desktop use, the N40 provides keyboard and mouse ports, as well as a 15-pin VGA connector with video-memory support (2 MB) for resolutions of up to 1280 by 1024 pixels with external monitors. For long-distance communications, there is both an internal 14.4-Kbps fax modem and an ISDN port. PCMCIA slots (two Type II or one Type III) will allow future Token Ring and wireless adapters. And for multimedia, the N40 comes with a built-in microphone and speakers, as well as a port for external audio.

The N40 supports a 256-color, 1280- by 1024-pixel virtual display on its 640- by 480-pixel LCD. Like some other Tadpole notebooks, the N40 supports panning by just running the cursor up to the edge of the screen, and you can zoom in and out with function-key combinations. In a Unix environment, it's a very nice feature to have. The LCD virtual-display feature also lets you simultaneously display on an external monitor with resolutions higher than 640 by 480 pixels.

The power supply is a svelte adaptive-voltage design that should work just about anywhere (110 to 240 V, 50 to 60 Hz) given an appropriate power cord. It's as light as they come. The adapter, power cord, charger, and two nickel-cadmium batteries all fit into the N40's canvas carrying bag (which lacks a shoulder strap).

Slimmed-Down AIX

AIX, which comes preinstalled, is so large and feature-rich that IBM had to pare some features to fit it onto the N40's 2½-inch 340-MB removable hard drive. Fortunately, the only missing features are those you're unlikely to need on a portable system, such as most of the server software. IBM claims that the N40's reduced AIX remains fully compatible with AIX 3.2.5.

continued

UNIX BENCHMARKS

The Unix benchmarks were run in a single-user mode to give some idea of the system's raw performance, and in a multiuser mode to give an idea of how much overhead is involved in running AIX. In the single-user test, the benchmark had only the error logger server and the NCE daemon running. The multiuser test added one remote NFS (NetWork File System) mount, the X display server, and the default number of servers—a fairly typical environment for a mobile user. The results are indexed. On the BYTE Unix benchmarks (version 3.11), a Sun SparcStation 1+ running SunSoft 4.3 = 1. Thus, the results below show the RS/6000 to be several times faster overall than the SparcStation 1+.

TEST	INDEX (SINGLE USER)	INDEX (MULTIUSER)
Arithmetic (type = double)	4.8	4.8
Dhrystone 2 without register variables	5.0	4.9
Execl throughput	5.1	5.0
Pipe-based context switching	2.1	2.3
Shell scripts (eight concurrent)	2.0	0.5

Due to lack of space on the 340-MB hard drive, both test sets failed to perform the file I/O tests.

IBM provides a CD-ROM with a full AIX distribution on it, so you can augment AIX's features once internal drives larger than 340 MB become available for the N40 (or if your N40 has a sufficiently large external hard drive and CD-ROM drive attached to it).

The only documentation that came with the system was two thin spiral-bound notebooks describing how to attach cables to the N40, configure AIX, and use the NCE (Nomadic Computing Environment). All other documentation is on the distribution CD-ROM disk. Unfortunately, you have to install the information on your hard drive to read it, and there just isn't room. It's too bad the CD-ROM isn't structured so that you could use AIX's information browser to read the documentation data right off the CD-ROM. As it is, you can store the documentation on an external hard drive or on a network server.

I found the N40 barely usable away from A/C power, even with the two batteries supplied.

Changing Environment

To those already familiar with AIX, the most interesting feature will be the NCE. It's a Tadpole-developed package of programs that provides a number of options for using the N40 in a changing environment. Most important for a Unix system, the save-and-resume feature lets you preserve the state of the system and restore it across power cycles relatively quickly. The feature requires an area of your hard drive the same size as your memory capacity.

You can initiate a save by using key strokes, by pressing the power button, through a menu, or by closing the lid. You then push the power button to restore. This feature is useful for quickly picking up the N40 and going somewhere else. Saving the system state takes a minute or two of disk writing, so don't expect to close the lid and just vamoose; IBM cautions that the notebook should remain undisturbed while the drive is active. (I was able to place the N40 in its case and gently carry it off during its save cycle, but I wouldn't recommend this.) A similar sleep mode saves the system state to disk and then goes into a low-power condition. Recovery is instantaneous.

A Location panel in the NCE window lets you set up for several locations, each with its own name, time zone, phone numbers, and network configuration, to list some of the possible parameters. You select one of these names to switch your operating environment to the resources available at a particular locale.

You can also select different peripherals through NCE so that you can use whatever resources are available at a site. You can pick up and go with the pause-and-resume feature and then quickly set up and work at a new site. AIX and NCE work together to resolve the problems traditional with changing hardware between boots. (However, servers at one site may not be available at another site.) Through NCE you can also make connections using Dial-in IP (SLIP), so you can use your central office's LAN resources via a modem.

Except for battery life, I found the N40 to be a nice notebook, if somewhat larger than I'm used to. It had sufficient horsepower to run the applications I could run, even if it didn't have all the applications I wanted to run. There are no WYSIWYG editors on the N40, for example—not even the freely available `xedit` or `emacs`. The Power Desktop GUI application that IBM provides is a nice facilitator for getting around in Unix's directory scheme, but it doesn't provide any inherent value to the system.

For instance, there are no word processing, database, spreadsheet, business graphics, or other general-purpose applications. Most Unixes don't come with these applications, but I expected a little more for the premium price IBM demands for this notebook.

The N40's AIX comes with two versions of its capable SMIT system management environment, a character-cell version and a GUI version. The latter version takes up more than the entire VGA display. However, it has nice, large fonts, and you can get around in it easily enough using the pan-and-zoom features or if you have a high-resolution external display.

The N40 has many nice features that suit it as a portable PC. NCE's Location feature, for example, greatly enhances your ability to work effectively in multiple locations. Software consultants and support specialists should find that just this single feature makes the N40 worth serious consideration.

On the other hand, I found the N40 barely usable away from A/C power, even with the two batteries supplied. As I mentioned, it's not that practical switching batteries because you must cycle power to make the switch. Additionally, I don't recommend trying to use the TrackPoint pointing device when under way in a bus or train. For some remote-site applications, however, the N40 could be indispensable. If you need AIX in a portable package, there's no substitute. ■

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About the Product

IBM RS/6000 N40 .... $11,995
(as tested, with 16 MB of RAM and a 340-MB hard drive)

IBM Corp.
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Armonk, NY 10504
(800) 426-2255
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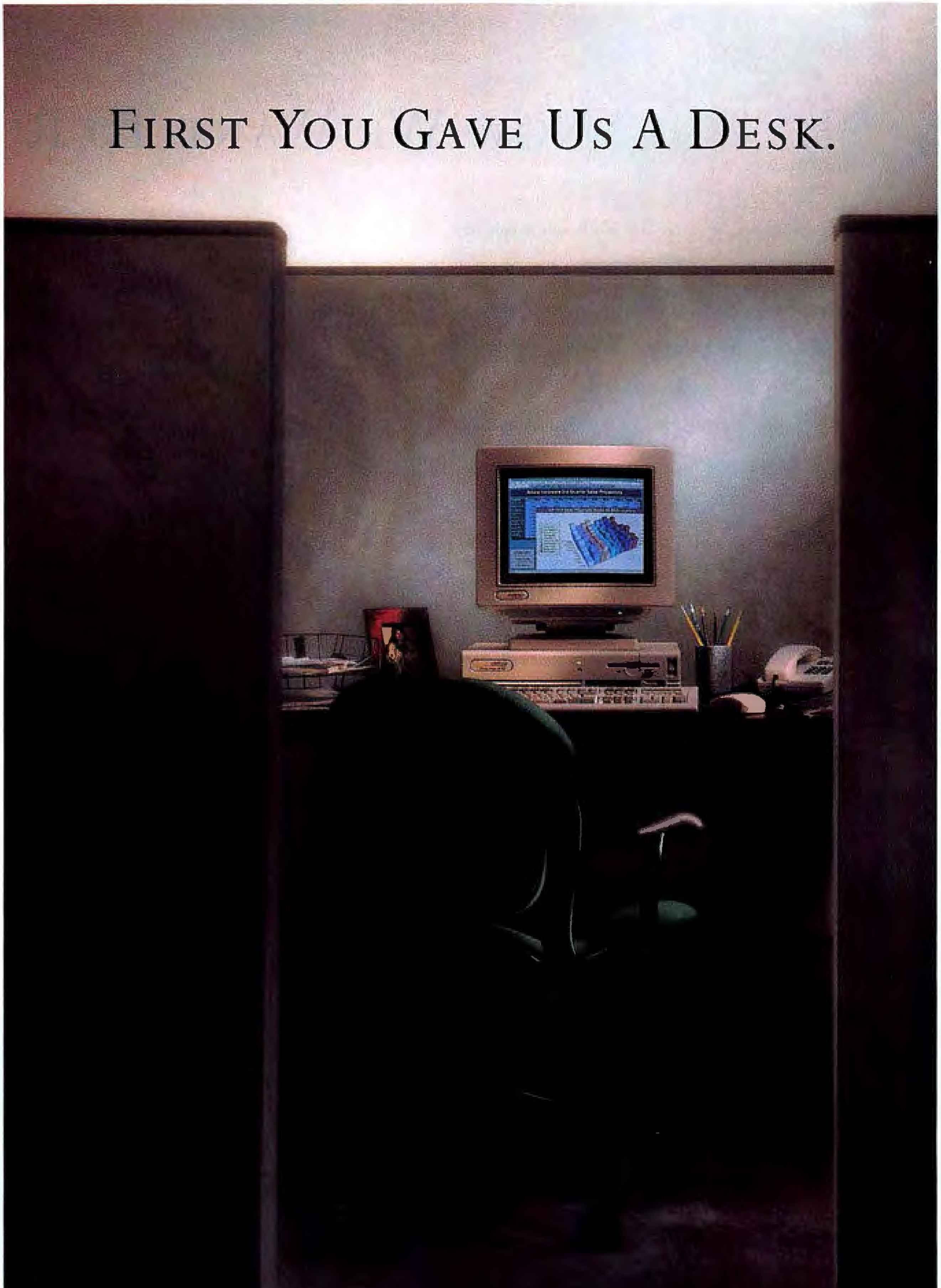
fax: (800) 426-4329
Circle 1088 on Inquiry Card.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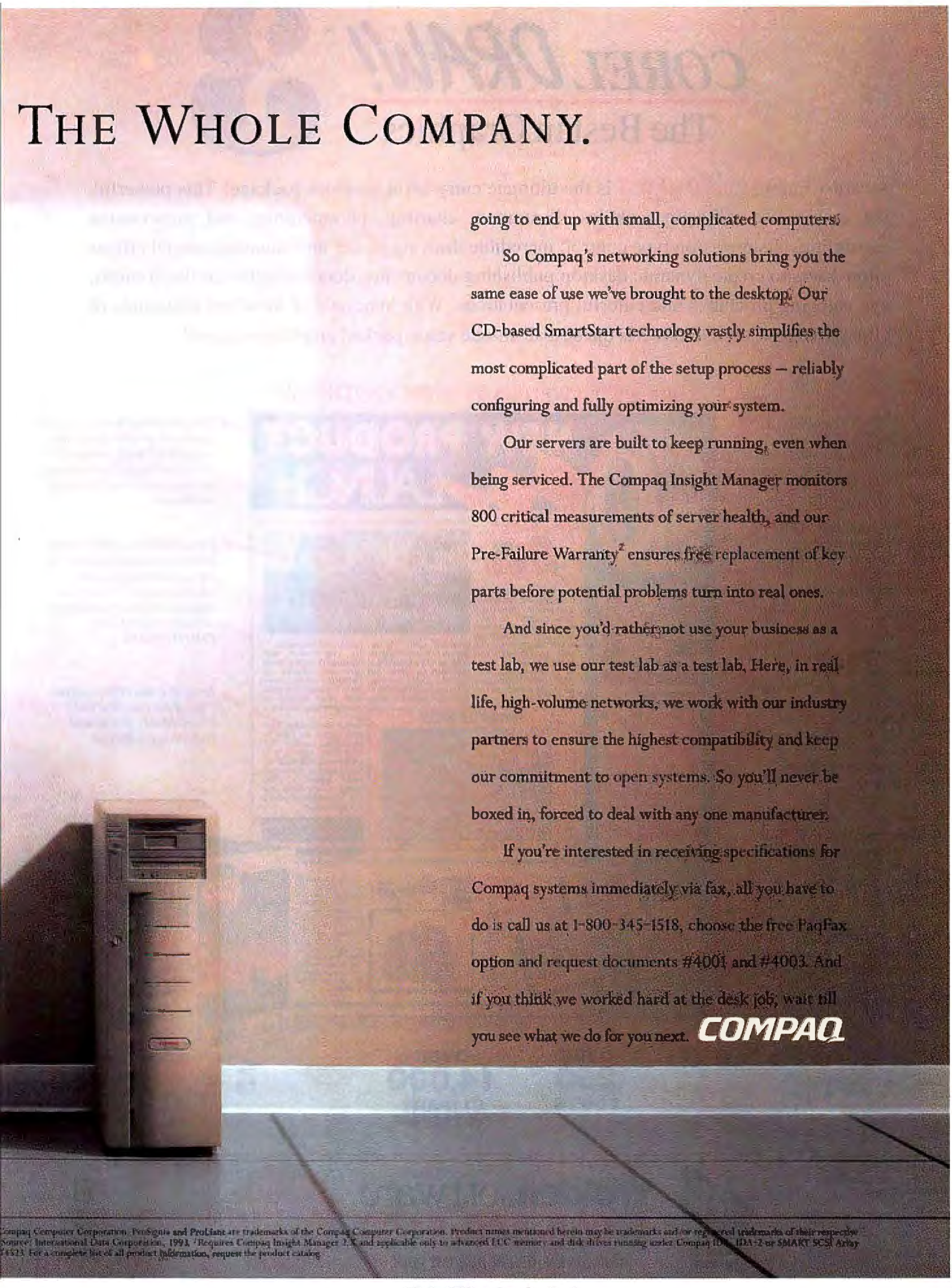

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Friendly Acquisition

Seven tools for building data acquisition applications in Windows—without writing a single line of code

IRA EGLOWSTEIN

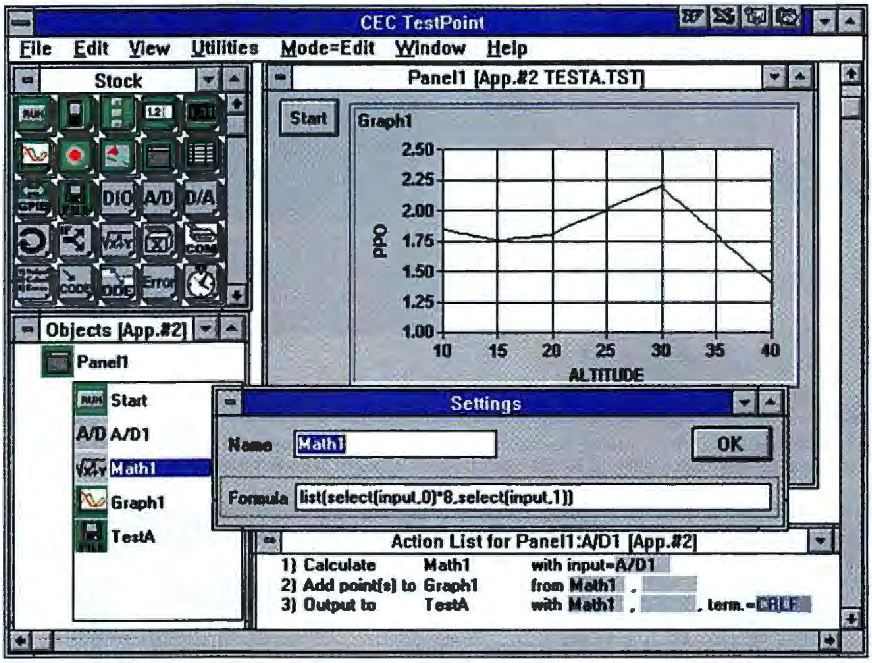
Ask anyone who has written data acquisition or control software from scratch—it's a tedious and time-consuming process. A large acquisition and control application written in C or BASIC could take weeks or months to complete. Imagine building that same solution in hours. That's exactly what graphical programming environments claim to do for data acquisition. A window replaces your text editor, icons replace subroutines, and lines and arrows determine the data flow.

If you're an engineer or scientist who wants to sample signals from a test source or take measurements from an ongoing experiment, perhaps you've been scared away from data acquisition by the thought of learning C or BASIC. Graphical programming environments also empower nonprogrammers to build data acquisition solutions.

Perhaps you're from the old school and can't imagine developing an application by dragging lines between graphical elements. These environments can work as front ends for your custom code. You may be a wizard with the low-level drivers for your hardware, but you don't want to spend the time writing math functions or graphing routines. These environments support external code or share data with other Windows programs.

Graphical programming environments have other significant advantages, as well. Developing a system with one of these environments takes less time and could save your company a considerable amount of money. Graphical programming may also leave you with applications that are easier to reconfigure as your needs change. Finally, it's harder to make programming errors in a graphical environment because you select actions from a menu instead of typing in keywords and program statements. If the system builds the syntax for you, you're less likely to make syntax errors in programming that can eat up a lot of debugging time.

None of this is to say that graphical programming is going to replace the countless data acquisition libraries available for conventional programming. Graphical environments have their limitations, too.



Math functions in CEC's TestPoint allow you to enter any function by typing in a formula. The Action List window describes the data flow from the A/D converter to the display graph and then to a disk file.

Acquiring Without Code

This review focuses on seven products: Capital Equipment Corp.'s TestPoint, Data Translation's DT VEE, HEM Data's SnapMaster, Intelligent Instrumentation's Visual Designer, Laboratory Technologies' Notebook, National Instruments' LabView, and Strawberry Tree's WorkBench PC. All run under Microsoft Windows and claim to provide complete data acquisition functionality without requiring you to write a single line of code. For hardware support, these products handle a selection of internal data acquisition boards, and they provide a graphical programming environment and analysis functions to process the acquired data. (One product, DADiSP from DSP Development, is not included here because its focus has a subtle but important difference: It's primarily an analysis tool that supports data acquisition through optional modules.)

Programming a data acquisition and control solution in a graphical environment involves selecting icons from a library of iconic functions and arranging them onto a working surface (variously called an *instrument* or a *panel*). Each icon has specific setup conditions that are often accessible by double-clicking on the icon once it's been placed. Selecting an input channel from your data acquisition board can be as easy as opening a document from your word processor. Once the icons are in place, you describe the data flow by connecting the icons in some logical fashion. In some products, this connection is visual as well as logical, taking the form of arrows showing the data flow. In other products, the data flow is managed by descriptive *action panels*.

To better facilitate sharing the data between your data acquisition environment and your other Windows applications, most of these products support DDE. For example, you might grab a series of acidity readings from a pH meter and, through DDE, channel them to a chemical analysis program for processing. If your application requires producing graphs that are beyond the data acquisition program's capability, you can let Excel grab the data through DDE and display the graph.

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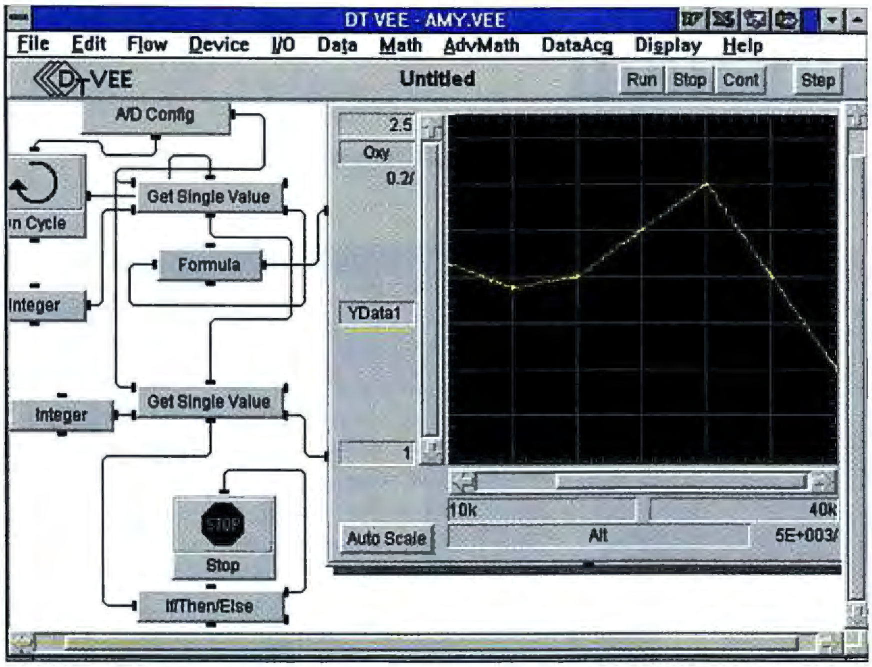
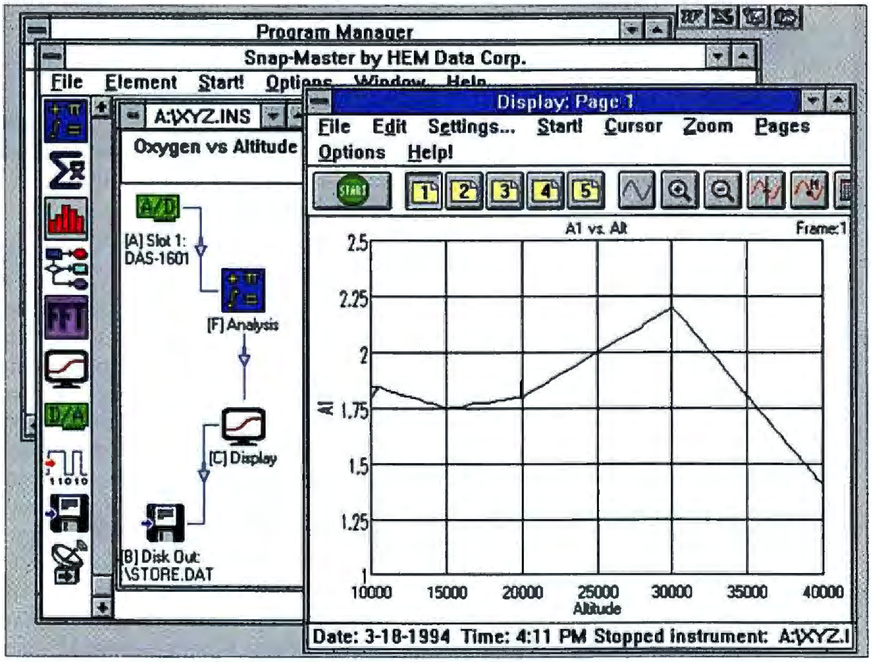


DT VEE's screen objects have detailed descriptions of their functions. In this view, the application icons were reduced to conserve space. Although DT VEE labels the axes on graphs, it doesn't label the ticks along the axes.



Snap-Master's displays are clear and easy to read. Data flows from step to step through pipes; arrows indicate the data-flow direction. Of the products included, Snap-Master's graphics are second to none.

Real-World Acquisition

To put these packages to the test, I wanted to use them to reproduce a test system I had developed for Scott Aviation, a division of Figgie International. One of Scott's products is an oxygen regulator used onboard commercial aircraft. The regulator has to control the oxygen flow from a pressurized air supply in response to changes in air pressure. The actual test system presented a few specific challenges that seemed reasonable to present to these data acquisition products.

The oxygen content of an air sample is determined by a dedicated oxygen sensor. The output of this sensor is a voltage, proportional to the measured oxygen level. To convert from voltage to the proper reading, you simply multiply the voltage by a constant.

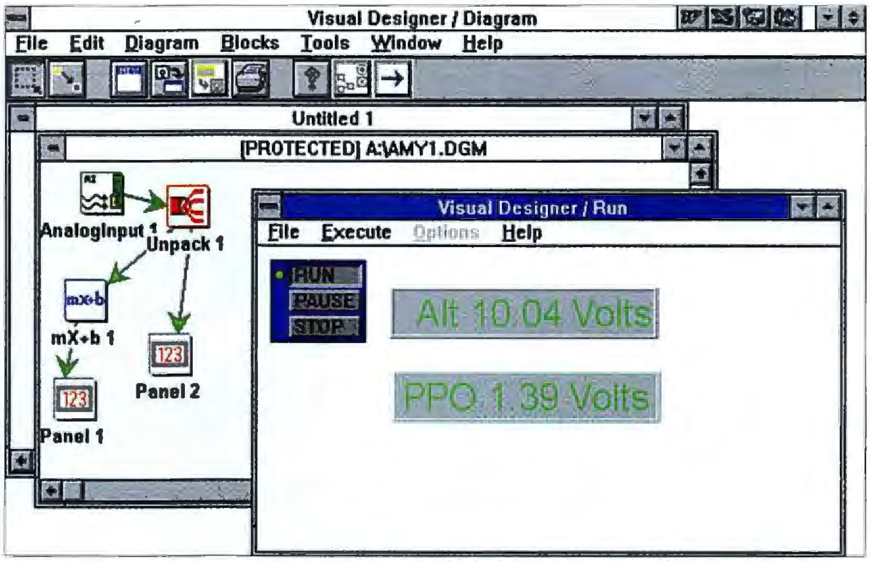
Altitude is a nonlinear function of air pressure: The pressure goes down as the altitude goes up. In the test fixture, a vacuum line lowers the pressure to simulate higher altitudes, and a transducer reads this pressure as a voltage.

Converting the pressure reading into altitude requires the first of two special treatments. There is no linear relationship between air pressure and a given altitude; because of the many different atmospheric layers on the earth's surface and a huge number of variables, the relationship between these two measurements is complex. The best way of performing the conversion is by looking it up in a table; it can also be approximated by a calculation. For this test, I wanted to use a pressure/altitude table from a disk file and have the data acquisition program perform a table lookup.

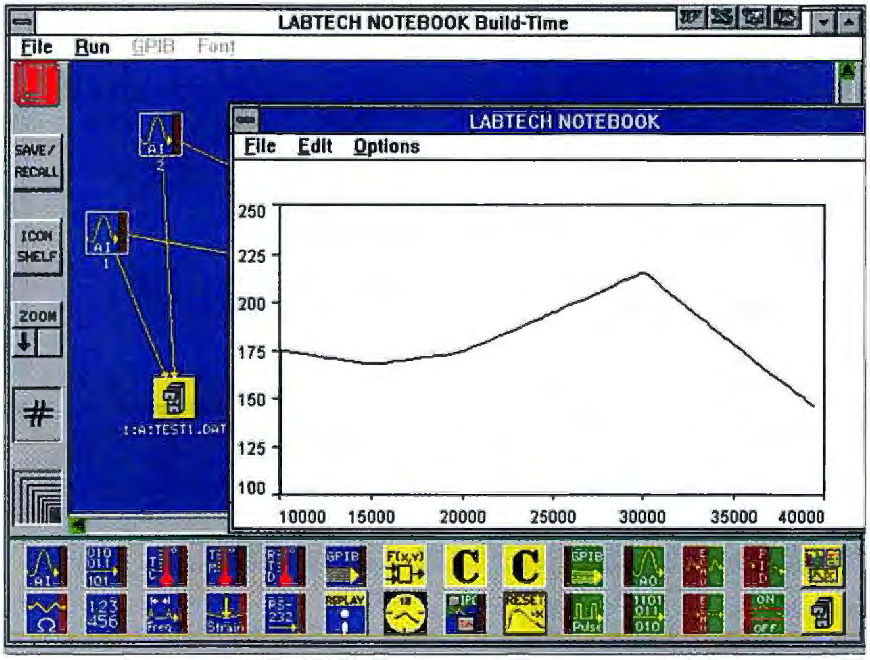
The other tricky detail is to control the simulated test altitude. A motorized valve controls the connection between the vacuum line and a test chamber; the more you open the valve, the lower the pressure in the chamber or the higher the altitude. To open or close the valve, the computer has to generate a pulse of varying width. A wide pulse opens the valve farther; a narrow pulse opens it less. The pulse goes to one of two connections, depending on whether you want to open or close the valve. To determine the pulse width, the actual measurement is compared with what *should* be happening; larger errors require a larger adjustment to the vacuum valve or a wider (longer) pulse.

For this test, I didn't use the actual laboratory hardware, but a simulation. I installed each package and the required I/O card in a 66-MHz 486DX2 machine with 8 MB of RAM. A second PC was connected to an Interface Systems DataPad unit (an external data acquisition box) that contained both digital and analog I/O cards. Software in the PC controlled output voltages to simulate varying pressure and oxygen measurements.

The valve-control functions were connected to digital inputs, and software handled the simulation of the valve's position by watching the pulse widths—or at least that was the intent. After spending considerable time with each product, it appeared that none of the products in the review could handle the pulse-width modulation without a substantial amount of work. For those products that support it, linking in an external support routine (written in C or some other language) may be the best approach.



Visual Designer doesn't support *x, y* plots and was unable to perform the display portion of the test. The AnalogInput icon controls two A/D channels, which must be broken apart using the Unpack module before displaying the data in digital panel meters.



Labtech's Notebook uses separate icons for each input channel. This makes it easy to control the flow of data, but it can be confusing if you have lots of active input channels. The *x, y* plotting function doesn't support labels or noninteger axis numbers. In this graph, the *y*-axis values are multiplied by 100 to make all the digits visible.

CEC's TestPoint

Programming a TestPoint application is simply a matter of selecting icons from the Stock Objects palette in the upper left corner of the screen. A click, drag, and drop operation moves the object to the Objects list area. When you drop the icon, a Settings menu prompts you for detailed configuration information. The Panel window provides the run-time interface; both input controls and result displays appear within this window.

One feature unique to TestPoint is the Action List (see the screen on page 147), which describes the interconnection and interdependence of the objects. You place items in the Action List by dragging them from the Stock Objects palette and then selecting parameters from a menu. During one of the test runs, I typed a formula into the math object. I ran the test, and `error 68` popped up on the screen. It turned out to be a typing error in the formula, but the error message wasn't very helpful.

The test setup in the screen begins by waiting for the manual start button in the Panel window. When you click on the button, TestPoint reads the A/D inputs, applies the math, and graphs the output. Each analog channel is accessed separately in a math object formula; that makes it easy to handle multiple inputs.

TestPoint can use standard Windows DLLs for accessing external code and DDE for sharing data with other Windows applications. Once you've developed a TestPoint application, you can attach the run-time environment to it and distribute the result royalty-free as a stand-alone program.

Data Translation's DT VEE

DT VEE's object menu is comprehensive; it seems as if just about any function you could want is represented by an icon. After you've positioned the icons on the screen, it takes only a few clicks of the mouse to interconnect the functions with wires (wire routing is automatic). Clicking the right mouse button on an icon brings up a menu appropriate for that object. Clicking on a shrink button reduces the icon size, making room for a great many objects on-screen at once.

Error handling is excellent. I eliminated one wire from my working application and tried to rerun it. DT VEE gave me an error-message window; I moved that aside so I could see the offending icon (which was outlined in red).

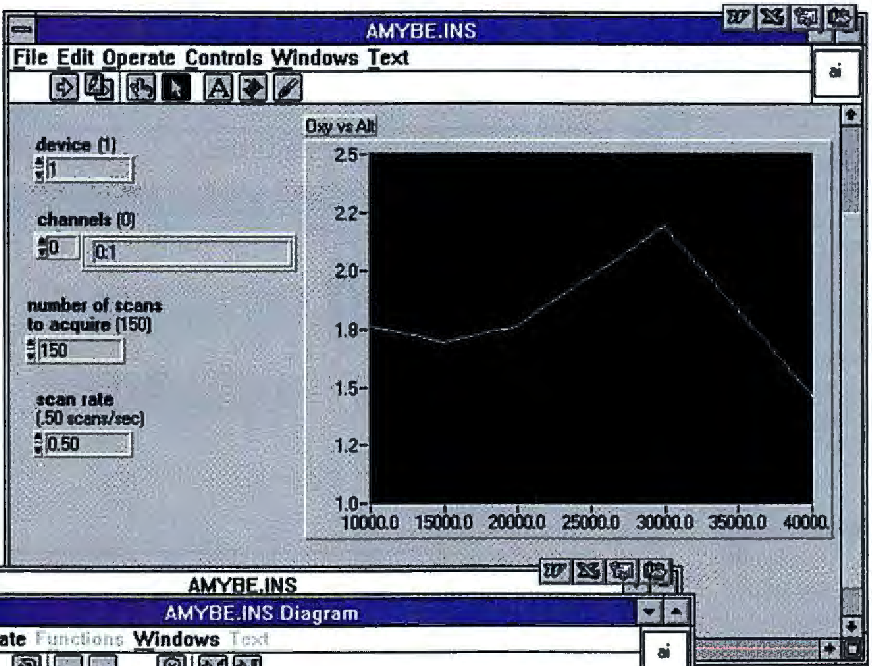
Installing DT VEE was straightforward, except that it wasn't obvious which of the several driver disks contained Windows drivers. It also became obvious that the A/D card I was using (DT 2835) could not handle automatic sampling at slow data rates. I solved that problem by setting the card for single-sample input and triggering it from a separate timer.

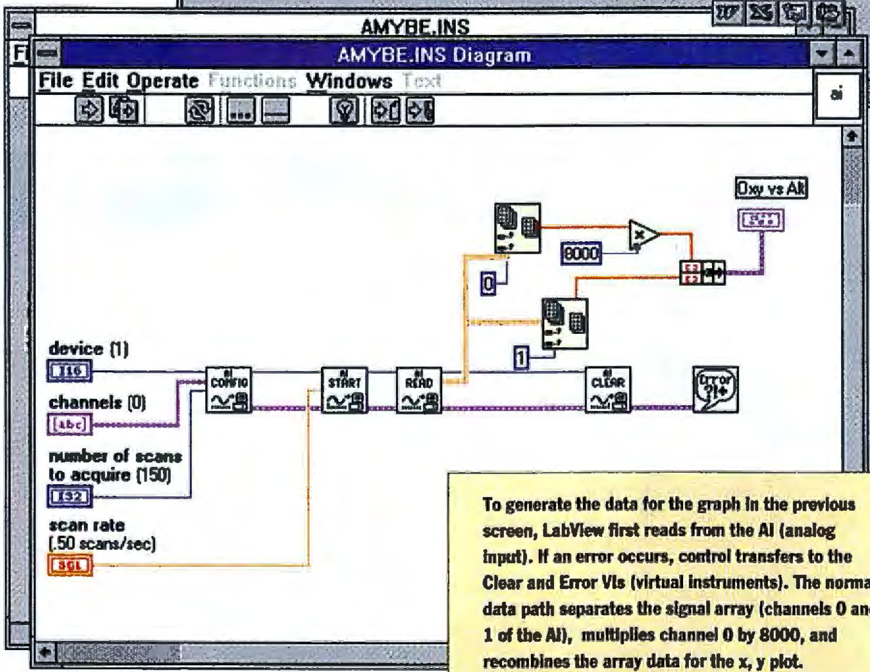
DT VEE is based on Hewlett-Packard's HP VEE for Windows 2.0 (the biggest difference being DT VEE's support for Data Translation boards). Like most of the other packages in this review, DT VEE can share data with other Windows applications through DDE; the documentation discusses only DDE client support. After you've built a DT VEE application, you can run it outside of the development environment through the optional run-time module.

HEM Data's Snap-Master

Snap-Master uses a straightforward approach to building data acquisition and control systems. The elements (icons) are

LabView's user interface, with the device configuration data (number of channels, scan rate, and number of scans) and a sample *x, y* output. Although LabView labeled the graph, it didn't indicate which axis was which (the *y*-axis is oxygen, and the *x*-axis is altitude).





To generate the data for the graph in the previous screen, LabView first reads from the AI (analog input). If an error occurs, control transfers to the Clear and Error VIs (virtual instruments). The normal data path separates the signal array (channels 0 and 1 of the AI), multiplies channel 0 by 8000, and recombines the array data for the x, y plot.

in a column on the left side, with a scroll bar. To use and configure an element, you drag it into the working window and double-click on it to enter any required settings. The screen on page 148 is a sample from my test application; it was trivial to get exactly the output I wanted.

HEM provides a single user's manual for Snap-Master. It's quite complete, but I would have appreciated a few more examples. It would also be nice if Snap-Master was a bit more forgiving about input formats. In one case, I typed in an extra space character in a math formula, which caused a run-time error; an extra space shouldn't do that. To perform the table lookup portion of the test setup, HEM suggests using DDE to another application (e.g., Excel) or writing an external module as a DLL.

If you don't need the entire package, you can buy just the modules you want: The data acquisition module (SM-DA), general analysis module (SM-GA), frequency analysis module (SM-FA), and programmer's toolkit (SM-PT) are available separately. Version 3.0 may be out by the time you read this, and it should contain HEM's data gateway module (a user programming aid) as well.

Intelligent Instrumentation's Visual Designer

Visual Designer menus make good use of cascading daughter menus to simplify the menu structure. Selecting a block (icon) from the menu brings up an additional option menu.

With Visual Designer, all the input channels on an acquisition card are lumped together into an array. To use one of several channels from a card, you have to wire the array output into an unpacking block to separate the channels. The screen on page 149 shows a simple application of this procedure. Note that unlike the other packages, Visual Designer cannot display data sets as *x, y* graphs.

Visual Designer has good error handling and provides a run-time module ($150 per copy, but Intelligent Instrumentation includes the license free if you use its hardware). Version 1.0 supports DDE only as a server, but version 2.0 should be out by the time you read this and should support DDE as both a server and a client.

Labtech's Notebook

When starting up Notebook, you choose either the build-time or the run-time module. The build-time module provides the environment for creating or editing an acquisition application; the run-time module executes your applications.

Notebook is unique in that each A/D channel is shown as a separate icon and has separate scaling capabilities. In my example, this approach reduced the number of icons required to set up the test scenario.

You access each icon's specification table simply by double-clicking on the icon and entering the parameters. Connecting icons (for data flow) is a relatively simple click-and-drag operation. Hardware support is excellent, too—Notebook includes Labtech's Universal Driver, which handles hundreds of I/O cards.

I found it odd that you have to enter Notebook's general menu through the LT icon (a stylized version of Labtech's logo) instead of through a pull-down menu. I also thought that I didn't have proper control of the application names when saving files. When using the run-time module, I would have liked to have the name of the application shown on the screen.

To solve complex math functions, the company suggests using the CAL(X) (or calculated function) icon, writing a function in C and using the C icon, or using other Windows products and DDE transfers. A stand-alone run-time module can be used to run finished applications. A separate product, Realtime Vision, can add graphical sliders, knobs, and displays and link them to your Notebook application through DDE.

The only serious problem I ran into when executing the test procedure was in scaling the x- and y-axes on x, y plots. I wanted the y scale to run from 1.0 to 2.5 with tick increments of 0.25, but Notebook displays axis scales only as integers (Labtech is planning to change this in the next release). The workaround was to scale the input and graph by 100 (see the screen on page 149).

National Instruments' LabView

LabView uses a graphical programming language, G, to create programs in block diagram form called *virtual instruments* (VIs for short). The program splits your development between two windows. The first is a user-interface panel with controls and display outputs; the second is a diagram of VIs that combine to build your application.

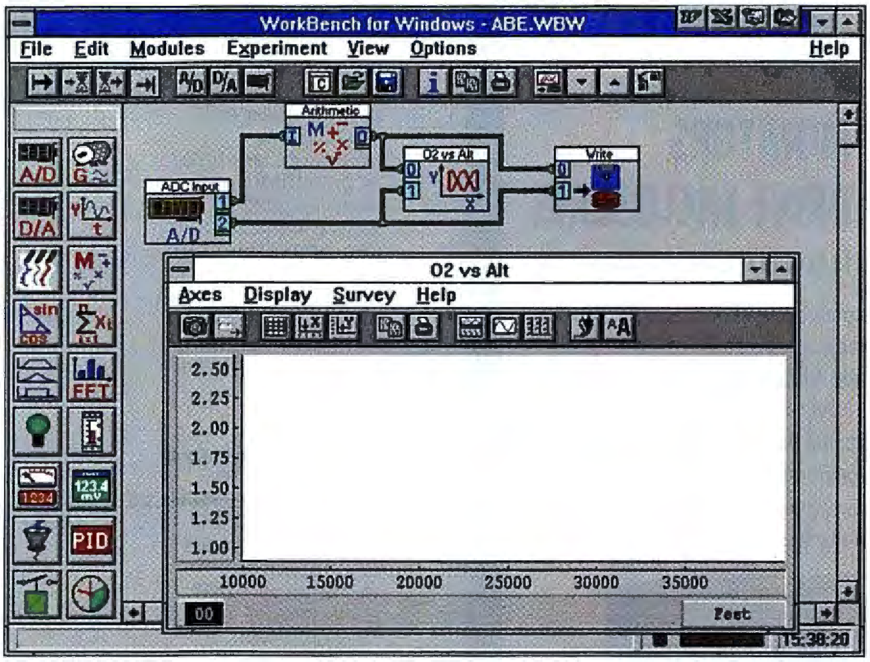
A typical data acquisition and control problem would involve several instruments. LabView has the unique ability to embed several VIs into a single hierarchical VI. You can then use this VI to build more complex systems. This grouping makes it easier to build sophisticated systems without getting bogged down in an endless mire of icons and wires.

The LabView environment is quite complex, as evidenced by the number of manuals (nine) accompanying the software and the customer training sessions available from National Instruments. To get started faster, I grabbed bits and pieces of applications from the sample solutions and modified them to solve my test problem. The learning curve is steep; I had to call the company's technical support to finish the test. The screens on page 150 illustrate the power and complexity of LabView.

Analog signals (from the A/D channels) are piped as combined data arrays. I wanted to multiply one channel by a constant, so I sent the signal into Index Array icons for separation, performed the multiplication, and then rebundled the arrays so they could be piped to the display. The panel and diagram are intimately linked; modifying the diagram also modifies the panel.

I wasn't happy with the x, y graph output. The graph doesn't update until the entire acquisition cycle is complete. In my test, I had slow-moving data that took 5 minutes to acquire, and I had to wait the full 5 minutes to see whether the result was what I expected.

When I asked about implementing the table lookup, the company suggested that I look through its analysis reference manual or implement the lookup through DDE. The manual offered a vast array of functions, but none would obviously solve my problem. I would need to spend a lot more time working with LabView before I could claim any real expertise. National Instruments understands this need—the company offers a one-week training course for new LabView users.



A WorkBench PC worksheet, set up to acquire two channels of data, multiply channel 0 by a constant, generate an x, y plot, and store the data to disk. The graph is empty because running this worksheet caused a run-time error.

Strawberry Tree's WorkBench PC

You can rapidly develop WorkBench PC applications by selecting modules from a palette on the left side of the screen and filling in any necessary details in a dialog box. Each module represents a single process and can contain support for multiple I/O channels. The I/O channels are clearly indicated on the module icon. Interconnections between the modules appear as colored wires. You connect modules by clicking on one module's output and clicking on another's input. Taken as a group, these features make using WorkBench fairly intuitive and contribute to the product's short learning curve.

I tested WorkBench with one of Strawberry Tree's ACjr A/D cards, an eight-channel, 12-bit card with 12 digital I/O lines. The card can be set to a selected range of I/O addresses and one of two interrupts. The ACjr refused to work in my 486/66; the software complained about a bad interrupt line. Strawberry Tree's technical support agreed that something strange was happening and sent me a replacement card installed in another machine.

Part of the test requires displaying two data sets against each other on an x, y graph. WorkBench had no trouble displaying other kinds of graphs, but the x, y plot caused WorkBench to crash with a floating-point error.

I was also disappointed with WorkBench's inconsistent use of labels. Some modules allow you to name the display windows; others do not. Strawberry Tree is looking into the problem.

In spite of its failure to complete the testing, WorkBench is worth knowing about. I'm looking forward to seeing if the next release fixes some of the problems.

Icons or Code?

It's refreshing to see that data acquisition software has moved into the Windows environment so effectively. While it can be argued that programmers working with conventional languages and I/O libraries *may* have more control over the acquisition process, not everyone who needs acquisition knows how to write code or wants to spend the time to do it. All these products do a good job of making data acquisition

About the Products

DT VEE 1.01 .... $1995
run-time only $495
Data Translation, Inc.
100 Locke Dr.
Marlborough, MA 01752
(800) 525-8528
(508) 481-3700
fax: 508-481-0627
Circle 1076 on Inquiry Card.

LabView 3.0 for Windows
(full development package) $1995
National Instruments
6504 Bridge Point Pkwy.
Austin, TX 78730
(800) 433-3488
(512) 794-0100
Circle 1077 on Inquiry Card.

Notebook for Windows 7.3.0 .... $995
run-time only $495
Laboratory Technologies
400 Research Dr.
Wilmington, MA 01887
(800) 879-5228
(508) 657-5400
fax: (508) 658-9972
Circle 1078 on Inquiry Card.

Snap-Master 2.0a
SM-DA $995
SM-GA $495
SM-FA $495
SM-PT $495
HEM Data Corp.
17336 12 Mile Rd.
Southfield, MI 48076
(800) 436-4330
(810) 559-5607
fax: (810) 559-8008
Circle 1079 on Inquiry Card.

TestPoint 1.1 .... $995
Capital Equipment Corp.
76 Blanchard Rd.
Burlington, MA 01803
(800) 234-4232
(617) 273-1818
fax: (617) 273-9057
Circle 1080 on Inquiry Card.

Visual Designer 1.0 .... $995
version 2.0.....$595 until 7/31/94
optional Custom Block Toolkit $795
Intelligent Instrumentation
6550 South Bay Colony Dr., MS130
Tucson, AZ 85706
(800) 685-9911
(602) 573-3504
fax: (602) 573-0522
Circle 1081 on Inquiry Card.

WorkBench PC 1.5
extended edition $1245
base edition $995
DLL toolkit $395
run-time only $330
Strawberry Tree
160 South Wolfe Rd.
Sunnyvale, CA 94086
(800) 736-8810
(408) 736-8800
fax: (408) 736-1041
Circle 1082 on Inquiry Card.

solutions easier for nonprogrammers to implement; one product may be more suitable than others for some applications.

First off, make sure the product supports the I/O hardware you need to use. Vendors that manufacture both hardware and software may not support anyone else's hardware. Labtech's Notebook is a clear standout in this respect: Its universal device driver supports hundreds of boards from dozens of vendors. HEM's Snap-Master and CEC's TestPoint also have excellent hardware support.

You also want to be sure that the functions provided in the package can perform the analysis you need. A number of the packages reviewed here are scheduled for updates; a call to the company's technical-support or sales number can probably tell you if a new version of the software can fill in a missing function.

If you can make a choice based purely on the software, National Instruments' LabView appears to do just about anything you might ever want done—once you've invested the time to learn it. If you would rather break open the shrink-wrap and get up and running within hours, DT VEE, Snap-Master, and WorkBench PC are your best bets.

The acquisition and control problems I need to address often have enough wrinkles in them that I'll still be relying on BASIC or C for custom code. I do like the idea of incorporating Windows into my solutions, and I'm looking forward to spending more time with Snap-Master. Windows may not be the ideal environment for every data acquisition solution, but for many of them, it's better than you might think. It's also a lot of fun. ■

Ira Eglowstein has been designing custom data acquisition hardware and software systems since 1973. His company, Interface Systems (Williamsville, NY), integrates data acquisition solutions into a variety of applications (it did the mechanical design and assembly for BYTE's battery-test station, Thumper 2). He can be reached on the Internet at ah789@freenet.buffalo.edu or on BIX c/o "editors."

Linking Development Teams

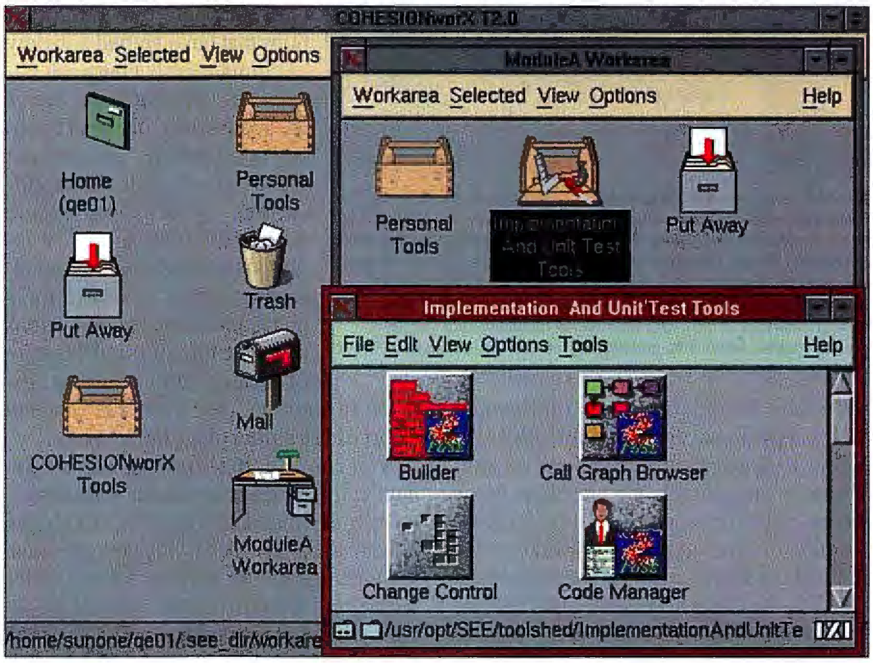
DEC's CohesionWorX delivers a sophisticated software development environment spanning heterogeneous networks

EDMUND X. DEJESUS

The popular image of the lone programmer writing a software application on a stand-alone computer is rapidly becoming a quaint anachronism. Most modern software development is the product of teams of programmers working on networked computers. Unfortunately, this distributed software development creates new sets of problems.

Heterogeneous networks may include computers from many different vendors, running different operating systems and environments. Software development tools, source code files, and data may reside anywhere on the network. Managing access to source files on a network can be a nightmare. Tools may run on one platform and not on others. Syntax to run tools may differ from one machine to the next. Programmers have better ways to spend their time than keeping track of what tools and files are where and how to access them.

One solution is CohesionWorX 2.0, DEC's new CASE environment for distributed software development on heterogeneous Unix networks. CohesionWorX consists of a suite of integrated tools and a supporting graphical environment for all stages of software development. Supported platforms now include Sun SparcStations or SparcServers running SunOS 4.1.3, Hewlett-Packard HP 9000 Series 700s running HP-UX 9.01, and DEC's own Alpha AXP running OSF/1 1.3.



CohesionWorX provides a consistent graphical environment on all platforms and transparent access to tools, source files, and data, no matter where on the network they physically reside. Besides the DEC FUSE tools, CohesionWorX offers a wide array of graphical Unix tools for mail, manual help, printing, shell, and other common activities. All these tools also appear as desktop icons; you need no knowledge of Unix syntax to use them.

A Consistent GUI

CohesionWorX provides a consistent graphical environment on all platforms and transparent access to tools, source files, and data, no matter where they physically reside on the network. Such cross-platform connectivity streamlines access to tools and data and can enhance cooperation and communication among programming team members, especially on large collaborative software development projects. Using libraries, programmers can manage access to files across the network. CohesionWorX offers DEC's FUSE tools for each stage of software development, including design, coding, build, debugging, integration, and management; each tool has an on-line tutorial and context-sensitive help system.

CohesionWorX displays a graphical desktop paradigm as an extension of The Santa Cruz Operation's SCO IXI X.desktop. CohesionWorX shares X.desktop's conventions for window display and behavior (i.e., multiple overlapping windows, scroll bars, and so on). One of the prime appeals of CohesionWorX is that it looks the same no matter which platform on the network you happen to be using.

There are several types of windows. You can create virtual *workarea* windows suitable for a specific task (e.g., test and integration) or software project. A workarea can contain tools and data appropriate to its purpose. DEC provides predefined task-oriented workarea types (e.g., Configuration Management and Detailed Design), each configured with tools specific to that type. When you open one of your workareas, it's like unpacking a desktop full of all the tools and files you need for that task or project. You don't waste time locating tools and files every time you sit down to work. Your workareas are available wherever you are on the network.

Desktop Tools

Data objects, like files, appear as representative icons in a window. The appearance of a file icon and any special symbols it might wear can suggest the file's contents, as well as other file attributes; for instance, a sheet of line-printer paper wearing eyeglasses is a read-only source file icon.

The icon represents a file on the workarea. The actual file can be anywhere on the network. You are spared the details of precisely which machine, drive, and directory contain the file; CohesionWorX keeps track of all that, so programmers can be programmers and stop being file clerks. You can view or edit a file (as its access allows) simply by double-clicking on its icon with the mouse.

Tools (e.g., editors) also appear as representative icons in a window. Running a tool is as simple as double-clicking on its icon or dropping a data icon (e.g., a document file) on a tool icon (e.g., a printer). As

Using libraries, you can manage access to files across the network. The foreground window shows a Check Out box where files are checked out of the library. The Code Manager window displays the files contained in the current library. Code Manager manages the source files by version and configuration. You never have to remember which is the latest revision: CohesionWorX remembers for you. You can display whole revision histories of files, with information including date and time, creator's name, comments, and status. You can also compare different versions of files.

with data icons, tool icons represent a tool's appearance and behavior, while the actual tool description files can be anywhere on the network. You need not know where on the network the tool (or its data) resides. In fact, you need not know anything about Unix or network operations at all. CohesionWorX keeps track of where everything actually is, as well as how to run everything. Tool icons animate to show when they activate, so you'll know when something is happening; for instance, when you drop a file on the trash can, debris appears in the trash-can icon.

You can control the priority of servers available to run a given tool. For example, if certain servers are often in use for intensive testing, you can specify another server to maintain tool performance. You can also employ speedier servers for specific one-time tasks, such as a resource-intensive compiler run.

Distributed Objects

CohesionWorX performs all this seeming magic with the help of its Control Services, based on DEC's ACAS (Application Control Architecture Services) and vendor-specific DCE (Distributed Computing Environment).

ACAS lets you access applications (including tools) independent of the platform you're on. ACAS handles communications between users and tools (e.g., running the tool) and between tools (so one tool can run another or pass data to another). ACAS takes care of the details of fielding user requests, finding servers to satisfy requests and supporting ongoing user-to-tool and tool-to-tool communications, all transparently to the user (see the figure "Distributed Objects with CohesionWorX" on page 158). You gain access to tools on other platforms, effectively multiplying the number of tools available.

This design strategy is especially attractive to organizations that have grafted a variety of computers to a network because of collaboration, merger, acquisition, or departmental consolidation. You need not leave behind tools and applications you are comfortable with and in which you've invested time and training. By allowing access to known tools and applications, organizations can save the time and expense of locating and acquiring new tools. In addition, they avoid the cost and effort of retraining disgruntled users.

You can add tools or even servers dynamically to the environment without disturbing existing activities or rebooting the system. ACAS (which is changing its name to ObjectBroker for version 2.5) complies with the CORBA (Common Object Request Broker Architecture) standards.

DCE services support distributed applications and provide interoperability across heterogeneous platforms. The DCE Security Service provides for secure (optionally encrypted) communication across the network and also authenticates users and their privileges on each machine on the network. Performing one log-in to DCE saves the time and bother of logging onto every server whose tools or data you access.

DCE's Cell Directory Service keeps track of where tools and data physically reside on the network and provides access to the tools and data across the entire network. This simplifies access to distributed tools and data tremendously, since DCE makes the networked resources look like a single virtual system to the user.

Given such complex interplay between the network, ACAS, and DCE, the initial installation of CohesionWorX can be a bit of a challenge. DEC recognizes this and provides detailed step-by-step manuals and release notes specific to every supported platform, in addition to DEC engineering support services. Much of the installation of CohesionWorX itself is automatic, using interactive scripts that request basic information the installer can provide.

Custom Workareas and Version Control

In a typical scenario, you create a new workarea for a software project or task. You can choose from predefined task-oriented workarea templates. Each workarea template is preconfigured with tools appropriate for its task. For example, the Implementation and Unit Test workarea might contain the CohesionWorX FUSE Editor, Builder, Debugger, and other tools.

Having created and named the workarea, you can then place appropriate tools and source files on the new workarea. For source files, this can be as simple as opening a directory folder, selecting one or more file icons with the mouse, and dragging

DEC CohesionWorX

Overview
Distributed software development environment for networks.

Hardware Platforms
Sun, HP, and DEC workstations.

Workstation Requirements
32 MB of RAM (48 to 64 MB recommended, depending on the specific platform).

Server Requirements
120 MB of disk space for CohesionWorX, 26 MB for ACAS and DCE, 150 MB of base swap space, and 50 MB per user. Disk space usage depends heavily on the load.

Environments
Unix (SunOS, HP-UX, OSF/1).

Languages Supported
C, FORTRAN, Pascal, Ada (optional), C++ (optional).

Tools Included
Editor, Builder (compiles programs, runs make files), Debugger, Code Manager (controls access to files in libraries), Profiler (displays program run-time statistics), Call Graph Browser (displays program call structure), Cross-Referencer (finds program data and function references).

Optional Tools
EnCASE (integrates tools into CohesionWorX), C++ Class Browser (displays C++ class hierarchies).

Pricing
CohesionWorX license fee: $2300
CohesionWorX C++ support license fee: $1000
CohesionWorX Ada license fee: $1000
CohesionWorX EnCASE license fee: $2400

Controlling Cross-Platform Objects

DEC's ACAS (Application Control Architecture Services) uses an object-oriented client/server paradigm to handle applications: A client requests services; a server provides requested services.

In an object-oriented model, objects have characteristics and perform certain behaviors (called *messages*). The behaviors are performed when the object receives a request. A *method* is a specific implementation of a message and may be platform-dependent. For instance, invoking an editor can involve different programs on different computers. Under ACAS, such abstract information about an application (called its *metadata*) is stored in a class repository database.

When you invoke a tool, a chain of client/server requests is initiated. When a client requests a service, ACAS uses information from its metadata and from user-defined preferences to select a method to satisfy the requested service and then find a suitable server for that method. Depending on the configuration and user preferences, a number of servers may be available for that method. ACAS uses a prioritized list of servers to try one, then another, until it locates a suitable one. The method server then satisfies the client's request. All the communications involving the user, the clients, and the servers are managed by ACAS.

Here's an example of how ACAS would handle a typical CohesionWorX interaction. You drag a file icon and drop it onto an editor tool icon. The desktop interface interprets this action as a request that the file be opened for editing. The desktop (as a client) requests a service of the editor (as a server). ACAS determines the possible methods that might satisfy the request for an editor. For instance, there may be several versions of an editor tool that run on different computers or under different operating systems.

When a suitable method (i.e., a specific editor) is identified, ACAS looks for a server for that method. The network may have several candidate computers appropriate for that method. Of these, you (or your system administrator) may have prioritized some. ACAS will try the first-priority server. If it is available, it becomes the method server (i.e., it runs the editor). If it is not available, the next server in the list will be tried, and so forth. Since ACAS, its data, the tool itself, and the server may be on many different computers in the network, even such a simple user action can require a great deal of communication to be successful.

the whole lot onto the new workarea. You can either move or copy the files to the workarea. In either case, the physical location of the files in the directory structure does not change: The icon on the workarea is a reference to the file, not the file itself. The file can reside anywhere on the heterogeneous network.

Besides populating your new workarea with the tools and files you need, you can also customize its appearance. You can specify colors for each part of the workarea window and choose the fonts for object labels. Different users often prefer different color schemes and types and sizes of fonts. The workarea will reflect your preferences no matter what machine on the network you happen to be using. You can even customize workarea window behavior, such as automatically saving the layout when closing the window.

If you want to manage access to some existing source files, you simply select the file icons and drop them on the DEC FUSE Code Manager tool icon. Code Manager creates a new library to contain and manage the source files by version and configuration. At present, CohesionWorX supports RCS (Revision Control System) and SCCS (Source Code Control System) style libraries. You can enter comments for each source file added to the new library. Code Manager then assigns initial version numbers to each file. You never have to remember (or waste time finding out) which is the latest revision: CohesionWorX remembers for you. You can display whole revision histories of files, with information including date and time, creator's name, comments, and status. You can also compare different versions of files.

You can edit source files with the FUSE Editor tool in a variety of intuitive ways: by running the Editor (double-clicking on its icon) and loading the file into the editing buffer, by dropping the file icon on the Editor icon, or by running the Editor from within another tool (e.g., the Code Manager tool). CohesionWorX also includes support for the widely used `gnu emacs` and `vi` editors.

If run from Code Manager or the library, the source file checks out of the library and loads into the Editor buffer. You can edit the file using multiple file buffers, search and replace, cut and paste, undo, and other standard editing functions. When you save the file, it checks back into the library with a new version number. You can also create new files with the Editor and even initiate compiles of source code.

Drag-and-Drop Compiler

By dropping the source file icon on the FUSE Builder tool icon, you can initiate a compile and build. CohesionWorX supports C, FORTRAN, Pascal, and (optionally) Ada and C++. Builder is a graphical front end to Unix `make` or `gnumake` utilities. You can use any of your existing make files with Builder or create new make files, using a graphical representation of the build to specify build dependencies.

After compiling, any syntax errors appear in a special transcript area of Builder. When you double-click on a syntax error, the Editor automatically loads the corresponding source file, opening it to the appropriate line of code. You can then edit and recompile. This is an example of the interoperability that simplifies and speeds up typical software development activities.

After a successful build, you can initiate the FUSE Debugger, a graphical front end for Unix system debug utilities (e.g., `dbx`, `xdb`, or `gdb`). You can set breakpoints within the source code of any component of the program, and you can set traces to track program execution. You can run the program from within Debugger, stop the program manually or with breakpoints, and then single-step through trouble areas. You can set up separate windows to monitor inputs and outputs. As with Builder, you can run the Editor from within Debugger, change source code, recompile, and continue debugging. This tight interoperation speeds and simplifies program debugging.

The FUSE Call Graph Browser tool

When a few engineers at Microsoft set out to write Windows NT™, they sat down with many cups of coffee, and computers built around the MIPS R4400™ RISC microprocessor.

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During the next few years, they worked long and hard, missing quite a few dinners with their families and untold televised sporting events.

Today, Windows NT makes it possible for companies to run their enterprise software on a whole new class of dependable, affordable machines. Like the NEC Express RISCserver™, direct descendant of the machines used to write NT itself. And it gives software developers, designers and engineers access to remarkable new tools like the NEC Image™ RISCstation™.

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A river of coffee. A raft

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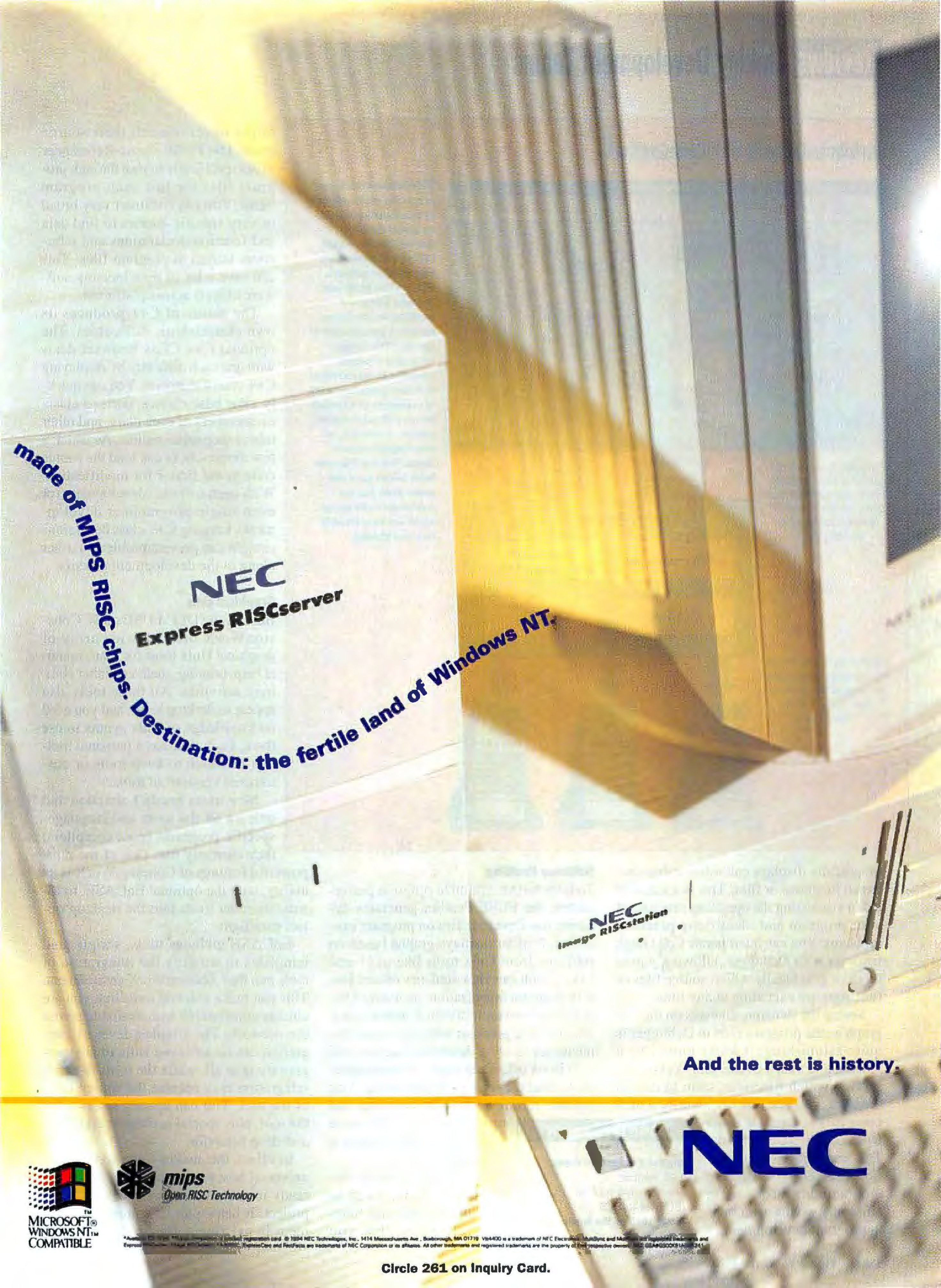
made of MIPS RISC chips. Destination: the fertile land of Windows NT.
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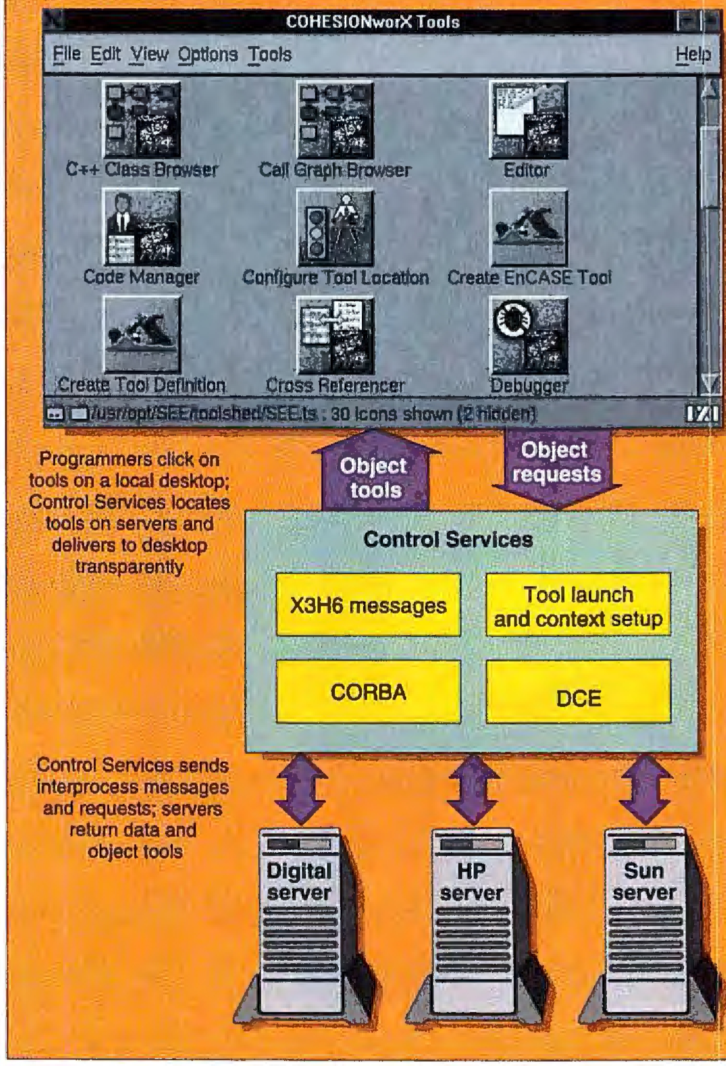
Distributed Objects with CohesionWorX



With CohesionWorX, you access the entire network by manipulating objects on a local desktop. Control Services—using DEC's CORBA-compliant ObjectBroker software, DCE, and the Multi-cast Message Server—identifies servers to run each tool, transparently to the user. This design strategy is especially attractive to organizations that have grafted a variety of computers to a network because of collaboration, merger, acquisition, or departmental consolidation. You don't have to leave behind tools and applications you are comfortable with and in which you have invested time and training.

graphically displays call relationships between functions or files. This is a valuable aid in visualizing the operating structure of your program and identifying potential problems. You can interoperate Call Graph Browser with Debugger, allowing you to monitor graphically which source files or functions are executing at any time.

Seeing the dynamic changes on the call graph as the program runs in Debugger is quite astonishing; it looks more like a video game than a CASE tool. Yet by observing which functions seem to run all the time, you can quickly identify which ones might benefit most from optimization efforts. This impressive interoperation can help you allocate programming efforts more efficiently, saving extra steps in program development.

About the Company

Digital Equipment Corp.
146 Main St.
Maynard, MA 01754
(800) 344-4825
Circle 1075 on the Inquiry Card.

Software Profiling

To help further optimize program performance, the FUSE Profiler generates dynamic run-time statistics on program execution. Profiler displays graphs based on statistics from Unix tools like `prof` and `pixie`. You can view statistics on any level of program organization, including files, functions—even individual instructions. This lets you pinpoint which program elements are slowing down the program and zero in on offending code. A few mouse-clicks load the source file for editing. You can then recompile the edited program and rerun Profiler, with some increase in performance expected.

Distributed software development projects can so camouflage data and function references that you might never unearth their source code. The FUSE Cross-Referencer exists specifically to root through program files for just such program items. You can construct very broad or very specific queries to find data and function declarations and references buried in program files. This can save a lot of time locating software objects across platforms.

The nature of C++ produces its own characteristic difficulties. The optional C++ Class Browser deals with one such difficulty by displaying C++ class hierarchies. You can quickly view base classes, derived classes, members of each class, and other inheritance relationships. As usual, a few mouse-clicks can load the source code in the Editor for modification. With team software development (or even single-programmer development), keeping C++ class definitions straight can prevent problems farther along in the development process.

Graphical Unix

Besides the DEC FUSE tools, CohesionWorX offers a wide array of graphical Unix tools for mail, manual help, printing, shell, and other common activities. All these tools also appear as desktop icons, and you need no knowledge of Unix syntax to use them. Each user has a personal toolbox in which to keep tools or customized versions of tools.

New users needn't abandon and unlearn all the tools and language-specific programs (e.g., compilers) they currently use. One of the most powerful features of CohesionWorX is its ability, with the optional EnCASE, to assimilate other tools into the desktop object paradigm.

EnCASE includes tools, scripts, and templates to simplify the integration of tools into the CohesionWorX environment. This can make existing tools that you are already comfortable with available across the network. The simplest level of integration can be achieved without any programming at all, while the most in-depth integration may require the source code of the tool. You can specify a server for the tool, plus special activation and drag-and-drop behavior.

In effect, this makes CohesionWorX a universal host to any third-party tools already in use on a software development project. It helps protect company investment in existing software development

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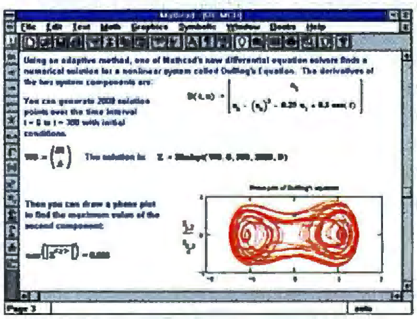

Mathcad PLUS 5.0's on-screen worksheet lets you easily combine equations, text and graphics.

Plus, like its Mathcad predecessors, it's as easy and intuitive as using a scratchpad. Simply enter equations in real math notation anywhere on Mathcad PLUS 5.0's on-screen worksheet. Add text and graphics. Change variables and instantly update your work. Mathcad PLUS 5.0 calculates answers quickly and accurately, then prints your results in impressive, presentation-quality documents.

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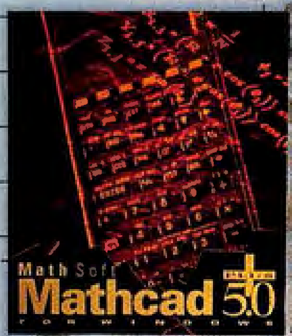

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An Emerging Standard

CohesionWorX supports standards, including operating-system and environment standards OSF (Open Software Foundation) Motif, Posix, X/Open, OSF DCE, and SPEC1170; ANSI X3H6 messaging specification; OMG (Object Management Group) CORBA messaging standard; and CDIF (Compound Document Interchange Format) and ECMA (European Computer Manufacturers Association) PCTE (Portable Common Tool Environment) standards. Government standards like MIL-STD-973 and DOD-STD-2167A are also supported.

An outgrowth of DEC's ASD/SEE (Aerospace-Defense/System Engineering Environment) work for the F-22 program, CohesionWorX provides an ideal environment for aerospace and defense-related software development and maintenance. DEC's future plans for CohesionWorX include support for other popular Unix and non-Unix platforms. Besides being a standalone software development solution, CohesionWorX also represents the foundation for DEC's CohesionWorX Team/SEE: a complete process management solution for managing the full lifestyle of medium- or large-scale software projects.

CohesionWorX is a heavyweight competitor of other Unix software development tools, such as HP's SoftBench and Sun Microsystems' SparcWorks. Its built-in support of heterogeneous networks is unique among comparable tools. Because of its consistent graphical interface, broad suite of included tools, ability to integrate third-party tools easily, and cross-platform power, CohesionWorX is a complete solution—and the emerging standard—in Unix software development. It's a solution you can stick with through every stage of software development. ■

Edmund X. DeJesus has a Ph.D. in physics and has been a professional programmer for over 15 years. He has worked for IBM and MIT Lincoln Laboratory and has taught at Boston University and Middle Tennessee State University. As a computer consultant, technical writer, and course developer in the Boston area, he has participated in early testing of DEC's CohesionWorX. You can reach him on the Internet at 70761,2303@compuserve.com or on BIX c/o "editors."

Power Workstation at a Pentium Price

HP's 712/60 uses innovative hardware packaging and the superscalar PA-7100LC CPU to achieve a low-cost, high-performance Unix workstation

BEN SMITH

On the outside, the Hewlett-Packard 9000 Series 700 Model 712/60 looks like one of HP's Apollo workstations. The $3995 price tag tells you it isn't. This shockingly low price is for a complete stand-alone system with a 15-inch 1024- by 768-pixel color display, built-in 8-bit graphics, 16 MB of RAM, and a 260-MB hard drive. The Model 712/60 sacrifices neither performance nor usability to achieve its low price; the key is packaging and HP's new PA-7100LC processor. The unit I tested sells for $7680 and came with 64 MB of RAM, a 20-inch color monitor, and a 260-MB hard drive.

My first impression of a Unix workstation's performance typically comes from the response of the user interface: How fast do applications launch and windows move? This subjective appraisal of workstation performance correlates well with my enjoyment of a system. Even on the 20-inch 1280- by 1024-pixel display that came with the reviewed unit, the Model 712/60's graphics system is remarkably fast. The system provides great graphics performance even with HP-VUE, HP's elegant yet resource-demanding Motif-based window and session manager.

The BYTE benchmarks proved that the Model 712/60's performance is good by more than just subjective measures, but the tests bring a few surprises as well (see the table "Performance Results"). The string sort is unexpectedly slow, probably due to the extra work required to manipulate data that is not aligned on even word boundaries.

Workstation Usability

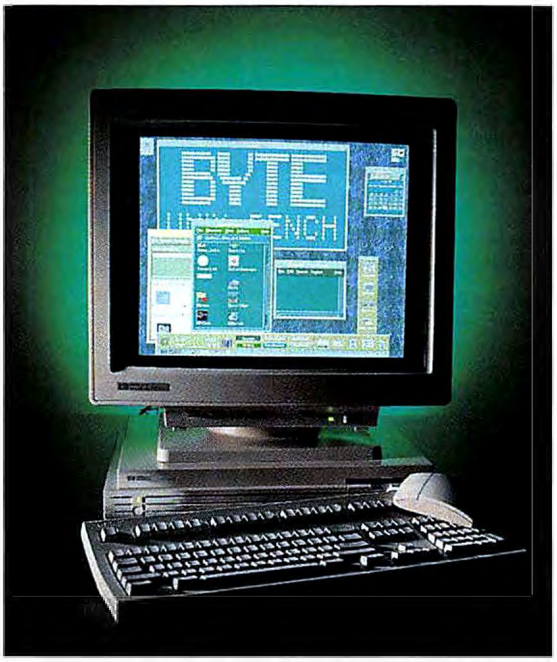
When so many new Unix workstations require a minimum of 32 MB of RAM and a 500-MB hard drive, it might seem unlikely that a system with only half that much memory and disk capacity would be useful, or even usable. However, HP has created a reduced version of its HP-UX operating system, called Desktop/UX, for its new entry systems. The 260-MB hard drive holds the entire operating system plus the required swap space and still has more than 100 MB left over for data and applications. Desktop/UX is still an XPG4 certified version of HP's most recent release of Unix, HP-UX 9.03.

What's missing? Desktop/UX includes a Posix C compiler, but not the ANSI compiler. It provides HP's on-line hypertext-based workstation documentation, but not the full Unix `man` pages or any text-processing utilities. Appropriately omitted are many system accounting, development, and management systems that are applicable only to servers.

Desktop/UX is all that most nontechnical workstation users require for applications like financial trading, customer service, and document management. Applications developers, image manipulators, engineers, and other more technical users will want more resources and the full-blown Runtime/UX. For these more demanding uses, the Model 712/60 can enclose as much as 128 MB of RAM and 1 GB of disk capacity. (Local external drives can take mass storage all the way up to 14 GB.)

HP-VUE has always been one of the more appealing and worthwhile window managers, and the new HP-VUE 3.0 design is even more attractive and intuitive. You can now drag any icon from the file manager to the background of any of the work spaces, and it will stick to that work area. Modifying HP-VUE's control bar (what HP calls the *front panel*) still requires that you edit a configuration file, but HP now documents the process clearly and completely in the help viewer.

Perhaps the most important improvement in usability for nontechnical workstation users concerns a small button on the front of the system—the power switch. When you push the switch in, the system boots; let it out with another push, and the system goes through an orderly shutdown. The Model 712/60 may not be the first system to have such a button, but the feature should be emulated on all low-end Unix systems.



Despite its simplicity and low cost, HP made the 712/60 easier to use for business users. The power button starts an orderly shutdown, for example. The user interface (VUE) control bar is intuitive and easy to configure.

Inside Look

If it wasn't for HP's reputation for building durable systems, I would have questioned what I found when I first opened up the 712/60 (see the photo on page 165). But a little thought and analysis overrode any doubt that this machine is robust.

My first reaction was that someone forgot to remove the packing material from the disk drives. The drives are mounted in plastic foam, and it first appears that only a single spring-metal clip holds them in place. In fact, the whole interlocking structure of the workstation's case keys them to stay snugly in position. Not only is this a no-tools maintenance design like those found in Silicon Graphics' workstations, it is also simple and inexpensive.

The next items to catch my attention were the power supply and fan, which are encased in plastic, not sheet metal. Because of the low power requirements of this PA-7100LC-based system (with a maximum power output of 70 W), the power supply can be small, and it therefore generates only a tiny amount of heat. The

PERFORMANCE RESULTS

BYTE's benchmarks are indexed. For the Unix benchmarks, a Sun SparcStation 1+ with 16 MB of RAM running SunSoft 4.3 = 1. For the BYTE portable benchmarks, the baseline system is a 66-MHz 486DX2 PC. The 712/60 does very well on the Unix benchmarks, but it doesn't show up well on the simple string-sort test in the portable benchmarks. This is probably due to the extra work required to manipulate data that is not aligned on even word boundaries.

TEST	INDEX
Unix benchmarks	
Arithmetic (type = double)	4.4
Dhrystone 2 without register variables	2.3
Execl throughput	4.3
File copy (30 seconds)	15.3
Pipe-based context switching	1.0
Shell scripts (eight concurrent)	3.2
Portable benchmarks	
Numeric sort	1.72
String sort	0.52
Bit map	2.33
Integer math	1.14
Floating-point emulation	3.59
Simple FPU	2.88
Transcendental FPU	3.66
Overall integer index	1.54
Overall FPU index	3.25

small fan is nearly inaudible.

What you might not notice right away is the diminutive CPU board. Clipped into place by spring plastic tabs extending up from the chassis base, the 11- by 5-inch motherboard appears less complex and sophisticated than most PC peripheral boards. But, as with many highly evolved designs, simplicity is the hallmark of quality and doesn't represent a lack of sophistication.

Nothing in this system is more sophisticated than its processor. HP's PA-7100LC is a low-power, low-cost RISC design with floating-point and integer processors integrated in the same chip. This 32-bit RISC processor has the clever ability to split 32-bit words into two 16-bit operations when appropriate. Since the PA-7100LC has two ALUs, partial word operations, such as in MPEG and JPEG compression and decompression, run nearly twice as fast as they do with processors that have a single ALU.

The Model 712/60 runs its PA-7100LC at 60 MHz and uses an external 64-KB direct-mapped cache for both instructions and data. The cache can communicate with the CPU at up to 400 MBps over the 64-bit-wide bus.

Color Recovery

Also clever is the way the 8-bit color graphics system handles 24-bit graphics. It uses hardware dithering that looks for all the world like true 24-bit color. HP calls it Color Recovery.

A special device driver (software) takes the 24-bit color data from the application program and encodes it in a special 8-bit format that a hardware decoder can use for its color calculations. Color-map corrections, edge detection, gamma correction, and precision floating-point operations are all carried out in the digital signal processor–like ASIC (application-specific IC) that HP designed for this purpose.

On close inspection, you can see that the 24-bit color emulation is more like antialiasing than the conventional ditty-dot dithering that you might find on an 8-bit-color Silicon Graphics workstation. Color Recovery doesn't work with just any application; low-level Xlib-based applications that require 24-bit color will have to be reworked. However, applications using most 3-D APIs need only be written to use a 24-bit true-color model. This implies that the Color Recovery process probably doesn't offer much for 24-bit 2-D applications, such as photo manipulation and video.

The array of connectors at the back of the Model 712/60 contains a full complement of external ports: parallel, asynchronous serial (a 16550A UART [universal asynchronous receiver/transmitter] capable of 460.8 Kbps), both twisted-pair and AUI (attachment unit interface) Ethernet connectors, and SCSI-2 (Alt-1 50-pin high density), as well as audio in and audio out. The keyboard and

About the Product

Hewlett-Packard 9000 Series 700 Model 712/60..........$7680
(as tested, with 64 MB of RAM, 20-inch color monitor, and 260-MB hard drive)

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CTX GREEN MONITOR FEATURE SUMMARY							
MODEL	6468GM	1451GM	1462GM	1562GM	1565GM	1765GM	1785GM
Size	14"	14"	14"	15"	15"	17"	17"
Dot Pitch (mm)	0.28	0.28	0.28	0.28	0.28	0.27	0.26
Hor. Freq. (KHz)	30-38	30-50	30-62	30-62	30-65	30-65	30-85
1600 x 1280 NI	—	—	—	—	—	—	Yes(60Hz)
1280 x 1024 NI	—	—	—	—	Yes(60Hz)	Yes(60Hz)	Yes(75Hz)
1024 x 768 NI	87Hz/I	60Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI
Mac Compatibility	—	—	Yes	Yes	Yes	Yes	Yes
Flat Square	—	—	—	Yes	Yes	Yes	Yes
Color Match	—	—	—	—	—	Yes	Yes
Digital Controls	—	—	—	—	Yes	Yes	Yes
MPR-II & ISO9241-3	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Power Savings	<30W	<30W	<30W	<30W	<5W	<5W	<5W

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*Based on official 1993 Monitrak U.S. monitor sales research.
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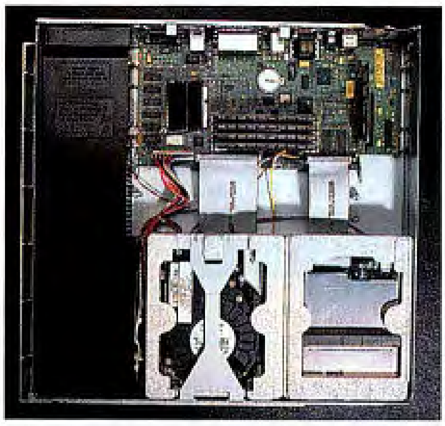

Using low-cost materials such as the foam sandwich disk mount, the Model 712/60 looks as though designed by a toy manufacturer. However, HP maintains its reputation for building durable equipment. This isn't cheap engineering; it's good engineering.

mouse ports are AT plug-compatible.

As options, you can add a second monitor, a second serial port, a second network interface, and a PC-compatible 3½-inch floppy drive. (SoftWindows and many Wabi-based applications are also available for further PC compatibility.) What you do not see in the Model 712/60 that you would find in HP's Model 715 workstation are EISA slots for upgrading. There is, however, plenty of space in the cabinet for a larger CPU board.

Not Just Another Workstation

You can purchase a Pentium-based PC for roughly the same price as this entry-level HP workstation. Open that PC, and you will find a large motherboard cluttered with cables and metal mounting brackets and bristling with peripheral cards. You can purchase a Unix license or install Linux (the freely available Unix clone) on your Pentium. However, you won't end up with half the quality and stability of the HP Model 712/60, with its mature and up-to-date version of Unix, its X Window System, and the HP-VUE user interface.

With an increasing number of corporate buyers now considering RISC-based workstations instead of Pentium systems, HP is offering a viable alternative. Using its powerful, low-cost PA-7100LC CPU, innovative package engineering, and intelligent usability features, HP has delivered an outstanding entrant to the low-end workstation market. ■

Ben Smith is a BYTE testing editor and is the author of Unix Step-by-Step *(Hayden Books, 1990). He can be contacted on the Internet at ben@bytepb.byte.com or on BIX as "bensmith."*

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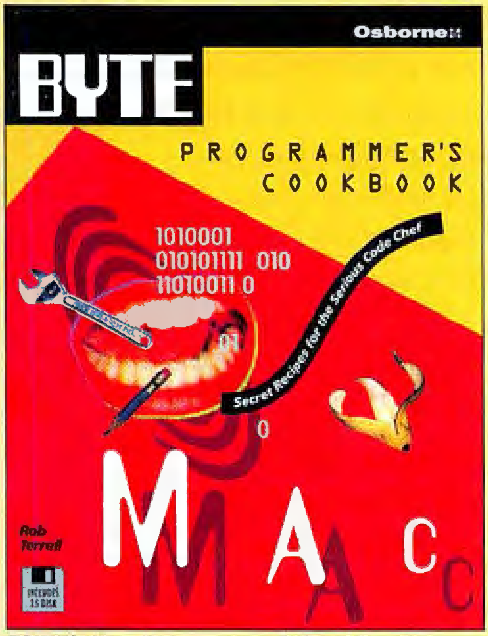

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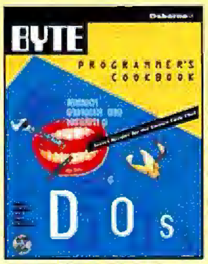

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26 MODEMS: FASTER THAN 14.4 KBPS

Is faster better even when standards are in flux? We stress-test 26 high-speed modems to identify the best for today's business applications

HELEN E. HOLZBAUR

The more characters per second your modem can transmit, the smaller your telephone bill will be. This month, we tested 26 modems that can shave communications costs by operating at speeds faster than the current CCITT V.32bis standard of 14.4 Kbps.

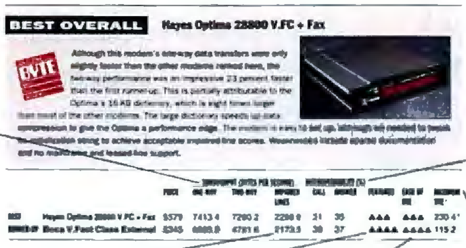
Fourteen of the modems anticipate the V.34 standard for 28.8-Kbps communication. The formal standard is expected to be announced around the time this issue reaches you. (For convenience, this report refers to the 28.8-Kbps modems as V.34, even though the standard isn't finalized and they cannot be considered "official" V.34 products.) The remaining 12 modems employ 19.2-Kbps communication, known as V.32terbo, which is a de facto high-speed communications standard that has been promoted by AT&T as an upgrade to V.32bis.

Why should you consider nonstandard modems? These high-speed modems excel when you can match like products at both ends of your communications link. When connected in this way, modem interoperability is not an issue, so the higher speeds of either 19.2 or 28.8 Kbps translate directly into cost savings.

What's more, in both modem classes, many vendors promise free or inexpensive upgrades to the new standard when it's officially announced (see the "Roll Call" on page 178). Falling prices are an added incentive for buying a high-speed modem. In our last Lab Report on modems ("V.32 or Better: 69 Modems," July 1993

How to use this guide

For both V.34 and V.32terbo modems, we have selected the best overall (which considers both data and fax performance), the best low-cost model, and the best modem for data-only applications.



Measured in bytes per second. Higher numbers indicate faster performance.

The percentage of modems the test modem successfully communicated with at speeds faster than 14.4 Kbps.

Measured in bytes per second. This is the average throughput over six simulated telephone lines with varying degrees of impairments.

A rating based on the completeness of each modem's set of features.

A rating of how easy the modem is to install and operate.

The DTE (data terminal equipment) rate is the maximum speed at which the modem can receive data.

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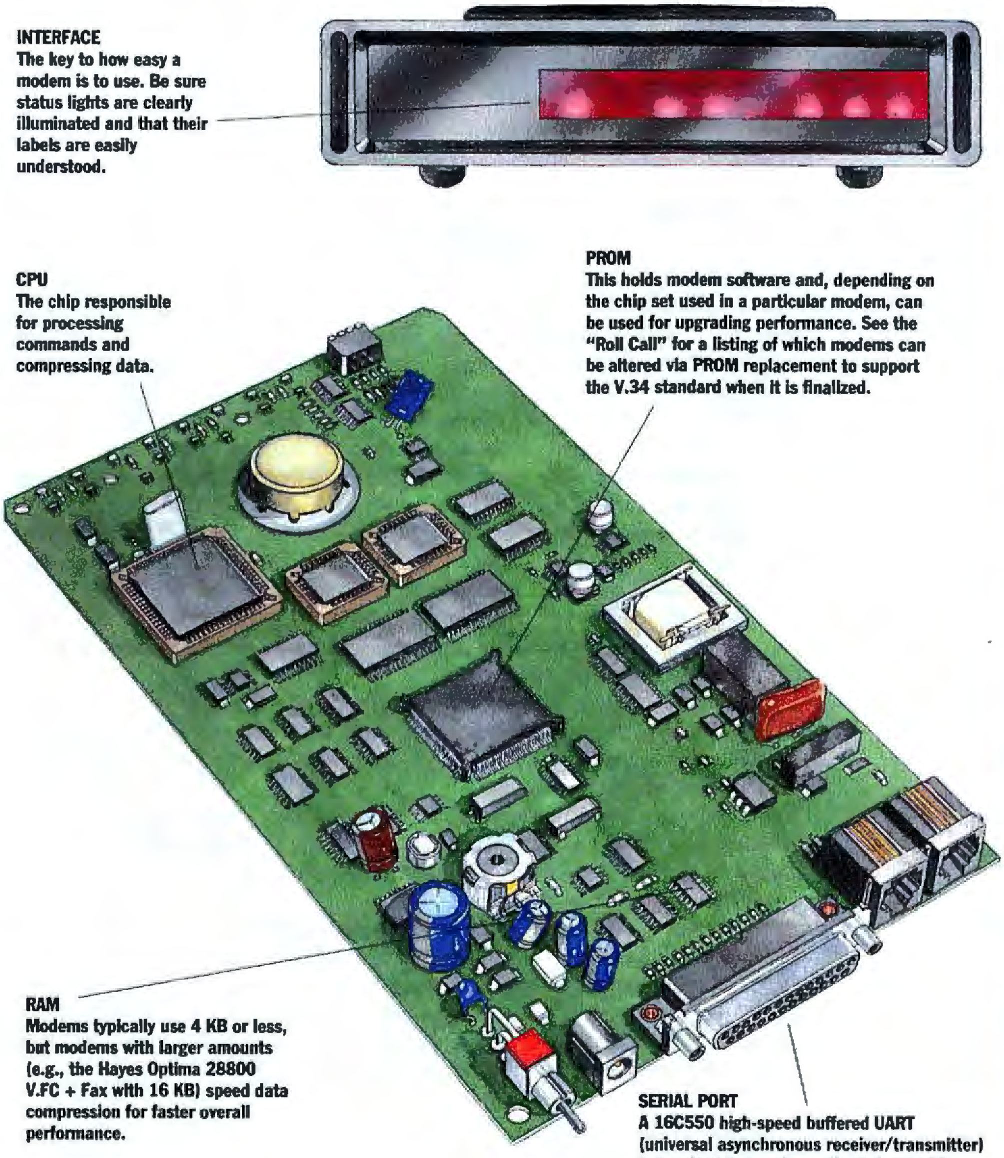
Modems, Inside and Out



INTERFACE
The key to how easy a modem is to use. Be sure status lights are clearly illuminated and that their labels are easily understood.

CPU
The chip responsible for processing commands and compressing data.

PROM
This holds modem software and, depending on the chip set used in a particular modem, can be used for upgrading performance. See the "Roll Call" for a listing of which modems can be altered via PROM replacement to support the V.34 standard when it is finalized.

RAM
Modems typically use 4 KB or less, but modems with larger amounts (e.g., the Hayes Optima 28800 V.FC + Fax with 16 KB) speed data compression for faster overall performance.

SERIAL PORT
A 16C550 high-speed buffered UART (universal asynchronous receiver/transmitter) is required for maximum throughput with V.34 modems. Some, including Boca's V.Fast Class External Bocamodem, come bundled with a 16C550 serial card.

JULY 1994 BYTE BEST HIGH-SPEED MODEMS

BEST

V.34

Hayes Optima 28800 V.FC + Fax

This 28.8-Kbps modem was the fastest one we tested for both one- and two-way data transfers. It offers a large (16 KB) dictionary, the largest we saw, to boost data-compression speed. The modem also comes with an accelerator card to enable your computer to send data to the modem at a maximum of 230.4 Kbps. The modem is easy to set up, and the clearly marked status lights on its front panel show the status of data receiving and transmitting operations.

PAGE 170

V.32TERBO

Zypcom Z32t-SX

Giving the top speed performance among the 19.2-Kbps modems, the Zypcom Z32t-SX posted one- and two-way speeds that were virtually indistinguishable. Its ability to handle our collection of impaired lines put it at the top in these rankings as well. The modem supports spoofing and leased lines, which makes it a good choice for some mainframe environments. The status lights and reset switch are cleverly located on the side of the modem, so you don't have to reach into a handful of cables to reset the modem.

PAGE 175

BYTE), the average price for a 14.4-Kbps modem was $532. The V.32terbo average in this report is $452. An even bigger difference can be seen on the high end. Last year, 28.8-Kbps modems averaged $955; this year, you can buy one for an average of $580.

If you need to communicate with customers or electronic services that use 9600-bps or 14.4-Kbps modems, all the modems that we tested in this report are designed to drop back to the slower speeds. Also, all but four modems in our sample offer 9600-bps or 14.4-Kbps fax capability. To help decide whether you should choose a V.34 or V.32terbo modem, look at the text box "V.34 Versus V.32terbo" on page 170.

To judge the best modems in each class, we measured their performance when sending files in one direction over a "normal" telephone line, as well as their ability to simultaneously transmit and receive over the same line. We also measured throughput over six different types of unstable lines (e.g., those that use satellite links) to see which modems could operate at high speeds in harsh, real-world conditions.

The ability to connect with other modems and fax machines rounded out our performance testing. Overall, each modem withstood about 10 hours of testing.

THE BEST

V.34 MODEMS

If you use long-distance telephone lines to set up network bridges, remotely control PCs, or access leased lines, you should consider one of these 28.8-Kbps modems. Under the best conditions, when communications links are unimpaired and when modems on both ends of the line can talk to each other at 28.8 Kbps, this setup translates directly into lower telephone charges.

However, until V.34 is formalized and widely implemented, there is no guarantee that two of today's V.34 modems will be able to communicate at their highest speed. In fact, our interoperability tests show that V.34 modems sometimes have to drop all the way to V.32bis rates of 14.4 Kbps—half their maximum speed—to communicate with V.34 modems from other vendors using a different chip set.

For example, the V.34 modems that used the Rockwell chip set were able to communicate with each other at 28.8-Kbps rates. However, when we connected them with V.34 modems that used an alternative chip set, such as Racal Datacom's or Motorola's modems, communication dropped to 14.4 Kbps. The same was typically true when we connected V.34 modems with V.32terbo models. The ZyXel U-1496E Plus, which uses a proprietary protocol for 19.2 Kbps, achieved that speed only when connected to another ZyXel modem; otherwise, it communicated at 14.4 Kbps.

While the majority of the slower V.32terbo modems negotiated the impaired lines without much difficulty, the V.34 group was a different story. Only one V.34 modem (Boca's V.Fast Class External Bocamodem) completed all six lines without a problem. Of the 11 remaining V.34 desktop modems, six needed revisions to their firmware, and five needed special commands (most of which were undocumented) added to the setup string. (Vendors promised that any firmware or setup-string changes made available to us for testing would be offered to the general public via a BBS.)

Based partly on its impaired-line performance, the Bocamodem ranked high in the Best Overall evaluations. In terms of speed, this modem can't compare with the first-place Hayes Optima, but the Bocamodem supports a wide variety of protocols, offers both Class 1 and Class 2 fax, has a five-year warranty, and sells for a relatively low price of $345.

The Zoom ZVFX28.8 is the lowest-priced ($299) V.34 modem we ranked. It had trouble with the long local loops as well as with the satellite lines. Our calls to the manufacturer led to new EPROMs, but the satellite lines still proved to be

V.34 VERSUS V.32TERBO

While standards continue to be worked out for high-speed modems, their potential benefits are clear. Faster transmission times mean direct cost savings if you regularly transmit data via modems. What payback can you expect from high-speed modems? One way to gauge this is to compare sample costs when sending a large file at the speed of the fastest V.34 and V.32terbo modems we tested. A 1-MB file sent from New York to San Francisco at 7400 bytes per second (the tested speed of the Hayes Optima V.34 modem) takes approximately 2 minutes, 25 seconds. At a telephone rate of $1 a minute, the transmission costs $2.25. The same call at 4600 bytes per second (achieved by Zypcom's Z32t-SX V.32terbo modem) would cost $3.60.

Does this mean you should automatically choose the faster technology? In a year, the answer to this may be an unequivocal "yes," but until the V.34 standard is formalized, you should make your modem choice cautiously.

V.32terbo represents a relatively simple change to the V.32bis (14.4 Kbps) standard, and, as such, V.32terbo may best be viewed as an enhancement to V.32bis rather than as a competitor to V.34.

V.34 is a more radical change than V.32terbo, and it attempts to push modem speeds to their practical limits on voice-band lines. Besides speed, V.34 is innovative in its ability to "probe the channel," or select the best techniques for optimum performance along the telephone line.

In our throughput tests over clean and impaired lines, we saw more consistent performance from the V.32terbo modems. By contrast, the V.34 modems we tested seemed a bit "green." They often required firmware updates or undocumented escape-code patches to coax them through our tests.

Many companies selling V.34 modems claim upgradability to the formal standard. This could range from a minor firmware code revision to a major board replacement.

Once V.34 is adopted, V.32terbo may survive by occupying a price point below the 28.8-Kbps products. Until then, V.34 may be the best choice for applications where you control both sides of the connection. When you control only one side, your best bets are probably a V.32terbo modem or a tried-and-true V.32bis modem.

CLASS	DCE RATE	AVERAGE PRICE	THROUGHPUT [1] (BYTES PER SECOND)	TRANSMISSION COSTS [2]
V.34	28.8 Kbps	$580	7413.4	$2.25
Comments: *Fast, but firmware remains "green." Standard promises innovations beyond raw speed. Ease for upgrading to formal V.34 standard is a question mark.*				
V.32terbo	19.2 Kbps	$452	4618.1	$3.60
Comments: *Slower, but more reliable in current incarnation, thanks to protocol existing for almost two years. Firmware is established, and test sample showed few bugs.*				

[1] Based on fastest modems in our performance tests.
[2] Based on 1-MB file with phone rates at $1 per minute.

troublesome. When we manually dropped the modem's speed to 19.2 Kbps, as recommended in the manual, the modem was able to complete the tests.

The Hayes Optima and Bocamodem are noteworthy because they ship with their own serial cards. The Boca card contains a 16550 UART (universal asynchronous receiver/transmitter), which is necessary if your system has an older UART, such as the 8250 or 16450. The benefit of the 16550 is in caching: The chip can hold up to eight characters during processing. The Hayes card, on the other hand, is an accelerator that boosts the DTE (data terminal equipment) rate of the modem to 230.4 Kbps.

The Supra FAXmodem 288 had the cleanest, easiest-to-read documentation of these modems. Commands were easy to find, and the manual included an index, a table of contents, and clear setup instructions.

The General Datacomm Desk Top V.F 28.8 is geared for network switching environments. It has a built-in serial interface that provides for DTE communication at speeds above the PC limit of 115.2 Kbps. The drawback to designs like this is a reliance on protocols that allow highest-speed communication only with like modems.

To be considered for Best Overall, a 28.8-Kbps modem had to offer data and fax communications. We considered all the products in this group and priced under $400 in our Low Cost category. Our Data Only category considered all 12 V.34 desktop modems.

KEY

Ease of Use:

Poor ▲ Fair ▲▲

Good ▲▲▲ Excellent ▲▲▲▲

BYTE BEST V.34

Need the highest speed?

BEST OVERALL Hayes Optima 28800 V.FC + Fax

Although this modem's one-way data transfers were only slightly faster than the other modems ranked here, the two-way performance was an impressive 23 percent faster than the first runner-up. This is partially attributable to the Optima's 16-KB dictionary, which is eight times larger than most of the other modems. The large dictionary speeds up data compression to give the Optima a performance edge. The modem is easy to set up, although we needed to tweak its initialization string to achieve acceptable impaired-line scores. Weaknesses include sparse documentation and no mainframe and leased-line support.

			THROUGHPUT (BYTES PER SECOND)			INTEROPERABILITY (%)				
		PRICE	ONE-WAY	TWO-WAY	IMPAIRED LINES	CALL	ANSWER	FEATURES	EASE OF USE	MAXIMUM DTE[1]
BEST	Hayes Optima 28800 V.FC + Fax	$579	7413.4	7260.2	2298.0	31	35	▲▲▲	▲▲▲	230.4[2]
RUNNER-UP	Boca V.Fast Class External	$345	6865.9	4781.6	2173.5	38	37	▲▲▲▲	▲▲▲▲	115.2
RUNNER-UP	Microcom DeskPorte Fast	$499	6868.1	5411.4	2215.9	38	38	▲▲▲	▲▲▲	115.2
RUNNER-UP	Zoom ZVFX28.8	$299	6881.4	5855.1	2176.9	35	27	▲▲▲	▲▲▲	115.2
RUNNER-UP	Supra FAXmodem 288	$399	6790.7	4227.3	1352.0	35	31	▲▲▲	▲▲▲▲	115.2
RUNNER-UP	Practical Peripherals PC288LCD V.FC	$429	6825.4	5331.0	1440.6	38	38	▲▲▲	▲▲▲	115.2

Looking for a high-speed bargain?

LOW COST Boca V.Fast Class External Bocamodem

This $345 modem transmitted our compressed file unidirectionally over a normal line at a rate of almost 6900 bytes per second. Although slower than the Hayes Optima, this speed is still faster than the fastest V.32terbo for about $60 less. It was also the simplest of the V.34 modems we tested because it required no setup-string tweaking or firmware updates. The Zoom ZVFX28.8, while faster, ranks second due to troubles during our impaired-line testing.

			THROUGHPUT (BYTES PER SECOND)			INTEROPERABILITY (%)				
		PRICE	ONE-WAY	TWO-WAY	IMPAIRED LINES	CALL	ANSWER	FEATURES	EASE OF USE	MAXIMUM DTE[1]
BEST	Boca V.Fast Class External	$345	6865.9	4781.6	2173.5	38	37	▲▲▲▲	▲▲▲	115.2
RUNNER-UP	Zoom ZVFX28.8	$299	6881.4	5855.1	2176.9	35	27	▲▲▲	▲▲▲	115.2
RUNNER-UP	Supra FAXmodem 288	$399	6790.7	4227.3	1352.0	35	31	▲▲▲	▲▲▲▲	115.2
RUNNER-UP	Cambridge DataSystem VFCXE2814	$299	6025.9	5634.2	842.0	38	31	▲▲▲▲	▲▲▲	115.2
RUNNER-UP	GVC FM1441288V	$379	6707.5	6694.8	1687.9	27	38	▲▲▲	▲▲▲	115.2

If only data is required...

DATA ONLY Hayes Optima 28800 V.FC + Fax

No surprises here. Even when excluding its fax capabilities, the Optima's speed and ease of use make it the top choice for data-only applications. Note: The General Datacomm's poor interoperability for faster-than-14.4-Kbps communications was also apparent in other modems using proprietary chip sets. Its performance was average for V.32bis and slower communications.

			THROUGHPUT (BYTES PER SECOND)			INTEROPERABILITY (%)				
		PRICE	ONE-WAY	TWO-WAY	IMPAIRED LINES	CALL	ANSWER	FEATURES	EASE OF USE	MAXIMUM DTE[1]
BEST	Hayes Optima 28800 V.FC + Fax	$579	7413.4	7260.2	2298.0	31	35	▲▲▲▲	▲▲▲	115.2[2]
RUNNER-UP	Microcom DeskPorte Fast	$499	6868.1	5411.4	2215.9	38	38	▲▲▲	▲▲▲	115.2
RUNNER-UP	Boca V.Fast Class External	$345	6865.9	4781.6	2173.5	38	37	▲▲▲▲	▲▲▲	115.2
RUNNER-UP	Zoom ZVFX28.8	$299	6881.4	5855.1	2176.9	35	27	▲▲▲	▲▲▲	115.2
RUNNER-UP	General Datacomm Desk Top V.F 28.8	$1095	6084.8	6000.7	2104.7	0	0	▲▲	▲▲▲▲	128.0

[1] Kbps. [2] When used with Hayes accelerator card.

How We Tested

Our performance tests subjected the modems to eight kinds of data transfer tasks and seven telephone-line conditions. We used DOS and Windows platforms to drive data through the modems.

THROUGHPUT TESTS

Our throughput tests measure each modem's speed when transmitting data in one direction and when simultaneously transmitting and receiving files. We used four different files: compressed, graphics, text, and database. These files have potential V.42bis compression ratios of 1 to 1, 2 to 1, 3 to 1, and 4 to 1, respectively. Test files ranged in size from 131 to 333 KB.

In this roundup, we report data-throughput (as well as impaired-line performance) tests in bytes per second, versus the bits-per-second ratings that are used to distinguish classes of modems (e.g., V.32terbo's 19.2 Kbps). We believe bytes per second is a clearer unit of measure because in real-world use, modems transfer files, either compressed or not, that conventionally are measured in bytes.

We connected like pairs of modems to a TAS Series II modem tester, which can re-create almost any line condition that you may encounter throughout the world. For throughput testing, the TAS system simulated the central-office impairment conditions (i.e., line 17c 1 1). We ran the throughput tests over a telephone line with minimal impairments to represent the majority of calls made in the U.S.

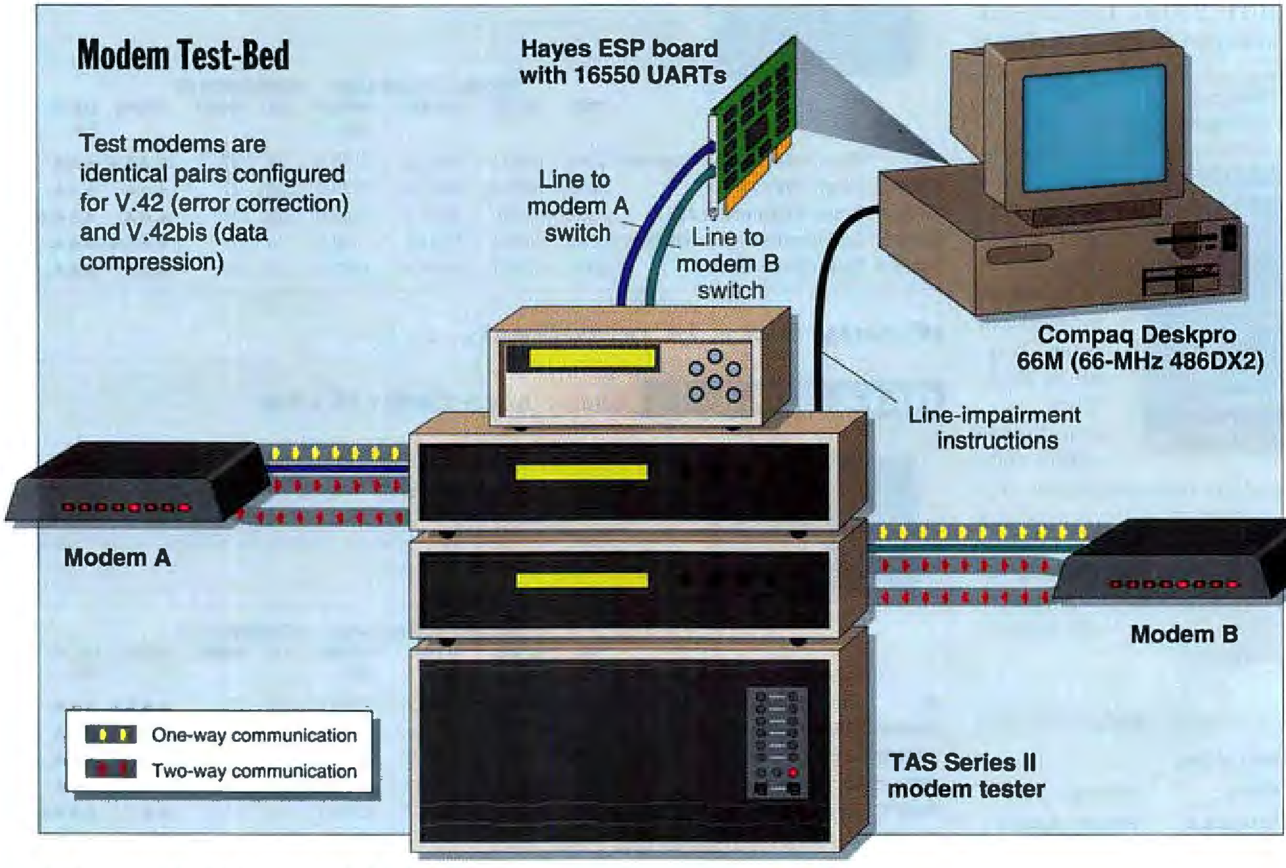
We connected the modems via the TAS system to a Compaq Deskpro 66M equipped with a Hayes ESP board to ensure that communication between the TAS system and the modems utilized 16550 UARTs. We configured the modems to receive data from the computer at the fastest rate they supported (up to 115.2 Kbps).

We initialized the error-correction and data-compression engines on all the modems because the throughput tests measure the performance of these two features. Each tested modem supported V.42 error correction and V.42bis data compression. We enabled V.42bis data compression and V.42 error correction, even if the modem's default settings specified other protocols. We also configured all the modems to use hardware (RTS/CTS) flow control. For data-compression and error-correction parameters, we used the default window and dictionary sizes.

To measure one-way transmission, modem A calls modem B, sends a file, and hangs up. Modem A repeats the process three more times. During a one-way transmission, modem B only receives data; it does not send anything back to modem A. In our two-way tests, modem A still makes four calls to modem B, but when modem B answers, both modems simultaneously send files to each other.

IMPAIRED LINE

The impairment combinations we used are based on the working papers of the



EIA/TIA's (Electronic Industries Association/Telecommunications Industry Association) TR-30.3 committee. Our test conditions are a subset of the lines discussed in that committee's PM-3064 draft recommendation for network simulation for modem testing. We chose the subset to represent three broad types of lines under two different local-loop conditions. These lines introduced a variety of impairments, including long satellite delays, phase roll, and noise. (See the text box at the right for details about individual lines.)

The TAS system simulated the trunk line and local loops at both ends of the connection. Long local loops (the connection between your telephone and the telephone company's switch) do exist in the U.S. (Our long local loop simulated a telephone connection about 30,000 feet from the switch, with four loading coils.) Few of the modems had difficulty with the long local loop in itself; problems were more likely to appear when the long local loop was combined with satellite delays or noise impairments.

The satellite-delay line was quite difficult for many of the modems, but it's a condition you are not likely to encounter in the U.S. We included it because you may see a delay of that magnitude if you have worldwide business dealings.

Each pair of modems performed a one-way transfer of a 131-KB compressed file over the given simulated line at least 10 times. We recorded the times and took an average. If a modem could not complete the test over a given line, and the vendor was not able to solve the problem, we assigned a zero value.

The modems make the connection at the highest speed possible. But they do not necessarily maintain that speed. We configured them to "fall back" to a slower speed when they encountered an impairment on the line that could challenge data integrity. When the impairment disappeared, the modems could "fall forward" to the higher speed. We found that V.34 modems often fall back below the V.34 standard to 14.4 Kbps to maintain a connection and fall forward to 28.8 Kbps when the line improves.

To determine our overall performance scores when ranking modems, we weighed results of the one-way data throughput tests (60 percent), the two-way tests (20 percent), and the impaired-line scores (20 percent).

IMPAIRED LINES: CRASH TESTS FOR MODEMS

The three lines introduced different impairment conditions.

The easiest line, 17d, is quite similar to the throughput line. There is mild white noise (22.0 decibels below 1 milliwatt), second-order nonlinear distortion (40.0 dB compressed), third-order nonlinear distortion (41.0 dB), near echo (40.0 dB), far echo (12.0 dB) ,and a short satellite delay (27.1 milliseconds).

Line 19 introduces a long satellite delay, which is more commonly found outside the U.S. Its parameters include mild white noise (22.0 dBm), second-order nonlinear distortion (43.0 dB compressed), third-order nonlinear distortion (44.0 dB), near echo (40.0 dB), far echo (16.0 dB), and a long satellite delay (337.1 ms).

The last line, 25, removes the satellite delay and introduces phase jitter and frequency shift. Phase jitter occurs when the phase of one part of the frequency tone is shifted relative to an earlier part of the tone; a frequency shift means that the tone that is received is different from the tone that is sent. The conditions for line 25 include mild white noise (22.0 dBm), second-order nonlinear distortion (51.0 dB compressed), third-order nonlinear distortion (53.0 dB), near echo (40.0 dB), far echo (16.0 dB), phase jitter (3.0 degrees, 60.0 Hz, sine wave form), and frequency shift (0.20 Hz).

Two different combinations of loop conditions were used to test modems under the three impaired lines. A "2 2" means that the modem on each end of the line was subject to EIA2 conditions. EIA2 simulates a 4000-foot connection linked to a 3000-foot connection, for a total of 7000 feet. This situation is typical of a telephone connection that is within 7000 feet, or about a mile and a half, of the telephone central office.

A "7 7" is an EIA7 condition on both ends of the connection. This is a much more difficult line for most modems to handle, because it simulates a telephone connection that is approximately 30,000 feet (or over 5 miles) from the telephone office: a 3000-foot connection to a bridged tap to a 6000-foot run with a bridged tap to another 6000-foot link to a bridged tap connected to a third 6000-foot link to a tap, completed by a 9000-foot run.

FAX TESTS

Transmission time is not really an issue for fax modems, because most of the fax machines receive data at only 9600 bps and must compress according to the CCITT standard. So, unless you know you are sending data from fax modem to fax modem, you cannot expect to see 14.4- or 19.2-Kbps performance (and if that is the case, you would see better results transmitting the file as data, rather than sending a fax).

Each modem that had fax capability was set up to send a fax to five different fax machines. We used Microsoft Windows for Workgroups to send a single-page fax to a Brother Intellifax AX-600, a Canon Faxphone 40, a Panasonic KX-F150, a Panasonic Panafax PX150, and a Sharp FO-510, which represent a real-world mix of vendors and old and new generations of fax machines. The modems were scored on the percentage of faxes they successfully sent.

INTEROPERABILITY

We set up each modem to call and answer all the other modems in the test sample. The numbers we report are the percentage of modems the test modem connected with at either 28.8 or 19.2 Kbps (i.e., the highest speed of the slowest modem). In all cases, test modems successfully connected with others in the sample. Consequently, a score of "0" is indicative only of faster-than-14.4-Kbps performance. Each of the four modems that received this score used proprietary chip sets; the overall interconnectivity of each of these modems was at least 65 percent.

FEATURES AND EASE OF USE

The features we valued most in our scoring included the protocols supported, the warranty, the number of interface indicators, the ability to spoof (i.e., emulate other handshaking protocols), support for leased lines, and auto-baud support. For fax modems, we also looked for the number of protocols and the speeds that were supported.

Contributors

Helen E. Holzbaur, *Project Manager/NSTL, was a network manager and systems administrator at Temple University for 10 years before joining NSTL.*

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FAX-MODEM COMMUNICATIONS

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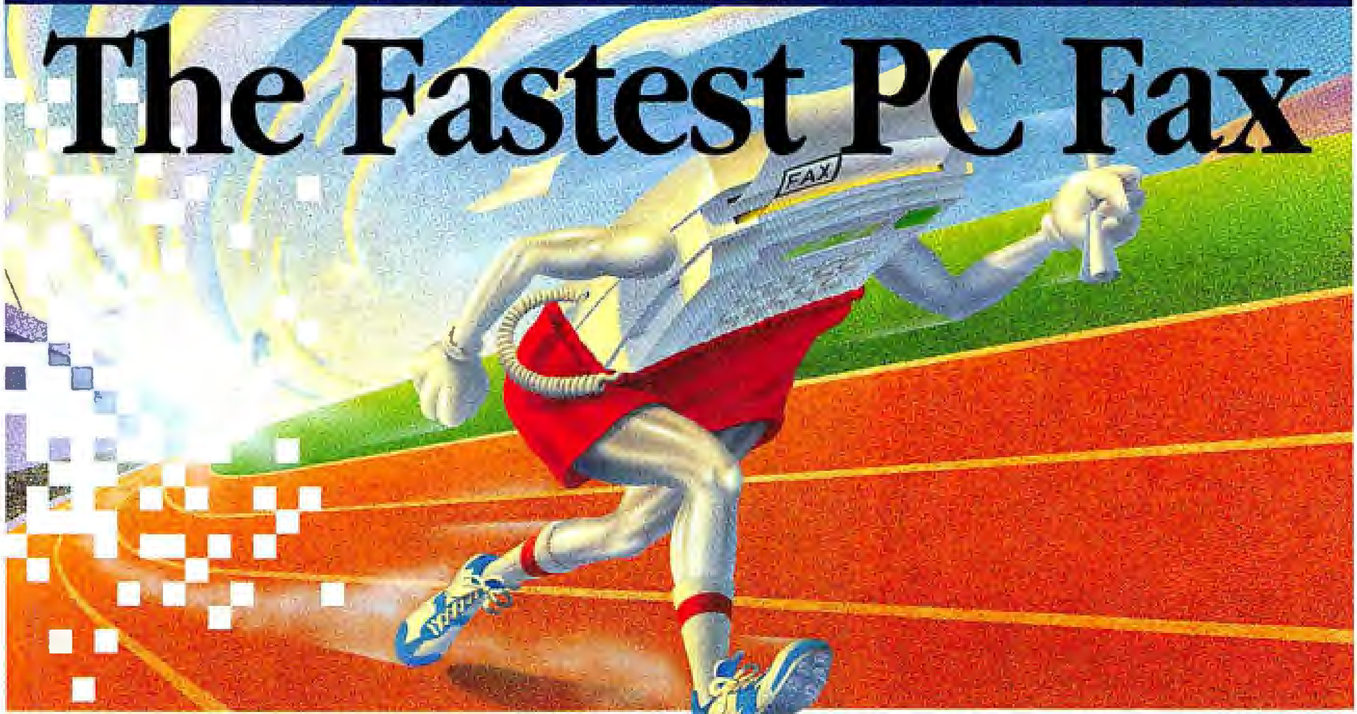

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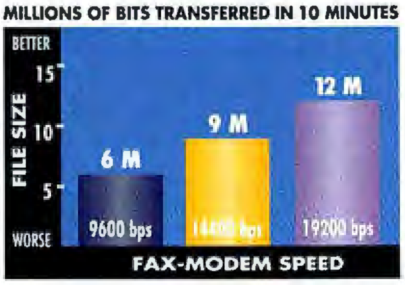

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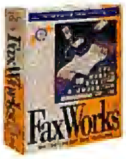

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V.32TERBO

If you need high-speed data communications but are wary about committing to V.34, V.32terbo's 19.2-Kbps performance may be your best choice. This AT&T-championed specification (it's not a standard formally adopted by any standards body) has been supported by a number of modem vendors over the last 18 months. V.32terbo modems are not only less expensive than their V.34 counterparts, the lowest-priced models cost as little as $30 more than 14.4-Kbps modems.

The throughput results for this group varied widely. The fastest one- and two-way speeds among the V.32terbo modems (Zypcom's Z32t-SX at 4618.1 and 4619.8 bytes per second, respectively) were more than twice as fast as the slowest in the throughput score (Archtek America's Smartlink 1914AT/BAT, at 2259.1 and 2229.5 bytes per second, respectively).The Zypcom modem's impressive speed even outperformed three V.34 modems in the two-way tests and six of the V.34 modems in the impaired-line scoring.

All the runners-up in the Best Overall category transmitted data one-way at a speed that was greater than 4300 bytes per second, about half the rate of the V.34 modems. Over the impaired lines, the modems were still able to maintain about one-third that rate.

KEY

Ease of Use:

Poor ▲ Fair ▲▲
Good ▲▲▲ Excellent ▲▲▲▲

For the best balance of speed and reliability . . .

BEST OVERALL Zypcom Z32t-SX

This modem's one- and two-way performance speeds are virtually indistinguishable. It also handles the impaired lines at almost 2000 bytes per second, a much smaller decrease than we measured in competing products. The modem supports Hewlett-Packard spoofing on leased lines, which makes it easy to use in a mainframe environment. The Z32t-SX offers clear status lights and an on/off switch that's on the side (rather than the rear), so you don't have to reach into a handful of cables to reset the modem. The major disappointment is its documentation: There is no index or glossary, and the vendor does not supply a quick reference card. Although it is in the same speed class as the V.32terbo modems, the second-place ZyXel modem uses a proprietary protocol to achieve its quick transmission rates. Its interoperability score for faster-than-14.4-Kbps communications is indicative of modems using proprietary chip sets. Although its features and documentation are merely average (it doesn't support spoofing or leased lines), its throughput scores were a mere 3 percent slower than the leader's. Its impaired-line performance was just about equal.

			THROUGHPUT (BYTES PER SECOND)			INTEROPERABILITY (%)				
		PRICE	ONE-WAY	TWO-WAY	IMPAIRED LINES	CALL	ANSWER	FEATURES	EASE OF USE	MAXIMUM DTE[1]
BEST	Zypcom Z32t-SX	$419	4618.1	4619.8	1970.5	31	27	▲▲▲▲	▲▲▲	115.2
RUNNER-UP	ZyXel U-1496E Plus	$499	4467.3	4466.9	1965.7	0	0	▲▲▲	▲▲▲	57.6
RUNNER-UP	Penril DX V.32terbo	$895	4303.2	3870.1	1859.0	35	31	▲▲▲	▲▲▲	57.6
RUNNER-UP	Multi-Tech MT1932ZDX	$299	4316.0	2990.8	1504.2	38	31	▲▲▲	▲▲▲▲	115.2

Want 19.2 Kbps at V.32bis prices?

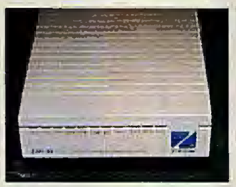
LOW COST Multi-Tech MT1932ZDX

Multi-Tech improved more than just the modem's performance when it upgraded its V.32bis model to V.32terbo. This model posted the fastest one-way transmission speed for the under-$300 group. A new manual is more complete than the one that comes with the V.32bis product.

			THROUGHPUT (BYTES PER SECOND)			INTEROPERABILITY (%)				
		PRICE	ONE-WAY	TWO-WAY	IMPAIRED LINES	CALL	ANSWER	FEATURES	EASE OF USE	MAXIMUM DTE[1]
BEST	Multi-Tech MT1932ZDX	$299	4316.0	2990.8	1504.2	38	31	▲▲▲	▲▲▲▲	115.2
RUNNER-UP	Cardinal MVP192E	$229	4078.1	2715.1	1635.3	38	35	▲▲▲	▲▲	57.6
RUNNER-UP	ATI 19200 ETC-E	$199	3811.4	2385.6	1165.9	19	23	▲▲▲	▲▲▲▲	57.6
RUNNER-UP	Archtek Smartlink 1914AT/BAT	$219	2259.1	2229.5	1617.3	35	27	▲▲▲	▲▲	57.6

Need the fastest "terbo" for moving data?

DATA ONLY Zypcom Z32t-SX



The Z32t-SX can send and receive data faster than any modem in its class over a normal telephone connection, and as fast as any 19.2-Kbps modem over impaired lines. Using its proprietary protocol, the AT&T Comsphere can achieve data transfer rates of 4400 bytes per second. The Comsphere is also the only modem in this class with an LCD and menu setup. These menus make it easy to change defaults and are particularly useful for vertical applications (e.g., kiosks and automatic teller machines) or mainframe applications where a PC is not readily available.

			THROUGHPUT (BYTES PER SECOND)			INTEROPERABILITY (%)				
		PRICE	ONE-WAY	TWO-WAY	IMPAIRED LINES	CALL	ANSWER	FEATURES	EASE OF USE	MAXIMUM DTE[1]
BEST	Zypcom Z32t-SX	$419	4618.1	4619.8	1970.5	31	27	▲▲▲▲	▲▲▲	115.2
RUNNER-UP	AT&T Comsphere 3800	$795	4448.4	4260.6	1960.2	27	35	▲▲▲▲	▲▲▲▲	115.2
RUNNER-UP	ZyXel U-1496E Plus	$499	4467.3	4466.9	1965.7	0	0	▲▲▲	▲▲▲	57.6
RUNNER-UP	Penril DX V.32terbo	$895	4303.2	3870.1	1859.0	35	31	▲▲▲	▲▲▲	57.6

[1] Kbps.

Portable Modems

Good things sometimes do come in small packages. We tested three fax modems that have broken the 14.4-Kbps barrier. These high-speed modems (two supported V.34, one supported V.32terbo) were dependable except when negotiating the noisiest telephone lines.

The Microcom TravelPorte Fast was the fastest pocket modem that we tested. Although it initially experienced some trouble on the impaired lines, changes to its setup string enabled the tests to complete. At the time of testing, Practical Peripherals was unable to resolve its impaired-line problems. This modem just didn't like long local loops or very noisy conditions; and it managed connections less than 50 percent of the time on all but the easiest of the impaired lines.

Three faster-than-V.32bis travel modems (from left): Microcom's 28.8-Kbps TravelPorte Fast, E-Tech's 19.2-Kbps P192MX, and the 28.8-Kbps PM288PKT V.FC from Practical Peripherals.

If you need portability and high-speed communications, you won't have to sacrifice performance. For example, both the Microcom and Practical Peripherals portable modems scored as well or better in our unimpaired throughput tests compared to their full-size counterparts (see page 171).

On the V.32terbo side, there is only one in our sample, the E-Tech P192MX. It had some trouble with satellite lines, so if you are an international traveler, you may want to give this some consideration.

The impaired lines that caused the most trouble with the portable modems are rare in the U.S. If you travel overseas, you may wish to consider the impaired score more heavily.

HIGH SPEED FOR THE ROAD

			THROUGHPUT (BYTES PER SECOND)			INTEROPERABILITY (%)				
VENDOR	MODEL	PRICE	ONE-WAY	TWO-WAY	IMPAIRED LINES	CALL	ANSWER	FEATURES	EASE OF USE	MAXIMUM DTE [1]
Microcom, Inc.	TravelPorte Fast (V.34)	$499	6879.9	5038.8	2111.5	27	31	▲▲▲	▲▲▲▲	115.2
Practical Peripherals, Inc.	PM288PKT V.FC (V.34)	$499	6827.5	5368.3	765.8	27	38	▲▲▲	▲▲▲	115.2
E-Tech Research	P192MX (V.32terbo)	$299	4456.6	3804.4	1154.7	31	31	▲▲▲▲	▲▲	115.2

[1] Kbps. Excellent ▲▲▲▲ Good ▲▲▲ Fair ▲▲ Poor ▲

HONORABLE MENTIONS

Over the speed bumps: Two modem vendors have taken different routes to break through the 38.4-Kbps Windows transmission barrier.

The Hayes Optima 28800 V.FC + Fax comes with an accelerator card that boosts the DTE from 115.2 to 230.4 Kbps through the serial port.

The Microcom DeskPorte Fast and Travel-Porte Fast come with a parallel-port alternative: Using the Microcom drivers, which redirect the data flow, the parallel-port interface provides for data transfer rates of close to 115.2 Kbps.

Tired of cryptic LED labels that refer to obscure functions like HS, DCD, OH, SD, and RD? The Global Village TelePort/Mercury uses graphical symbols that indicate speed, carrier, hook status, send, and receive. This easily understandable front panel is a pleasure for experienced communicators and won't intimidate data-communications novices.

ROLL CALL OF MODEMS TESTED

VENDOR	MODEL	PRICE	THROUGHPUT (BYTES PER SECOND) 1-WAY	2-WAY	IMPAIRED LINES (BYTES PER SECOND)	FAX CONNECTIVITY SCORE (PERCENT)	INTEROPERABILITY [4] SCORE (PERCENT) CALL	ANSWER	EASE OF USE SCORE	FEATURES SCORE
V.34										
Boca Research, Inc.	V.Fast Class External Bocamodem	$345	6865.9	4781.6	2173.5	100	38	27	▲▲▲	▲▲▲▲
Cambridge Telecom, Inc.	DataSystem VFCXE2814	$299	6025.9	5634.2	842	100	38	31	▲▲▲	▲▲▲▲
Cambridge Telecom, Inc.	Discovery 2814CX	$349	6113.9	4892.5	816.2	0	35	35	▲▲▲	▲▲▲▲
General Datacomm Industries, Inc.	Desk Top V.F 28.8	$1095	6084.8	6000.7	2104.7	N/A	0	0	▲▲▲▲	▲▲
GVC Technologies, Inc.	FM144/288V	$339	6479.3	6577.8	482.7	100	27	38	▲▲▲	▲▲▲
Hayes Microcomputer Products, Inc.	Optima 28800 V.FC + Fax	$579	7413.4	7260.2	2298.0	100	31	35	▲▲▲	▲▲▲
Microcom, Inc.	DeskPorte Fast	$499	6868.1	5411.4	2215.9	100	38	38	▲▲▲	▲▲▲
Motorola Codex	3260 Fast	$995	5670.9	3796.2	2333.3	N/A	0	0	▲▲▲▲	▲▲
Practical Peripherals, Inc.	PC288LCD V.FC	$429	6825.4	5331.0	1440.6	100	27	38	▲▲▲	▲▲▲
Racal Datacom, Inc.	ALM3239SD	$1195	4936.4	4195.7	2086.7	N/A	0	0	▲▲▲	▲
Supra Corp.	Supra FAXmodem 288	$399	6790.7	4227.3	1352.0	100	35	31	▲▲▲▲	▲▲▲
Zoom Telephonics, Inc.	ZVFX28.8	$299	6881.4	5855.1	2176.9	100	35	27	▲▲▲	▲▲▲
V.32TERBO										
Anderson Jacobson (CXR)	1945-FXD	$695	3861.1	2734.1	1595.4	100	35	31	▲▲	▲▲
Archtek America Corp.	Smartlink 1914AT/BAT	$219	2259.1	2229.5	1617.3	100	35	27	▲▲▲	▲▲▲
AT&T Paradyne	Comsphere 3800	$795	4448.4	4260.6	1960.2	N/A	27	35	▲▲▲▲	▲▲▲▲
ATI Technologies, Inc.	19200 ETC-E	$199	3811.4	2385.6	1165.9	80	19	23	▲▲▲▲	▲▲▲
Cardinal Technologies, Inc.	MVP192E	$229	4078.1	2715.1	1635.3	100	38	35	▲▲	▲▲▲
Digicom Systems, Inc.	ScoutPlus Terbo	$329	3173.4	3496.4	1172.3	100	8	31	▲▲▲▲	▲▲▲
Global Village Communications	TelePort/Mercury	$399	4077.8	2700.9	1586.8	100	38	35	▲▲▲	▲▲▲
Multi-Tech Systems, Inc.	MT1932ZDX	$299	4316.0	2990.8	1504.2	100	38	31	▲▲▲▲	▲▲▲
Penril Datability Networks	DX V.32terbo	$895	4303.2	3870.1	1859.0	100	35	31	▲▲▲	▲▲▲
Zypcom, Inc.	Z32t-SX	$479	4618.1	4619.8	1970.5	100	31	27	▲▲▲	▲▲▲▲
ZyXel	U-1496E Plus [2]	$499	4467.3	4466.9	1965.7	100	0	0	▲▲▲	▲▲▲
PORTABLE										
Microcom, Inc.	TravelPorte Fast (V.34)	$499	6879.9	5038.8	2111.5	100	27	31	▲▲▲▲	▲▲▲
Practical Peripherals, Inc.	PM288PKT V.FC (V.34)	$499	6827.5	5368.3	765.8	100	27	38	▲▲▲	▲▲▲
E-Tech Research	P192MX (V.32terbo)	$329	4456.6	3804.4	1154.7	100	31	31	▲▲	▲▲▲▲

= BYTE Best.

[1] Kbps. [2] Supports 19.2 DCE with proprietary protocol. [3] Requires Hayes accelerator
[4] Faster-than-14.4-Kbps performance; see "How We Tested."

Excellent ▲▲▲▲ Good ▲▲▲ Fair ▲▲ Poor ▲

FEATURES CONTINUE ON NEXT PAGE

CHIP SET VENDOR	UPGRADABLE TO V.34?	MAXIMUM DATA SPEED [1] DCE	DTE	MAXIMUM FAX SPEED [1]	FLASH EPROM	COMMAND SET HAYES ESCAPE	TIES ESCAPE	BREAK ESCAPE	PROPRIETARY
Rockwell	$95; hardware replacement	28.8	115.2	14.4		✔			
Rockwell	Not available	28.8	115.2	14.4		✔		✔	
Rockwell	Not available	28.8	115.2	14.4		✔		✔	
Proprietary	Free; downloadable software	28.8	128	N/A	✔	✔	✔		
Rockwell	$79; hardware replacement	28.8	115.2	14.4		✔			
Rockwell	**Replacement method to be determined**	**28.8**	**230.4 [3]**	**14.4**		✔	✔	✔	
Rockwell	$39; hardware replacement	28.8	115.2 [3]	14.4	✔	✔		✔	
Proprietary	Free; hardware replacement	28.8	115.2	N/A		✔	✔		✔
Rockwell	$89; hardware replacement	28.8	115.2	14.4		✔		✔	
Motorola/TI (DSP)	Downloadable software; price to be determined	28.8	115.2	N/A	✔	✔			
Rockwell	$64–$79; hardware replacement	28.8	115.2	14.4	✔	✔			
Rockwell	Hardware replacement; price to be determined	28.8	115.2	14.4			✔		
AT&T	Hardware replacement; price to be determined	19.2	115.2	9.6		✔		✔	
AT&T	Not available	19.2	57.6	14.4		✔		✔	✔
AT&T	$350; hardware replacement	19.2	115.2	N/A	✔	✔		✔	
AT&T	Not available	19.2	57.6	19.2			✔		
AT&T	Not available	19.2	57.6	14.4		✔			
Proprietary	Not available	19.2	115.2	14.4			✔		
AT&T	Not available	19.2	57.6	14.4		✔		✔	
AT&T	Not available	19.2	115.2	14.4			✔	✔	
Proprietary	Not available	19.2	57.6	14.4		✔			
AT&T	**$199; hardware replacement**	**19.2**	**115.2**	**14.4**		✔	✔		
Proprietary	$249; hardware replacement	19.2	57.6	14.4					✔
Rockwell	$39; hardware replacement	28.8	115.2 [3]	14.4	✔	✔		✔	
Rockwell	$89; hardware replacement	28.8	115.2	14.4		✔		✔	
AT&T	Not available	19.2	115.2	14.4			✔		

N/A = not applicable. ✔ = yes.

ROLL CALL OF MODEMS TESTED

		FAX SUPPORT		ERROR CONTROL/COMPRESSION							REMOTE
VENDOR	MODEL	CLASS 1	CLASS 2	V.17	V.29	MNP 5	MNP 10	LAPB	LAPM	V.42BIS	CONFIGURATION
V.34											
Boca Research, Inc.	V.Fast Class External Bocamodem	✔	✔	✔	✔	✔			✔	✔	
Cambridge Telecom, Inc.	DataSystem VFCXE2814		✔	✔	✔	✔			✔	✔	
Cambridge Telecom, Inc.	Discovery 2814CX		✔	✔	✔	✔			✔	✔	
General Datacomm Industries, Inc.	Desk Top V.F 28.8					✔			✔	✔	✔
GVC Technologies, Inc.	FM144/288V	✔	✔	✔	✔	✔				✔	
BYTE Best: Hayes Microcomputer Products, Inc.	Optima 28800 V.FC + Fax	✔		✔	✔	✔			✔	✔	
Microcom, Inc.	DeskPorte Fast	✔		✔	✔	✔	✔		✔	✔	✔
Motorola Codex	3260 Fast					✔			✔	✔	✔
Practical Peripherals, Inc.	PC288LCD V.FC	✔	✔	✔	✔	✔			✔	✔	
Racal Datacom, Inc.	ALM3239SD					✔			✔	✔	✔
Supra Corp.	Supra FAXmodem 288	✔	✔	✔	✔	✔	✔		✔	✔	✔
Zoom Telephonics, Inc.	ZVFX28.8	✔	✔	✔		✔	✔		✔	✔	
V.32TERBO											
Anderson Jacobson (CXR)	1945-FXD	✔	✔		✔	✔	✔		✔	✔	✔
Archtek America Corp.	Smartlink 1914AT/BAT	✔	✔	✔	✔	✔			✔	✔	
AT&T Paradyne	Comsphere 3800			✔	✔	✔			✔	✔	✔
ATI Technologies, Inc.	19200 ETC-E	✔		✔	✔	✔			✔	✔	
Cardinal Technologies, Inc.	MVP192E	✔	✔	✔	✔	✔			✔	✔	
Digicom Systems, Inc.	ScoutPlus Terbo	✔		✔	✔	✔			✔	✔	
Global Village Communications	TelePort/Mercury	✔		✔	✔	✔			✔	✔	
Multi-Tech Systems, Inc.	MT1932ZDX		✔	✔	✔	✔			✔	✔	✔
Penril Datability Networks	DX V.32terbo	✔	✔	✔		✔			✔	✔	✔
BYTE Best: Zypcom, Inc.	Z32t-SX	✔	✔	✔	✔	✔	✔		✔	✔	✔
ZyXel	U-1496E Plus [2]		✔	✔		✔			✔	✔	✔
PORTABLE											
Microcom, Inc.	TravelPorte Fast	✔		✔	✔	✔	✔		✔	✔	✔
Practical Peripherals, Inc.	PM288PKT V.FC	✔	✔	✔	✔	✔			✔	✔	
E-Tech Research	P192MX		✔	✔	✔	✔			✔	✔	

BYTE Best logo = BYTE Best. [2] Supports 19.2 DCE with proprietary protocol. N/A = not applicable. ✔ = yes.

REMOTE PASSWORD	SYNCHRONOUS COMMUNICATION	BUNDLED SOFTWARE	CALLER ID	RING DIFFERENTIATION	WARRANTY (YEARS)	PHONE	TOLL-FREE PHONE	INQUIRY NO.
		Faxworks for DOS and Windows			5	(407) 997-6227	None	1105
	✔	Bit/Com for DOS, Windows, Mac		✔	5	(408) 747-1894	None	1106
	✔	Bit/Com for DOS, Windows, Mac	✔	✔	5	(408) 747-1894	None	1107
✔	✔	None			2	(203) 574-1118	None	1108
N/A	✔	WinFax 4-IN-1, Comit DOS Lite; WinFax Lite; MicroPhone 1 STF			5	(201) 579-3630	(800) 289-4821	1109
N/A	✔	Smartcom Exec Lite; SmartcomLE & Fax			2	(404) 441-1617	None	1110
✔	✔	FaxWorks for Windows			5	(617) 551-1955	(800) 822-8224	1111
✔	✔	None			2	(508) 261-4000	None	1112
	✔	QuickLink 2 for Windows and DOS; MacCom Center Data/Fax	✔	✔	Lifetime	(805) 497-4774	(800) 442-4774	1113
✔	✔	None			2	(305) 846-1601	(800) 333-4143	1114
✔	✔	Comit for DOS and Windows; FaxTalk for WIN; FAXcilitate, MicroPhoneLT for Mac.	✔		5	(503) 967-2400	(800) 727-8772	1115
N/A		Comit Data/DOSFax Pro; Comit for Win/WinFax Lite; MicroPhone LT, STF FF Fax			7	(617) 423-1072	(800) 631-3116	1116
✔	✔	None			3	(408) 435-8520	(800) 537-5762	1117
	✔	FaxLite, Comit for DOS and Windows; FaxLite for Macintosh			2	(818) 912-9800	(800) 368-5465	1118
✔	✔	None			2	(813) 530-2000	(800) 482-3333	1119
	✔	FaxWorks and Comit for Windows			5	(905) 882-2600	None	1120
	✔	FaxWorks and Comit for Windows			Lifetime	(717) 293-3000	None	1121
		QModem, Fax Lite for DOS; WinFax Lite			5	(408) 262-1277	(800) 833-8900	1122
N/A	✔	Global Fax, Global Fax OCR, ZTerm for Mac			5	(415) 390-8200	(800) 736-4821	1123
✔		Multi-Express for Windows			10	(612) 785-3500	(800) 328-9717	1124
	✔	None			2	(301) 921-8600	(800) 473-6745	1125
✔	✔	DOSFax Lite/Comit; WinFax Lite/Comit; ProFax Lite	✔	✔	2	(510) 783-2501	None	1126
✔	✔	ZFax	✔	✔	5	(714) 693-0808	(800) 255-4101	1127
✔		FaxWorks for Windows			5	(617) 551-1955	(800) 822-8224	1128
		QuickLink 2 for Windows and DOS		✔	Lifetime	(805) 497-4774	(800) 442-4774	1129
		QuickLink 2 for DOS, Windows, and Mac	✔	✔	2	(408) 730-1388	(800) 328-5538	1130

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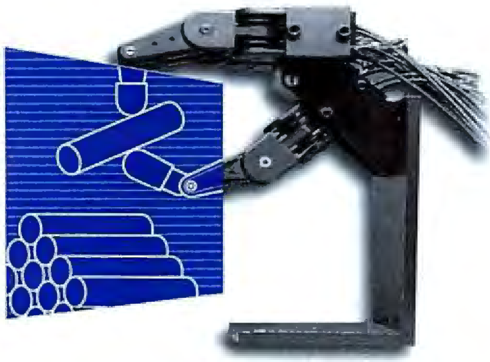

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A Taligent Update

Will systemwide object frameworks reinvent programming?

JON UDELL

Taligent's long-awaited object technology, which began incubating at Apple six years ago, debuts this summer when a developer release of the TAE (Taligent Application Environment)—a collection of densely interconnected C++ frameworks—ships to 100 ISVs (independent software vendors) and corporate developers. TAE, like OpenStep, requires a host operating system. It was originally hosted on Opus, Apple's never-released 680x0-based microkernel. Then, in November 1993, Taligent rehosted TAE on AIX and standardized 300 developers on IBM PowerPC model 250 workstations—the same platform that early developers will use. When TAE ships next year, it will be hosted on the Unix systems that Taligent investors prefer—IBM's AIX, Apple's PowerOpen, and Hewlett-Packard's HP/UX—and on OS/2. By the end of 1995, TAE should also be up and running on Taligent's own microkernel-based TOS (Taligent Object Services). TOS is built on the same Mach 3.0-derived IBM microkernel that IBM's forthcoming Workplace OS uses. The two systems are evolving in parallel, and IBM and Taligent are trading technologies back and forth along the way.

TAE's 100 frameworks, comprising over 2000 C++ classes and over 30,000 member functions, represent arguably the richest and most complete object system yet offered to software developers.

Why hosted versions of TAE? There's no shortage of operating systems, and they're all converging on the same threaded, microkernel-based architecture that TOS and Workplace OS share. Taligent's investors and potential customers aren't clamoring for yet another operating system, they're asking for versions of TAE that work with the operating systems—and coexist with the applications—they've already deployed. TAE's 100 frameworks, comprising over 2000 C++ classes and over 30,000 member functions, represent arguably the richest and most complete object system yet offered to software developers. "Most systems expose a surface area," says Mike Potel, Taligent's vice president for technology development. "We expose a volume." The company says that TAE's ability to speed development of applications and enable new modes of collaborative work won't diminish when it rides on top of Unix, OS/2, or other potential hosts (e.g., a future Mac OS or Windows NT).

"We map bottom to bottom—the lowest parts of our system to the lowest parts of the host," says Potel. On OS/2, for example, TAE's 2-D/3-D graphics framework bypasses the services of Microsoft's Presentation Manager and talks directly to the display drivers. TAE also uses the host's disk and network drivers, as well as its memory manager and file systems.

Why TOS? While much of the value of Taligent's object technology can be delivered at the application level, the company also sees an opportunity for object-driven innovation at the operating-system level. Decoupled, TAE and TOS can mature independently. Although the synaptic web that binds Taligent frameworks together is densely woven, few frameworks make direct operating-system calls. As a result, the transition from Opus to AIX was seamless for most Taligent engineers, says chief technologist Mark Vickers. Meanwhile, the TOS team is recreating the operating-system services not contained in the microkernel—file systems, I/O, device-driver support, and networking—as a set of foundation frameworks. These are, in IBM's parlance, *personality neutral services* that run in their own out-of-kernel address spaces. If analysis shows that context switching and message passing among these processes significantly degrades system performance, some of these address spaces can be coalesced.

To enable out-of-kernel device drivers to run efficiently, TOS will borrow a technique from Workplace OS—injecting interrupt handlers into the kernel. Taligent will give its TOS device-driver frameworks to IBM for use by Workplace OS driver writers, hoping to reap a harvest of portable drivers for TOS. Like the NT driver model, Taligent's model abstracts generic devices (e.g., SCSI) to simplify the creation of specific drivers (e.g., Ultrastor 24F). However, where NT drivers must simulate inheritance of generic-device behavior by procedural means, Taligent drivers really do inherit from generic devices. In addition to adopting Taligent's driver model, IBM has optimized the microkernel so that it can efficiently handle the dozens of address spaces and hundreds of threads active in a Taligent system.

The TOS team is re-creating the operating-system services not contained in the microkernel—file systems, I/O, device-driver support, and networking—as a set of foundation frameworks.

C++ is the language of choice, but only after Taligent jacks up the C++ run-time system and overhauls it. The refurbished system, like Smalltalk, NextStep, and SOM, can dynamically load classes at run time. While Taligent is building an incremental C++ compiler for multiple targets, the fruits of that labor aren't expected for some time. Meanwhile, both the implementors and the users of TAE will use standard C++ tools.

Frameworks for Innovation

A TAE framework exports two different kinds of APIs: the client and the framework. The client API offers conventional entry points that applications and other frameworks call. The framework API enables subclassing of frameworks. One major use of framework APIs will be to connect TAE to the outside world—to map the data-access framework, for example, onto ODBC (Open Database Connectivity), or the messaging framework onto standards such as X.400, MAPI, and VIM, or the document framework onto OLE and OpenDoc, or the file-system framework onto FAT, HPFS, HFS, and ISO 9660. Taligent plans to write some of these adapters but will rely on its investors and on third parties for many others. This strategy could be risky. If TAE doesn't arrive in command of a wealth of legacy services, developers will be hard-pressed to justify using it, no matter how elegant its internal architecture might be.

Clients of TAE's document, user interface, graphics, international text, data access, and other frameworks will find them to be richly functional. Objects that use the document framework, for example, can embed multiple live objects within themselves and can themselves embed within other objects. Documents can also be shared across a network according to several protocols. In one mode of sharing, independent copies of a document pass changes back and forth. In another, replicants synchronize on a canonical copy. Because documents also inherit from command objects, they're inherently scriptable and can undo and redo changes. There's no official scripting language yet, however. Taligent, a member of CIL (Component Integration Laboratories), hopes that OpenDoc's open-scripting architecture will supply the hooks for IBM's Rexx, Apple's AppleScript, and others.

Because the objects that appear in applications derive from system frameworks, systemwide tools can operate on them. The Taligent system might promote the Microsoft Word toolbar, for example, to a global tool palette that could apply emphasis and font changes to any text-framework-derived object. That's fine for Notepad-like documents built using the system text framework, but what about Quark-like documents that supply their own formats, justification, and kerning? "Even if Quark overrode 90 percent of our text framework," says Taligent's Potel, "it could retain the 10 percent that knows how to wire into the system."

Taligent isn't trying to build a distributed-file system or a global directory. Its strategy relies on objects that unify various flavors of these services and virtual places that structure our use of those objects.

C++ frameworks to date, such as TCL, MFC, and OWL, operate on a per-application basis. TAE's systemwide frameworks can afford profoundly greater leverage. The first beneficiary is Taligent. The version of TOS+TAE shown to BYTE during a recent visit ran on a Mac Quadra 800 but used no Mac software—not even the ROMs. It represented about three-quarters of a million lines of code. In contrast, NT represents 4 million lines, and that doesn't include MFC (Microsoft Foundation Classes). Taligent cites the compactness of its system as proof of the high level of reuse that TAE developers can expect.

Mac or Windows programmers today have to write a lot of code to customize system components such as windows and scroll bars. Worse, two implementations of a window with a left-justified title or a unidirectional scroll bar might look the same but won't share common code. "When you see two things that look similar in our system," says Vickers, "you can be virtually certain that they share common DNA."

User-written frameworks are the technical equals of Taligent-supplied frameworks. In conventional systems, applications that must extend the system software typically do so privately, for their own benefit. Taligent expects that TAE's radically open architecture will encourage ISVs to supply such extensions as public frameworks—which can themselves become products.

People, Places, and Things

TAE's frameworks for collaboration move beyond the container documents of OLE and OpenDoc toward a truly task-oriented virtual world reminiscent in some ways of General Magic's MagicCap. Instead of walking down the hall to a meeting room for a conference, for example, you click on an icon that leads to a virtual meeting room, after packing your virtual briefcase with the documents and software tools you'll need for the meeting. There, you meet with others—who might physically be next door or in another hemisphere—to exchange business cards, discuss and annotate documents, and conclude deals.

The business cards you collect during the meeting are tokens of great value in the Taligent system and have several uses. You can drag a business card to a phone to call someone or into an E-mail header to address a note or onto a query form to activate a lookup. The telephony, E-mail, and database applications all expect to be passed the same kind of object; each extracts a different piece of information from it. Documents, similarly, surface not merely as containers of stuff, but as another important kind of object currency circulating through the system. Taligent's human-interface designers want applications, and even documents, made subordinate to work flow. They believe, I think rightly, that you have to make computer tasks correspond much more closely to real tasks. First-generation GUIs sometimes had the right ideas (e.g., the Mac's Trashcan) but couldn't make them pervasive.

How does Taligent's TAE compare to Microsoft's Cairo? "It wants to solve the needle-in-a-haystack problem," says Vickers, referring to the way in which Cairo's distributed, object-oriented file system will collect vast quantities of data and automatically index it for rapid retrieval. While that's an important problem to solve, he allows, "why build a haystack out of all your company's hard disks?" Taligent isn't trying to build a distributed-file system or a global directory. Its strategy relies on objects that unify various flavors of these services and virtual places that structure our use of those objects.

Will the strategy work? To date, there is little hard evidence one way or the other. Taligent showed BYTE multiple active embeddings, one kind of document collaboration, and several intriguing things that business-card objects can do. But the most compelling demonstration, the one that spells out the "people, places, and things" vision, remains speculative—as of now, it's still just a Macromind Director animation. I don't think even Taligent knows for sure whether, or how effectively, the TAE frameworks can make these kinds of ideas real. That's what the first 100 ISVs and corporate developers (and BYTE) will try to figure out. ■

Jon Udell is a BYTE senior technical editor at large. You can reach him on the Internet or BIX at judell@bix.com.

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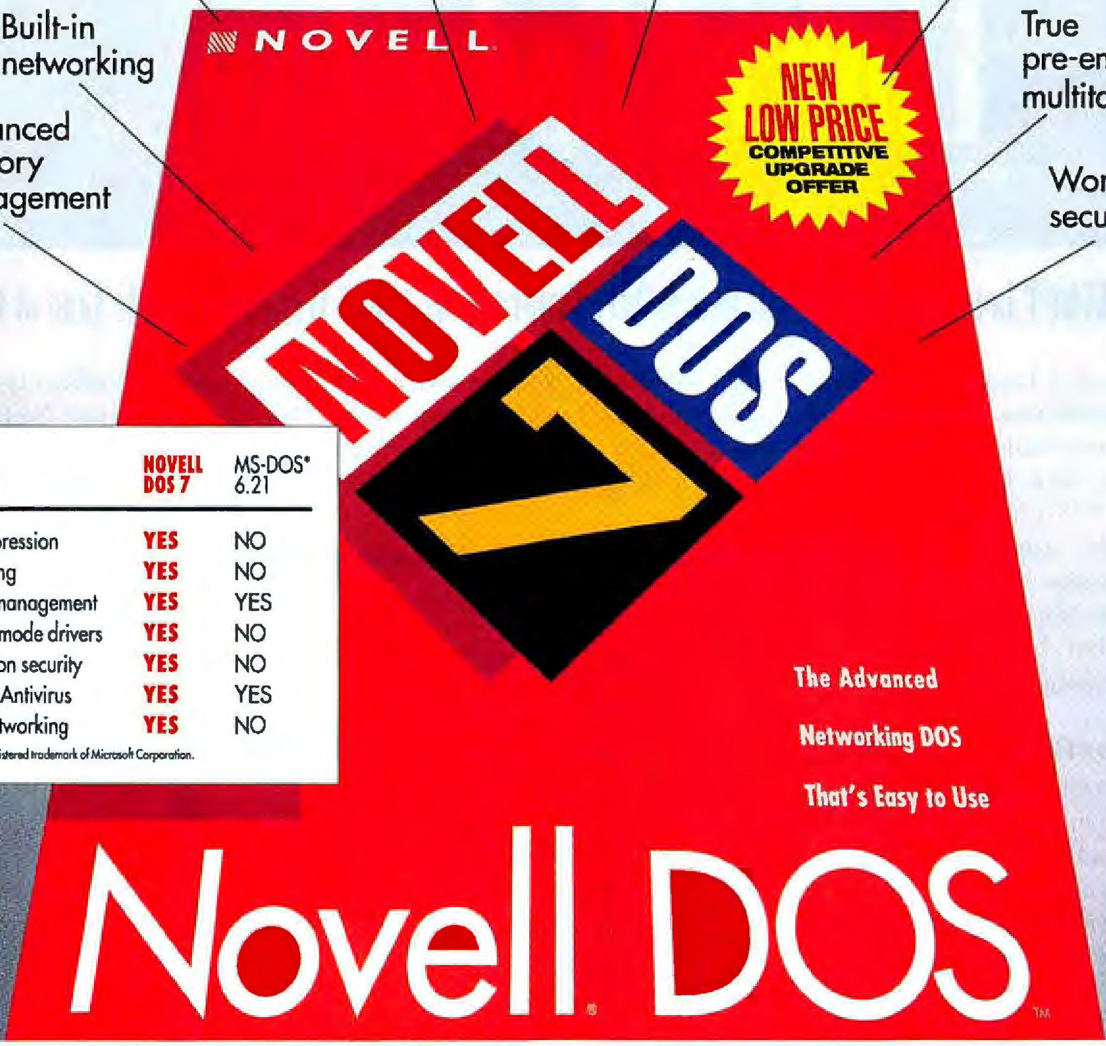

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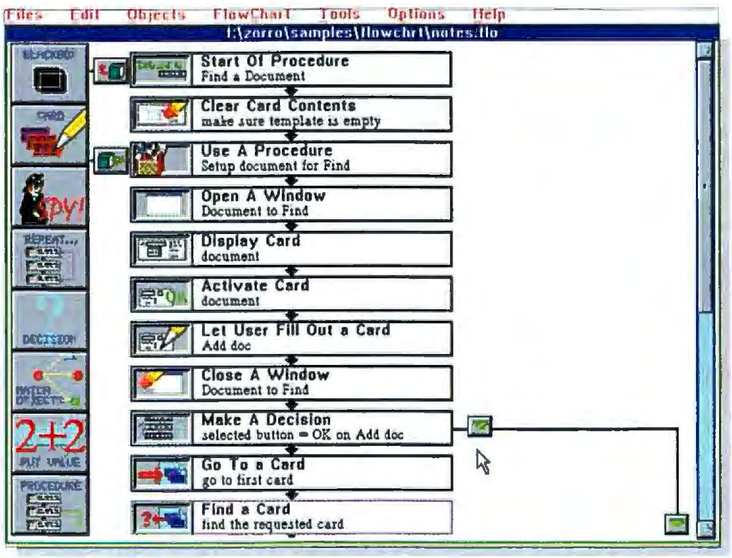

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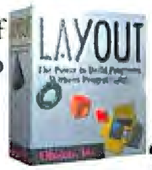

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Visual Programming's Many Faces

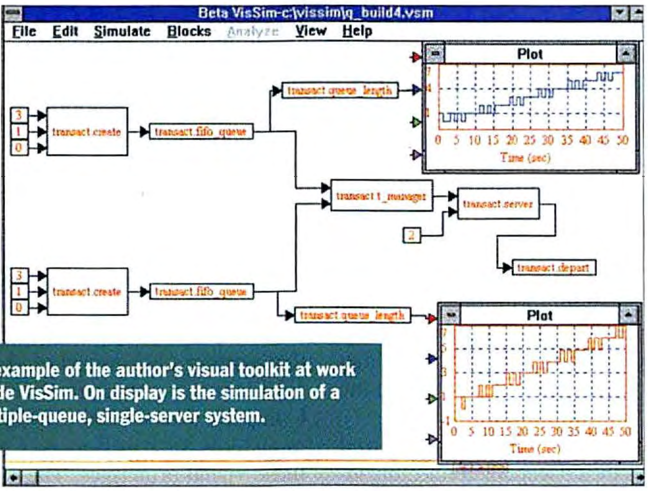
A future programmer may look less like a writer laying down words and more like an electrician wiring together circuit components

PETER D. VARHOL

With the arrival of programming tools such as Visual Basic, the term *visual programming* has entered the lexicon of mainstream computing. However, the term means very different things to different people. For many, Visual Basic—and its cousin, Visual C++—may be all they know, or expect to know, about visual programming. To others, Visual Basic is hardly representative of the vast array of different technologies that share the label of *visual*. Among the other alternatives are Digitalk's Parts, Powersoft's PowerBuilder, Meta Software's Design/CPN, and Novell's Visual AppBuilder.

The goal of all of these different approaches is the same: to make programming easier for programmers and accessible to nonprogrammers. Some are used for rapid prototyping and rapid applications development, others are used for systems or applications design, and still others can produce stand-alone applications for distribution. In all cases, visual languages and visual programming let users put more effort into solving their particular problem rather than learning about the computer or about a programming language. This way, an engineer, for example, does not also have to be a computer programmer to simulate a complex control system.

The term *visual programming* strongly implies graphics. Although it is possible to "program visually" in a textual environment, you lose much of the visual aspects of the program in doing so. It also implies an object-oriented—or at least an object-like—view of a program. There's nothing like representing every program activity as a screen object to reinforce object-oriented principles, even if a component is not an object in the strictest sense.



An example of the author's visual toolkit at work inside VisSim. On display is the simulation of a multiple-queue, single-server system.

Visual User-Interface Builders and Beyond

The best-known approach to visual programming is the interface builder, typified by Visual Basic and HyperCard. These tools provide a set of screen objects, such as buttons, scroll bars, and menus. You position these constructs on a form and describe their behavior through the use of a scripting language associated with each one.

Visual Basic goes beyond being a simple screen builder to being a component builder, because its components (called VBXes), which can be quite complex, can be abstracted from one application and placed in another (see "Componentware," May BYTE). You might call this a visual environment for program construction.

The ability to do this has been available commercially since the mid-1980s, but it became widely known with Visual Basic. What you are doing is visualizing the software design from the user interface down and then implementing it. Visual Basic and similar tools constrain you to think of an application in terms of the user interface, making it more likely that the program will be very user-centered.

However, Visual Basic and Apple's HyperCard lack the ability to extend predefined objects by inheriting their characteristics. You can add new components, but only with conventional programming techniques.

Visual System Modeling

A second category of visual languages might be thought of as visual modeling tools. You can use these to create visual models of systems, programs, or data. But what separates these from simple drawing packages is that it becomes possible to "execute" the model to simulate the operation of a program or a system. Products such as i-Logix's Statemate and Meta Software's Design/CPN do just this.

Both of these products support the system-design process. Statemate uses state charts, while Design/CPN employs colored Petri nets. State charts work best when modeling the transition of a system from one state to another, while colored Petri nets are more useful for modeling the flow of control in a system. Both of these design formalisms have a logical structure that makes the resulting models *deterministic*, meaning that there is only one set of outputs for any set of inputs.

Visual Solutions' VisSim gives you a predefined set of engineering and mathematical functions to visually create a continuous state simulation, such as the flight path of a ballistic missile. These functions are encapsulated into visual boxes on the screen. You wire these boxes together to create a flow of data. VisSim lets you extend its language by writing DLLs that translate into additional screen boxes, and you can generate C code from the simulation and compile it to run in stand-alone or embedded applications.

Physically, these visual models bear no resemblance to the actual or proposed system. What they do is represent an important aspect of the system, such as the flow of data or control. Rather than being static, these tools can also simulate that aspect, helping the designer to see whether or not the design works and to make adjustments based on the simulated results.

My own experience with visual languages falls into this category. Seeking to simulate the transmission of packets on computer networks, I developed a visual toolkit for discrete event simulation. This toolkit, which works in conjunction with Visual Solutions' VisSim, provides a set of high-level visual boxes, such as a Queue and a Server, that represent major queuing functions. To create a simulation, you simply select the appropriate boxes from the menu, place them on the display, and use wire connectors to indicate the flow of packets in the simulation (see the screen). Other boxes let you generate random numbers and collect statistics.

Visual-Programming Activities

While you visually assemble the screen in Visual Basic, you still have to write some traditional code to operate the interface and to provide the necessary computational engine for the application. Although this represents what might be the most popular form of visual programming today, perhaps the greatest potential resides in performing actual programming tasks through visual means.

Among the commercial applications falling into this category are Prograph International's Prograph, Novell's Visual AppBuilder (formerly Serius Developer), and Digitalk's Parts. With these applications, you are actually programming with visual expressions. Visual AppBuilder provides a number of high-level programming constructs, such as menus and menu items, windows, buttons, text and numbers, and pictures. To write a program, you position these constructs on the screen and connect outputs from one to inputs to others, depending on your flow of data or control. Each construct uses dialog boxes that allow you to define the activity that is performed when a particular event occurs.

Even this approach, however, cannot get entirely away from traditional programming. Visual AppBuilder lets you use C or Pascal to write your own constructs, which can then be compiled into your own customized visual library. This would probably be necessary for many customized applications. I was a beta tester for Serius Developer before the company was acquired by Novell, and while I liked the idea of programming visually, I found that I had to write several of my own objects in Pascal to create the kind of applications I wanted.

This type of visual programming works well for specialized tasks. Adept, from Symbologic, uses the concept of connecting visual objects together to produce expert systems. Screens, modules, and expert rules are created through the use of icons and dialog boxes. Some database tools, such as PowerBuilder, let you use objects to define database activities, such as database queries and even database files themselves.

These categories of visual-programming approaches are not mutually exclusive. Digitalk's Parts, for example, combines a sophisticated visual-interface builder with object-oriented operations. Parts, based on Smalltalk/V, is truly object-oriented. You construct your user interface out of predefined objects and then connect them to other objects that define the activities of the user interface. For example, the multiplication button on a calculator user interface can be connected to a multiplication object that actually performs the work. Parts also gives you the ability to create your own visual components and to inherit characteristics from existing components.

Given the power of this object-oriented visual approach, it is likely that the other tools described here, such as Visual Basic, will grow in this direction. Increasingly, users need to decouple an object from the underlying operating environment and share it across applications and systems. Object extension and inheritance will likely make their way into even the interface builders.

The question remains as to whether visual languages can be used in large-scale software development efforts. One corporate user of Easel Corp.'s Easel told me that its visual environment became hopelessly complex after about 300 objects. Visual languages that interact with existing technologies may turn out to be the most useful solution. For example, Parts lets programmers encapsulate existing Cobol code as a Parts object, allowing them to abstract an existing engine and visually extend it to include a GUI and other functions.

So What is Truly a Visual Language?

While purists may argue over whether any of these methods are truly visual languages, there is no refuting their utility. Few people deny that Visual Basic and similar tools are worthwhile for at least prototyping and, as the tools get better and computers get faster, for actually delivering production applications.

Programming with visual expressions excites many people as possibly being the future of programming in general. Parts and AppBuilder both support the emerging design and development methodology known as JAD/RAD (Joint Application Design/ Rapid Application Design). With this methodology, members of a small team of users interact in very specified roles to decide exactly what they want in an application, which can often be produced as they watch.

One caution that must be heeded while working with any of these tools is that they constrain the user to view a program in a particular way, as I noted earlier with regard to Visual Basic. This is not necessarily a bad thing; we can certainly use more user-centered programs like the ones produced by Visual Basic.

But a form with user-interface gadgets steers you into thinking about an application as one screen at a time, which may not always be appropriate. Parts and Visual AppBuilder provide a somewhat different perspective, focusing on the interrelationship between the user interface and the resulting program activities.

The products mentioned here are by no means the only ones that support some aspect of visual programming. Others include GUIdance Technologies' Choreographer, Easel's Enfin, and Computer Associates' CA-Realizer. Many traditional programming tools, such as Borland C++, are beginning to adopt many of these visual principles. The visual approach to programming is clearly an emerging technology that promises to make systems and software designers more productive and make software development activities accessible to more people. ■

Peter D. Varhol is chair of the graduate computer science department at Rivier College (Nashua, NH). You can contact him on the Internet or BIX at pvarhol@bix.com.

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Pentium Secrets

The Pentium collects lots of information about code execution, and now you can get access to it

TERJE MATHISEN

When Intel announced the Pentium processor in March 1993, I immediately ordered the three-volume user's manual. For people like me, who wanted to write the fastest, most efficient code possible, volume 3 appeared to be the most useful. Imagine my chagrin, then, when every interesting section on optimization contained a reference to Appendix H, which consists of a single, illuminating paragraph stating that the information I desired is "considered Intel confidential and proprietary." This information is only available to those willing to sign a nondisclosure agreement with Intel.

From the published Pentium documentation and other sources, I knew that the Pentium could return detailed statistics on all major parts of its CPU—just the type of information that is essential for code optimization. The best place to look for such information was in the new, documented RDMSR (read machine-specific register) and WRMSR (write machine-specific register) instructions. These instructions work on a set of 64-bit MSRs (machine-specific registers) contained in the Pentium.

To use RDMSR and WRMSR, you move the register identifier (i.e., the number) of the desired MSR into register ECX. Invoking RDMSR will then transfer the contents of the indicated MSR into the paired registers EDX:EAX, while WRMSR copies EDX:EAX into the internal register. The Pentium user's manual documents MSRs 0h, 1h, and 0Eh, and also states that MSRs 3h and 0Fh, as well as values above 13h, are reserved and illegal. I felt sure the undocumented registers held the key to the optimization information I wanted.

As the first step in deciphering the undocumented registers, I wrote a test program that dumped the contents of the MSRs. (I quickly discovered that any attempt to read MSR 0Ah halted my PC, so until somebody finds a use for it, I suggest leaving that one alone.) Running the test program, I found that the content of most of the registers was static. The exception was MSR 10h, which was changing rapidly indeed. Guessing that MSR 10h might contain a running cycle count, I divided the value contained in 10h by my processor's 60-MHz clock speed. My hunch paid off when I ended up with a nice display of the number of seconds since I had last powered-up.

Using RDMSR to read MSR 10h gives you the highest precision counter available to 80x86 programs. By reading the value in MSR 10h before and after a block of code, you'll know exactly how long the processor took to execute the block, down to the last cycle.

These results parallel the ones you get when you use the RDTSC (read time stamp counter) (0F/31) instruction. Mike Schmid revealed the existence of this instruction in the January issue of *Dr. Dobb's Journal*. As with many of the MSRs, RDTSC is not documented anywhere, except in the instruction decoding tables, where it fits right between WRMSR (0F/30) and RDMSR (0F/32). A quick comparison of RDTSC and RDMSR shows that both access the same running cycle count, with RDTSC being an alternative and slightly faster way to retrieve the data.

Unfortunately, RDMSR and RDTSC are kernel mode (ring 0) instructions. My PC crashed when I ran these instructions inside a DOS box or with a memory manager. I am guessing that you can enable ring 3 access to RDTSC, maybe by using MSR 0Eh (test register 12 in the Intel manual), which is documented as "new feature control,"

PENTIUM COUNTERS

INDEX	NAME	INDEX	NAME
0	Data read	15	Pipeline flushes
1	Data write	16	Instructions executed
2	Data TLB (translation look-aside buffer) miss	17	Instructions executed in the v-pipe
3	Data read miss	18	Bus utilization (clocks)
4	Data write miss	19	Pipeline stalled by write backup
5	Write (hit) to M or E state lines	1A	Pipeline stalled by data memory read
6	Data cache lines written back	1B	Pipeline stalled by write to E or M line
7	Data cache snoops	1C	Locked bus cycle
8	Data cache snoop hits	1D	I/O read or write cycle
9	Memory accesses in both pipes	1E	Noncacheable memory references
A	Bank conflicts	1F	AGI (Address Generation Interlock)
B	Misaligned data memory references	22	Floating-point operations
C	Code read	23	Breakpoint 0 match
D	Code TLB miss	24	Breakpoint 1 match
E	Code cache miss	25	Breakpoint 2 match
F	Any segment register load	26	Breakpoint 3 match
12	Branches	27	Hardware interrupts
13	BTB (branch target buffer) hits	28	Data read or data write
14	Taken branch or BTB hit	29	Data read miss or data write miss

or MSR 0Dh, which seems to contain a value similar to MSR 0Eh; however, I have yet to discover how to enable ring 3 access.

Counter Culture

My next break in deciphering the MSRs came during a visit to a U.S-based developer. There, I saw a utility that displayed a number of interesting statistics about programs running on a Pentium machine. The utility could dynamically display one or two internal counters from a list of 38 different hardware events. The statistics were all related to different aspects of processor performance and were just the information I needed to perform informed code optimization on the Pentium.

For example, when the developers used the utility to profile another program, the utility revealed that the target program was generating a lot of accesses to misaligned memory variables. A simple recompile of the target program, using doubleword (4-byte) alignment, resulted in a 2½-times speedup.

The developers realized that the utility would be useful for other programmers, so they obtained permission from Intel to distribute the program, as long as the source code was kept secret. I obtained a copy of the executable file to see if I could figure out how it accessed the Pentium statistics.

My first obstacle was creating a disassembled listing. I converted the program code into a list of Define Byte (DB xxh) statements. I encapsulated this naked code within an assembly program wrapper, ran Borland's TASM (Turbo Assembler), and then converted the object file into a listing. Next, I located the RDMSR and WRMSR byte sequences (the Pentium wasn't around when my object disassembler was written) and started working backwards from there. After a few days of tracing and testing, I found out how the internal counters work.

The controller for the Pentium hardware counters is MSR 11h; more specifically, the lower 32 bits of MSR 11h. The first 16 bits determines the data that will end up in MSR 12h, while the second 16 bits determines the counter that will report its results in MSR 13h, which is the nineteenth and last MSR on a Pentium. An obvious extension for Intel's next CPU, the P6 (Hexium, anyone?) would be to use all 64 bits of MSR 11h and add two more stat counters as MSR 14h and 15h. The lack of more MSRs limits you to accessing no more than two counters at a time.

The encoding of each 16-bit block of MSR 11h is identical. The first 6 bits (0 to 5) are an index into the list of available hardware events (see the table "Pentium Counters" on page 191). When set, bit 6 enables counting of events in the operating-system rings 0, 1, and 2, while bit 7 enables ring 3 monitoring.

Bit 8 indicates whether you want to collect the number of hardware events or the CPU cycles that the events use. Thus by setting up both counters to track the same item, with one counting events and the other counting cycles, you get a measurement of the average time it takes to complete the tracked event.

Using this information, I wrote P5Stat, a profiling program that accesses the Pentium hardware counters. P5Stat accepts another program name on the command line and then sets out to execute the indicated program 20 times. The first time through ensures that all the caches are loaded, while on each of the next 19 runs P5Stat collects two of the 38 different hardware counters available. After the last run, P5Stat dumps all the results to standard output, where it can be redirected to a file for later use.

P5Stat has proven useful in code optimization. For example, I recently used it on WC 5.26, a freeware word count program that I wrote almost three years ago. I discovered that without optimization the dual-pipeline Pentium gave a 43 percent speedup compared to running all the code in a single pipe (i.e., on a 486). Using P5Stat to identify crucial bottlenecks, I rearranged the inner loop of the counting function for the new version, WC 5.40. This required more instructions, but P5Stat showed that I had achieved nearly 100 percent filling of the dual pipes, resulting in an actual counting speed of 1.5 cycles per byte, or 40 MBps on my 60-MHz Pentium. This is a 33 percent speedup over the previous Pentium version of WC. (See the "Program Listings" on page 9 for information on how to obtain P5Stat and WC 5.40.)

The profiling information available to Pentium programmers is a powerful aid in software development. With the information in this article, you can access these features and use them to identify bottlenecks and inefficient coding practices in your programs. I hope Intel makes official information available to all programmers and that such useful features are incorporated into other architectures such as Alpha, PowerPC, and SPARC. ■

Terje Mathisen is a systems architect for Norsk Hydro in Norway and has been developing high-performance IBM-compatible software since 1981. You can reach him on the Internet or BIX at terjem@hda.hydro.com.

Using the Hardware Counters

First, define macros for the new instructions:

```
RDMSR MACRO
  db 0fh, 032h
ENDM
WRMSR MACRO
  db 0fh, 030h
ENDM
```

Then when you want to use the specific counters, I suggest that you read the current value of MSR 11h first and only modify the part you need to set up your counters:

```
mov ecx,11h
RDMSR
and eax,0FE00FE00h; save the upper 7 bits in each half
or eax,Nr1_idx+Nr1_ctrl+(Nr2_idx+Nr2_ctrl) shl 16
WRMSR
```

Now any read of MSR 12 will retrieve the current value of hardware event Nr1, while MSR 13h contains event Nr2:

```
mov ecx, 13h
RDMSR
push edx
push eax
dec ecx
RDMSR
push edx
push eax
```

Finally, insert the code to be tested here.

```
mov ecx, 12h
RDMSR
pop ebx
sub eax,ebx
pop ebx
sbb edx,ebx
call disp64; display first count
inc ecx
rdmsr
pop ebx
sub eax,ebx
pop ebx
sbb edx,ebx
call disp64; display second count
```

Pretty Good Privacy

This controversial security scheme for messages is a collection of international cryptographic methods

WILLIAM STALLINGS

If you rely on E-mail for business or personal communications, beware: If you send messages over a network, they are subject to eavesdropping. And, as Oliver North and John Poindexter found out, if messages are stored in a file, they are subject to perusal months or even years later. You also need to be concerned about impersonation: That message asking leading questions may not be from your attorney at all, but from some hotshot reporter with excellent hacking skills.

What to do? PGP (Pretty Good Privacy) is the E-mail security package for Everyperson. Developed a few years ago by Phil Zimmermann, PGP combines confidentiality and digital-signature capabilities to provide a powerful, virtually unbreakable, and easy-to-use package. Freeware versions are available for Windows, the Macintosh, DOS, OS/2, the Amiga, and other platforms.

Much has been written about the political and legal issues surrounding PGP. In this discussion I'll show how PGP works by explaining its four services for messages: authentication, confidentiality, compression, and E-mail compatibility. The figure "The PGP Process" shows the relationship among these four services.

Authentication

PGP employs the RSA public-key encryption scheme—a time-proven and easy-to-implement encryption method that is named after its inventors: Rivest, Shamir, and Adleman—and the MD5 (Message Digest version 5, also from Ron Rivest) one-way hash function to form a digital signature that assures the receiver that an incoming message is authentic (i.e., that it comes from the alleged sender and that it has not been altered). The sequence is as follows:

1. The sender creates a message.
2. MD5 is used to generate a 128-bit hash code of the message.
3. The hash code is encrypted with RSA using the sender's private key, and the result is prepended to the message.
4. The receiver uses RSA with the sender's public key to decrypt and recover the hash code.
5. The receiver generates a new hash code for the message and compares it with the decrypted hash code. If the two match, the message is accepted as authentic.

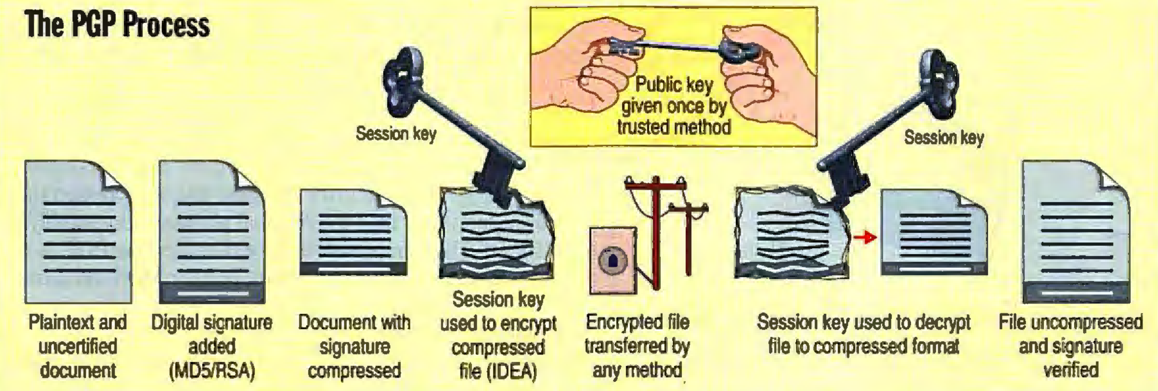
The combination of MD5 and RSA provides an effective digital-signature scheme. Because of RSA's strength, the receiver is assured that only the possessor of the matching private key can generate the signature. Because of MD5's strength, the receiver is assured that no one else can generate a new message that matches the hash code—and, hence, the signature—of the original message.

Each person's signature is independent and is therefore applied only to the document. Otherwise, signatures would have to be nested, with the second signer signing both the document and the first signature, and so on.

Confidentiality

Another basic service provided by PGP is confidentiality, which is provided by encrypting messages to be transmitted or to be stored locally as files. In both cases, the conventional encryption algorithm known as IDEA (International Data Encryption Algorithm) is used. IDEA is a relatively new algorithm that is generally considered to

The PGP Process



be much stronger than the widely used DES algorithm.

In any conventional encryption system, the problem of key distribution must be addressed. In PGP, each conventional key is used only once. That is, a new key is generated as a random 128-bit number for each message. This session key is bound to the message and transmitted with it, as explained below.

❶ The sender generates a message and a random 128-bit number to be used as a session key for that message only.

❷ The message is encrypted, using IDEA with the session key.

❸ The session key is encrypted with RSA, using the receiver's public key, and is prepended to the message.

❹ The receiver uses RSA with his or her private key to decrypt and recover the session key.

❺ The session key is used to decrypt the message.

IDEA is substantially faster than RSA, so to reduce encryption time, the IDEA/RSA combination is used in preference to simply using RSA to directly encrypt the message. Also, the use of RSA solves the session-key distribution problem, because only the receiver is able to recover the session key that is bound to the message. Thus, to the extent that RSA is secure, the entire scheme is secure. To this end, PGP provides the user with several RSA key-size options:

- *Casual (384 bits):* known to be breakable, but with much effort
- *Commercial (512 bits):* possibly breakable by three-letter organizations
- *Military (1024 bits):* generally believed to be unbreakable

Both confidentiality and authentication services can be used for the same message. First, a signature is generated for the plaintext message and is prepended to the message. Then, the plaintext message, along with the signature, is encrypted using IDEA, and the session key is encrypted using RSA.

In summary, when both services are used, the sender first signs the message with his or her own private key, then encrypts the message with a session key, and then encrypts the session key with the receiver's public key.

Compression

As a default, PGP compresses a message after applying the signature but before encryption. Compression has the benefit of reducing the size of an E-mail transmission.

Note in the figure "The PGP Process" that the signature is generated before compression. It is preferable to sign an uncompressed message so that you can store only the uncompressed message together with the signature for future verification. If you were to sign a compressed document, it would be necessary either to store a compressed version of the message for later verification or to recompress the message when verification is required.

Message encryption is applied after compression to strengthen cryptographic security. Because the compressed message has less redundancy than the original plaintext, cryptanalysis is more difficult. The compression algorithm used for PGP is ZIP, a popular algorithm originally developed for DOS machines.

E-Mail Compatibility

When PGP is used, at least part of the block to be transmitted is encrypted. If only the signature service is used, then the mes-

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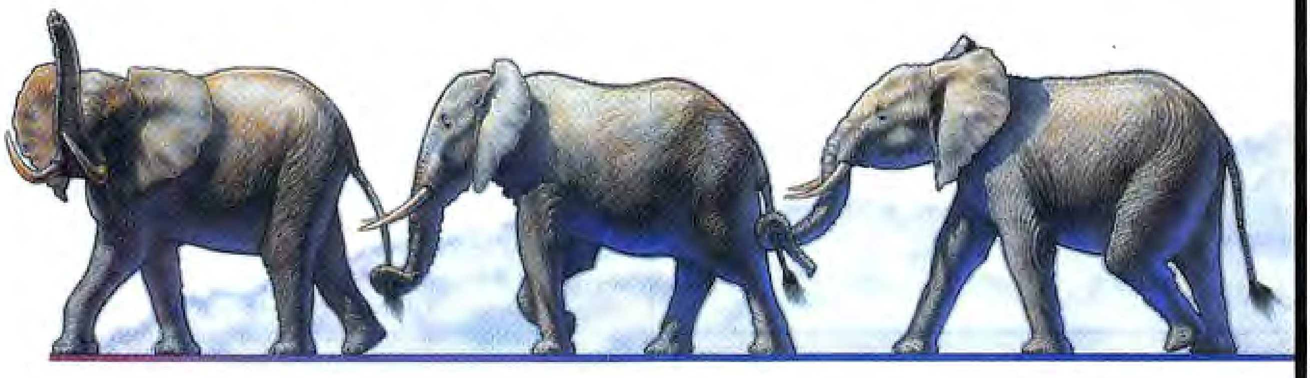

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THE INSIDE NAME IN UPGRADES

Circle 102 on Inquiry Card (RESELLERS: 103).

sage digest is encrypted (with the sender's private RSA key). If the confidentiality service is used, the message plus signature (if one is present) is encrypted (with a one-time IDEA key). Thus, all or part of the resulting block consists of a stream of arbitrary 8-bit octets.

However, many E-mail systems permit the use of only those blocks that consist of ASCII text. To accommodate this restriction, PGP provides the service of converting the raw 8-bit binary stream to a stream of printable ASCII characters.

The scheme used for this purpose is known as radix-64 conversion. Each group of three octets of binary data is mapped into four ASCII characters. The use of radix-64 expands a message by 33 percent. Fortunately, the session key and signature portions of the message are relatively compact, and the plaintext message is compressed. In fact, the compression should be more than enough to compensate for the radix-64 expansion.

One noteworthy aspect of the radix-64 algorithm is that it blindly converts the input stream to radix-64 format regardless of content, even if the input happens to be ASCII text. Thus, if a message is signed but not encrypted, and the conversion is applied to the entire block, the output will be unreadable to the casual observer. This provides a certain level of confidentiality.

As an option, PGP can be configured to convert to radix-64 format only the signature portion of signed plaintext messages. This enables the receiver to read the message without using PGP. PGP would still have to be employed to verify the signature, however.

Public-Key Management

As you can see, PGP contains a clever, efficient, interlocking set of functions and formats to provide an effective confidentiality and authentication service. But to complete the system, one final area needs to be addressed: public-key management.

In the PGP documentation, Phil Zimmermann neatly captures the importance of this area. "This whole business of protecting public keys from tampering is the single most difficult problem in practical public-key applications," he says. "It is the Achilles' heel of public-key cryptography, and a lot of software complexity is tied up in solving this one problem."

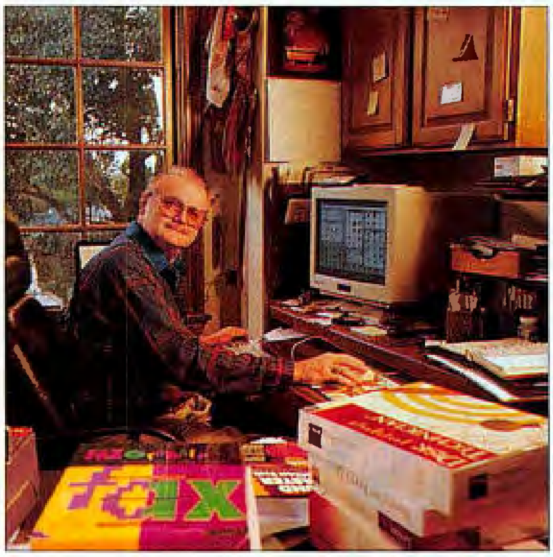
A number of approaches are possible within PGP for minimizing the risk of a user's public-key file containing false public keys, such as physically passing the key via surface mail or floppy disk, verifying a key by telephone, or transferring and confirming the key through a trusted third party. But another, more likely method is already being used: The use of a trusted key server and verification by monitoring the sender's PGP fingerprints in postings to Usenet newsgroups and other public forums.

PGP is young, strong, and coming on. It is already being widely used, and its growth is being fueled by the rapid growth in Internet use and the increasing reliance on E-mail for everything from legal documents to love letters. It is already the practice of many people to include their PGP fingerprint in E-mail messages. Expect to see more of this and to see such fingerprints appearing in print, as one does with this article, in the future. ■

William Stallings is an independent consultant and a frequent contributor to BYTE. He is the author of over a dozen books on data communications and computer topics and is currently at work on a user's guide to PGP. This article is based on material from his most recent book, Network and Internetwork Security *(Prentice-Hall, 1994). His PGP fingerprint is B1 4E 2A BD 96 08 8B A4 67 83 D1 09 FE 52 56 6C. You can contact him on the Internet at stallings@acm.org or on BIX c/o "editors."*

JERRY POURNELLE

An Educational Trip



AMY ETRA © 1994

Jerry travels to London to attend a conference on education and then goes to Birmingham to visit a major English computer show

The ICTE (International Conference on Technology in Education) met this year at the University of London, an institution distinguished by having on display a wax model containing the complete skeleton of Jeremy Bentham, one of the university's founders. As I understand it, Mr. Bentham, looking pretty good for his age, is wheeled—stovepipe hat and all—into meetings of the trustees, where he is recorded as "present but not voting." Naturally I went to see him: he sits in a corridor off the South Cloister, where he attracts little attention except from visitors.

I'd never been to an ICTE, and when Mrs. Pournelle was invited to present a session built around The Literacy Connection, her program for teaching reading (see my June column)—it was also the formal launch of the new Macintosh version—this looked like a good chance to get the latest on what's happening in education. It also gave me an opportunity to get to a British computer show in the enormous new exhibit hall at Birmingham International Airport.

The ICTE was held in the University of London's Education Institute, a building whose architecture is described by those who like it as "royal brutal." The inside was nicer, with a well-designed lecture hall.

Sessions varied. Some were from education theorists who used phrases like "epistemological and didactical domains of validity" but were under the impression that they were communicating with the audience. I was more interested in examples of technology in use.

There isn't a lot. It's not that it doesn't exist: the potential is certainly there, and, where used skillfully, technology can produce remarkable gains in education quality. Of course, it's not always used skillfully and sometimes does little to no good, but that's not the real problem. The big difficulty is that quite often it doesn't get used at all in any systematic way.

A major factor is cost. The average classroom has a budget of under $500 a year for materials and technology, hardware and software alike. That doesn't buy a lot of software, much less put computers into the classrooms.

One ICTE session was on the use of videoconferencing. Eddyth Worley, a distance-learning consultant, put on a demonstration in which both PCs and Macs were networked with teachers in London and Austin, Texas, over ordinary phone lines.

Inputs could be from any video source, such as a camcorder or a small video camera, like the VideoLabs Flexcam we have. The demonstration used hardware compression boards furnished by Northern Telecom. It all worked impressively well, but many classrooms don't have telephone lines and modems, much less several thousand dollars worth of software and proprietary compression boards.

Those that do have modems can participate in projects like the global classroom system, in which cultural and environmental data from all over the world is collected and compared. You can get information on the Global Laboratory Project from TERC, a company that organizes projects such as student ozone research. They sell lab equipment and provide guidance on how to set up projects. I was quite impressed by the

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- BYTE Magazine, January 1994 -

PC Digest RATINGS REPORT

★★★★ Recommendation

"The KFC CA 1507, recipient of the EPA's Energy Star, offers a full range of image adjustment controls. This monitor complies with the DPMS power management standards suggested by the VESA and will work with any VESA-compliant computer."

- PC Digest, November 1993 -

KFC's new green monitors consume less than 1.5 Watts when inactive, and less than 20 Watts when on stand-by. Compared to the average of 85~100 Watts for an ordinary monitor, each KFC monitor contributes substantially to a greener environment. And you're not just sharing the contribution, you're also saving money.

CA1718 was the Best Value Runner-up for Spreadsheet & Graphics Color Monitor in BYTE Magazine's January 1994 BYTE/NSTL Lab Report. CA1507 (picture not shown) was awarded the "Best Value: General Business Color Monitor" by BYTE Magazine in January 1994 BYTE/NSTL Lab Report.

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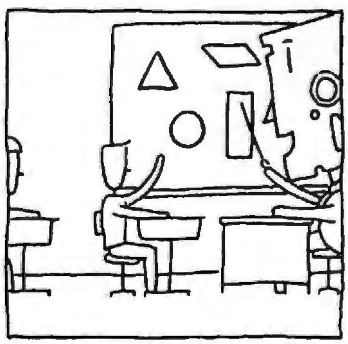
demonstration put on by Boris Berenfeld, TERC's senior scientist.

Note in every case that the results of education technology have affected education quality, at increased expense. That is generally universal, and one major reason why it has taken so long for education technology to spread more widely. This was the conclusion of an interesting report by Danish researcher Hans Siggard Jensen of the Copenhagen Business School: while technology often improves education quality, it costs more and is not necessarily cost-efficient. That lack of cost-efficiency has hindered the spread of education technology.

Jensen's study concluded that education technology can be cost-efficient only if the system can transfer more of the "work" to the learners, who are either not paid or receive low pay (an example of students receiving low pay being vocational school students who are paid for "retraining"). The same is true with distance learning: teacher productivity can be raised only if the instructors behave as if they are in a virtual classroom; but left to itself, the situation generally defaults to a series of one-on-one encounters.

One reason education technology isn't as widespread as it ought to be is a simple lack of computers: although some schools have machines in the classrooms, most don't. Most school computers are in the offices of administrators and are used for school administration, not education.

That's changing slowly. One mechanism of change is teachers themselves, who bring their own machines to school. Some find a company that's changing computer models and would be willing to donate older machines to a school if someone would just ask. Sometimes a parent or group of parents will lend or give a machine to the class.



One of the main problems with computers in classrooms is security. Schoolrooms are increasingly subject to theft. Worse, machines that are locked down are often destroyed by vandals frustrated because they couldn't steal the equipment. It's a sad commentary that one reason we aren't using more technology in education is that we don't have low-cost computer security enclosures, but it's true.

Laptops are one way around the security problem, and some teachers simply bring one to class and take it home at night. That's not elegant, but it seems to work.

Once the computers get into the classroom, there are many networks for exchanging ideas on how to use them. Roberta runs one of the largest (the Education Round Table, or ERT) on GEnie and moderates a smaller one on BIX. Most computer BBSes have an education forum and libraries of software, both freeware and shareware. Few of those programs approach commercial programs in sophistication, but many of the commercial programs are prettier than they are effective. The most important thing is to find out what other teachers are doing and how it works for them.

The ICTE is a major place for learning that. Like most professional conferences, there's at least as much value in the hall and coffee-break conversations as in the formal sessions. I wish that every school teacher in the country could attend at least one ICTE meeting. That wouldn't solve the education crisis in the U.S., but it sure would help. Next year's conference runs from February 28 to March 3 in Orlando, Florida.

There's a lot of educational software, but most of it is for a single user, not for the classroom. There's software to increase vocabulary (David Kay, formerly of KayPro and now of SmartTek Educational Technology, has a good series called Wordsmart that covers the lower grades to college level), electronic-workbench software (one of the best is Electronics Workbench from Interactive Image Technologies), and math and physics software.

There are games disguised as education programs, and there's Myst, which is an education disguised as a game. It's almost worth buying a Mac just to have it. Myst comes from Broderbund Software, the same people who made The Manhole, one of the earliest CD adventures. It's hard to describe: Myst is a small world you can explore. It's full of puzzles, all of which have logical solutions. Myst forces you into the hypothesis-experiment mode, which means it's teaching the essence of the scientific method, but I don't suppose most of those who play with it think of that. Mostly, it's a fun world to explore.

Roger Wagner (rwagnerinc@aol.com) has a program called Hyperstudio that rivals HyperCard. More on that when I get a copy. He told me the story of a teacher

Pournelle

friend, Tony Latesse, who develops his own educational software. His philosophy is "One Goal, One Stack, in One Evening." It seems obvious when said, but I hadn't thought of it. It's also clear that with this approach, it doesn't take a great many evenings to build up an impressive library of software tailored to the specific needs of your class.

If you have a Mac with a CD-ROM drive and any interest in classical literature, you can't afford not to get The Madness of Roland from Greg Roach at Hyperbole Studios. This is an imaginative use of hypertext and QuickTime for the Mac. Roach says he originally conceived this as a stage presentation, but he soon found no one could afford to produce it. It features live actors.

Roland, or Orlando, was one of the paladins of Charlemagne. He is best known for his last stand in the pass at Roncesvalles, but his earlier madness induced by love generated a number of poems. The best known of these is Ludovico Ariosto's *Orlando Furioso*. Ariosto is largely unknown today, but he was one of the most influential poets of the Renaissance and had a considerable impact on English literature; he's worth rediscovering. Roach's presentation is genuinely fun and is a real-live, no-question-about-it work of art for multimedia. Recommended.

We took the train up to Birmingham to see the National Computer Shopper show. The train ride was delightful. My British friends complain about their trains, but I found them clean, fast, frequent, and on time.

There will always be an England. I got a newspaper to read on the train ride, and as we rode for the hour or so to Birmingham, I read an article in London's *Daily Mail* about the latest sex education scandal. Apparently someone in the Department of Health hired the "agony uncle" of a teen magazine to write a sex education manual, and several hundred thousand copies were printed before the politically appointed Minister of Health saw it. She instantly blushed and ordered them all destroyed; they were far too explicit and "treated sex in a mechanical way without regard to emotions."

The Labour opposition "shadow" Minister of Health (the person who would become Minister if Labour were to win a majority in the House of Commons) had demanded a copy but was told none were available. Perhaps so, but the *Daily Mail* had obtained a copy, and when I read excerpts from it as printed in the paper, I

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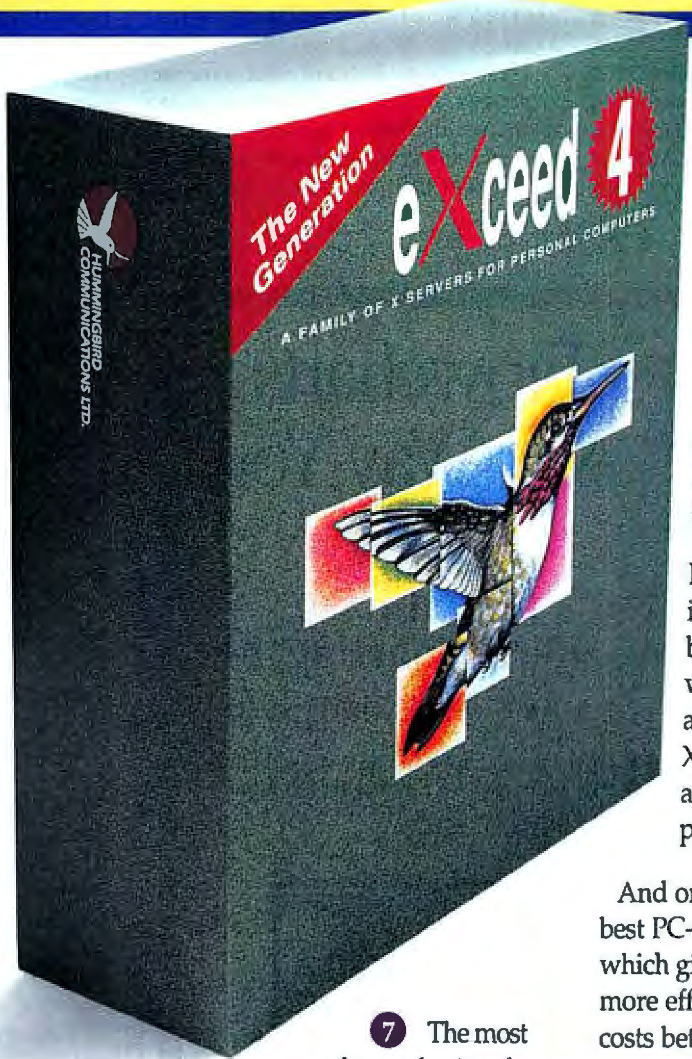

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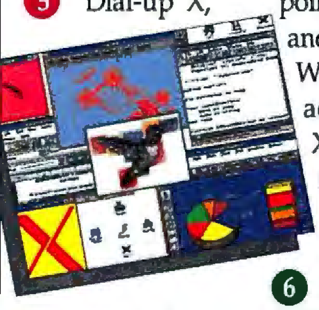

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managed to shock some of the business-people in our train compartment.

If the *Daily Mail* had a copy, I bet someone with a scanner got one as well, and I expect if you really want to read this thing, you can find it on the Internet. I doubt it has become road kill on the information highway.

The National Computer Shopper show was well organized, not as large as the old West Coast Computer Faire in its prime, but bigger than the recent Los Angeles Computer Faire. Many of the larger companies, including IBM and Microsoft, were there. Creative Labs also had a large booth, which shouldn't be surprising, because one feature of the show was a Doom (see my April column) tournament. There was a huge booth where you could play Doom until you were hooked and then purchase a copy.

There were a number of other game presentations, as well as the usual computer retailers with blowout sales and dealers in business and education software. Prices were lower than those I saw in London stores, but, of course, I wasn't really shopping. Memory in Britain is £33 a megabyte, comparable to U.S. prices, and a 66-MHz 486DX2 VL-Bus clone was £700 at the show.

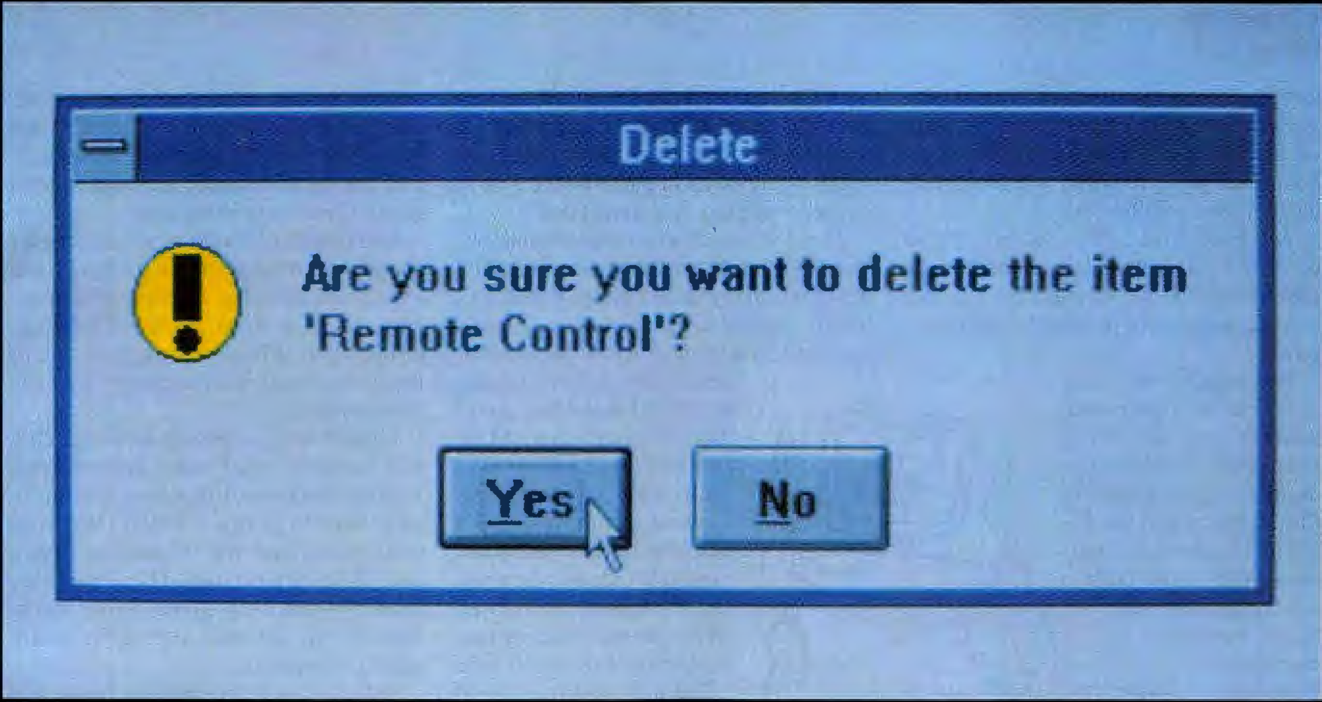
Unlike the old West Coast Computer Faire, this show didn't go in much for conferences and speeches; everyone was too busy playing Doom, anyway. It was a good overview of computing in Britain, and I'm glad I went, particularly since it was a fine day and the trip from London to Birmingham runs through some really delightful countryside, clean and green with a canal running alongside the tracks. I also saw signs proclaiming the virtues of Britain's clean nuclear power plants that run the electric railroads. That's something you don't see much of over here.

It's astonishing what they can do with disk storage. Our new Pentium has a DEC hard drive with a gigabyte of storage, 1000 MB, for under $1000. That's impressive, but BSE has more than half that, 520 MB, on their latest Flashdrive. Flashdrives operate from the parallel port. The whole package, including batteries to run it for several hours, is smaller than a cigar box. The new 520-MB model is fast, too, faster than regular hard drives were only a couple of years ago.

Installation is simple: you just add `DEVICE=C:\FLASHDRV.SYS` to your CONFIG.SYS file and copy the file to your root directory. I do have a few warnings. The BSE installation program puts the device statement as the very first thing in your CONFIG.SYS file, and if you're running QEMM.SYS, that will probably lock up your system. If that happens, you can either get out your panic floppy disk or turn off the Flashdrive and reboot; the device won't install if it can't find a valid drive. Then edit CONFIG.SYS to put the FLASHDRV.SYS statement below QEMM.SYS. That done, you can run QEMM's OPTIMIZE command: FLASHDRV.SYS loads high quite well.

The other warning is that if you have an older Flashdrive unit, such as the 120-MB version partitioned into four 30-MB logical drives, be sure to save your old device driver. The new FLASHDRV.SYS is superfast, but it's not backward-compatible with the older drives.

I copied my old FLASHDRV.SYS into a subdirectory called OFLASH and put the statement `DEVICE=C:\OFLASH\FLASHDRV.SYS` into the CONFIG.SYS file. After testing it with the old unit, I remarked both device-driver statements out. When I'm ready to go on a trip, I bring up whichever Flashdrive I'll be carrying and copy



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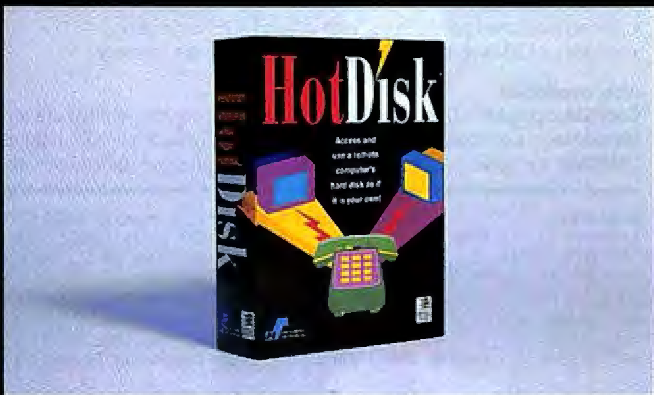
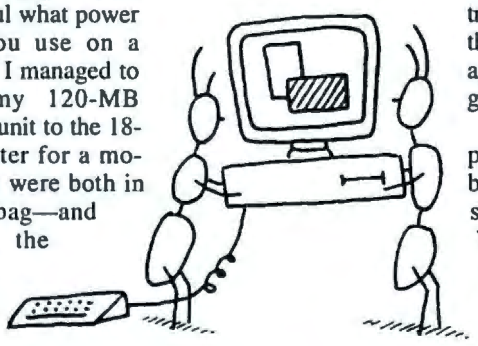


Circle 266 on Inquiry Card (RESELLERS: 267).

all the necessary elements of my work environment onto it. Flashdrives work with all the portables I have, including notebooks; all that's required is that the machine have a parallel port.

The Flashdrive unit has a printer port on it. My 520-MB unit prints only if it's powered by the AC adapter, but I'm told current models will print with just battery power.

Incidentally, you want to be careful what power adapter you use on a Flashdrive. I managed to connect my 120-MB Flashdrive unit to the 18-VAC adapter for a modem—they were both in my travel bag—and blew out the electronics. BSE says that happens several times a year. The fix is a new drive electronics board and a new plastic bottom to the drive case, because the overpower blows a small condenser on the drive board. The drive unit isn't harmed. BSE sent me the repair kit, and it took me about 5 minutes to get it running like new.



BSE drives are a good deal for portables and sneakernets. For that matter, they make great backups. You can even access one across a Windows for Workgroups network, provided that the host machine is set to share it. I'm paranoid enough that when I work on the road, I save it onto a floppy disk as well as the Flashdrive; but I have to say I have never lost a byte saved on a Flashdrive, and I haven't been particularly gentle with mine. Sometimes it travels in my wheeled carryon; other times it gets wrapped up in pajamas and sent in checked luggage. Recommended.

There are times when I hate Windows. For instance: I recently tried to install a new game in my Games group. It wouldn't install, and the error message said that I had insufficient memory; I should shut down some applications and try again. I shut down everything except Program Manager and tried again—and got the same error message.

Some programs don't properly release resources back to Windows when you shut them down, so I closed Windows and reset my machine by turning it off. Then I restarted and brought up Windows. When I went to install my game, I got the same error message. Since there was nothing to shut down, this didn't seem helpful. Of course, it happened on a Sunday night when I couldn't call anyone.

All right, I'm using too much memory, I thought. I have a lot of fonts installed. Let's get rid of some and free up some resources. I went through the font library with fire and sword. If you've ever installed CorelDraw, you'll have an awful lot of fonts you'll probably never use. Some other programs give you oddball things as well. For instance, from somewhere I had two Hebrew letter fonts installed. I figured that if I ever needed them I could reinstall, and eliminated them along with a number of others named for obscure cities like Yakima. Then I exited Windows, reset the machine, came back, and got the same error message when I tried to install my new game.

Eventually I figured it out, although I am not sure what put me on the right track. My Games group has a number of obsolete game icons in it, games that I long ago eliminated. When I eliminated one of those, the "insufficient memory" problem went away.

I had 28 items in the Games group. That, as it happens, is too many. Since we previously discovered that you can't have more than 28 groups, it follows that Windows will allow you to access no more than 784 programs total. This is probably a lot, but still, it is a limit. More worrisome is why the error message is so singularly misleading.

If any of this is documented, I can't find it. Brian Livingston's *Windows Secrets* has three index references to the "insufficient memory" message, and none of them remotely hint that the problem is too many files in one group. I sure wish someone would write a good Windows debugger before Windows drives me totally up the wall.

So if Windows drives you nuts, what about using OS/2, which doesn't have that problem? Well, it has troubles of its own: I recently managed to crash OS/2 to hardware reset level, and all I was doing was editing a reply to some MCI mail in Norton Commander. I didn't do anything weird, either, just went to the end of the message and came back up into the text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to edit; and whambo, Commander locked up, and I couldn't manage to get OS/2 to respond. Eventually there was nothing for it but to turn the machine off. That kind of lockup is pretty rare for OS/2.

It's less rare for Windows, but I use Windows more than OS/2. Most of my Windows crashes seem to be associated with sound cards. As soon as I open an application and get the message that Sound Blaster is in use by another program, I worry. About half the time when that happens, I find I can't shut Windows down properly. Ctrl-Alt-Del will usually shut down broken applications, but not always, as, for instance, a few minutes ago, when I had to use hardware reset to get out of Windows.

The real lesson is that whether you use Windows, OS/2, or just plain DOS, you should save early and often, and back up your work frequently. None of that has changed since CP/M days.

I like Microsoft Word 6.0 for Windows, I really do, but I think it is part of the plot to drive me mad. I'd done quite a lot of work on the sequel to *Legacy of Heorot*—our working title is *Beowulf's Children*—and it was time to let Larry Niven take a pass through it. Ever since Niven and I changed over to Word 6.0 because we like the version-control and document-comparison features, we've had some file transfer problems, so I was very careful. First, I saved our work, about 70,000 words. Then I closed the file and closed Word. Then I used File Manager to copy BEO1.DOC to a floppy disk. I took that floppy disk to Percival the Pentium, copied the file to the appropriate subdirectory, opened Word 6.0 on Percival, and read the file in. No problems, so I sent Niven home with the disk.

An hour later he called me. He was getting an error message that in theory offered him the choice of canceling or ignoring, but choosing ignore did nothing, and choosing cancel informed him that he had a general protection fault in Word 6.0. This was getting in the way of his trying to edit the novel.

"All right," says I. "Turn off your machine. Wait and turn it on. When it's up, do CD NC and then NC to get into Norton Commander. Now, let's go to C:\WINWORD\BEOWULF and tell me what you see."

"I see a file called BEO1.DOC and another called $BEO1.DOC," Larry said.

I told him to select both files and delete them. Then use Commander to copy BEO1.DOC from the floppy disk again. Now enter Windows and see if you can edit it. That worked fine, except Larry said, "This sure doesn't feel much like being an author."

"Well, I can always print it out and let you do rewrites on a typewriter," I said with amiable malice; but he was right. When you're trying to write fiction, you don't want to be thinking about word processors and general protection faults.

I sent E-mail to Chris Peters, Microsoft's Word guru, and worked on something else. It wasn't long before I had an answer from Chris: clearly something is wrong, and while Microsoft works on it, do Tools, Options, select the Save folder, and turn off fast saves. I did that.

Next morning Larry called: he was getting the same problem again. Fortunately, he hadn't done much work on the file, so little was lost, but he was getting pretty upset, which was no wonder. I had him close Word, open it again, and attempt to read in BEO1.DOC. It crashed, so we went through the drill again, starting with turning the machine off and recopying from the floppy disk. "Now," I said, when he was back in Word for Windows again, "Before you read in the file, do Tools, Options, Save, and select 'always create backup copy.' That should exorcise this bug."

"Can we cut off its head, drive a stake through its heart, and bury it at a crossroad?" Larry asked.

"And build a cathedral over the crossroad. Right."

And, in fact, the "always create backup copy" option seems to have done that. We no longer see the file $BEO1.DOC, which I think was causing the problem, and we no longer get disk crashes.

I make no doubt that Microsoft will fix this and get out a new maintenance release, possibly before you read this; but my advice for Word 6.0 users is to select the "always create backup copy" option and leave it on. I find that it doesn't add more than a couple of seconds to the time required to save a whole novel, and since I save at the end of nearly every paragraph—a habit I got into in CP/M days—it sure makes me feel better to know that at worst I'll lose only a few minutes' work. Save early, save often, and make backup copies, that's my motto.

Incidentally, one of the things I like about Word 6.0 is the organization of all those options; if you get Word 6.0, do pull down Tools, select Options, and poke around in all the folders you find. You'll be glad you did.

One thing I found, under general options, was a button that lets me use white-on-blue text. I've always wanted that, and I suspect they put it in just for me. Alas, it works just fine if it's turned on when you're creating a document, but when I select that option and load a new document, I get black-on-blue, which is unreadable. Nice try, though, and maybe they'll get that fixed in the next release, too. Microsoft does work to keep Word in good shape. It's big, but it's fast, and the scaled-down laptop installation version works well enough on my Zenith Mastersport.

In my April Awards column, I said that I wasn't writing about new printers because no one had sent me any. That's subject to misinterpretation, and a reader wrote to say that he was thinking of cobbling up some junky eight-wire dot-matrix printer and sending it to me so that I would write about it. I think I'd better clear this up.

We got several new printers last year, and I should have said that other than the Fargo dual-mode color printer (which I did write about), I hadn't received any printer I felt compelled to write about. I get a lot of stuff here that I never mention. Sometimes it's pretty good stuff, but not so much better than what I'm already using that I feel I just have to replace what I've got. In particular, the Hewlett-Packard LaserJet III I've had for a couple of years now has proved to be plenty good enough for what I do. The only thing I might have replaced it with was the Kyocera Ecosys, and Roberta snarfed that.

You have to remember, I don't do "reviews" as such. I am primarily a writer, which is to say I have about the same computer requirements as many small businesspeople. I write, do spreadsheets, keep databases, and draw illustrations and maps. I need programs and equipment for all that. I also have some interest in and connection to the space program and other high-tech research, so I look at stuff related to that. My wife has spent her life in the education field. I write about what we use, and our interests are broad enough that we work with a lot of equipment and software. We're also chronically behind on our work, and I hold deeply the opinion that if it ain't broke you shouldn't fix it, so I don't lightly change from something that works to something new.

Of course, I like playing with new stuff, and I have an obligation to experiment with enough new hardware and software to fill this column every month, so I do try a lot of new things; some get into this column and some don't. Although the earthquake helped us clear out some space, Chaos Manor is filling up again; so, in general, if I'm not impressed with something, I get rid of it fast, and it's not around when it comes time to write. There's always more worth writing about than I have space for.

So my apologies if I misled anyone. We did get several printers, but none I fancied over the LaserJet III for DOS/Windows and the Apple LaserWriter for the Mac. Niven has a LaserJet 4, which we both like, and if I were to replace my LaserJet III, that's what I'd get.

I think the U.S. Patent Office has gone mad. Their latest outrageous action would be funny if the consequences weren't so serious.

As you may know, PC Dynamics of Westlake Village, California, has a screen saver that pops up the Energizer bunny doing odd things at random times. Niven has it installed on his machine: you'll be working on something, and suddenly there's that silly rabbit parachuting down through your work. PC Dynamics has licensed the bunny image and pays a fee for using it.

Comes now the law firm of Knobbe, Martens, Olson, & Bear demanding money on behalf of Software Advertising of La Costa, California, on the grounds that Software Advertising has a patent that covers any "system which integrates an advertisement into a computer software program without altering the function of the program. Screen-saver programs, which perform their intended function yet display advertisements, are the type of programs covered by the patent," writes attorney Edward J. Treska.

This is bizarre. For instance: Flying Toasters was not originally the advertising logo of Berkeley Systems, so it was all right for them to use it; but now that Berkeley has trademarked Flying Toasters and uses it as a logo, presumably they owe a royalty to Software Advertising.

Moreover, Microsoft's Flying Windows is clearly in violation, and Messrs. Knobbe et al. should write a threatening letter to Bill Gates on behalf of Software Advertising. For that matter, I have a scanned image of the first issue of BYTE in which my column appeared as a regular feature; I use it as wallpaper. Am I in violation of a patent?

The framers of the U.S. Constitution did not like monopolies, because King George III had been in the habit of granting monopolies on such things as trade in salt or matches to his friends. The Constitution thus rejects monopolies, but it does say that Congress shall have the power "To promote the Progress of Science and the useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." Clearly I respect that power, since I make a living because of the copyright law it authorizes. But on the other hand, I copyright only what I have written. I don't seek a patent on the letter *e* or the comma just because no one else has patented it.

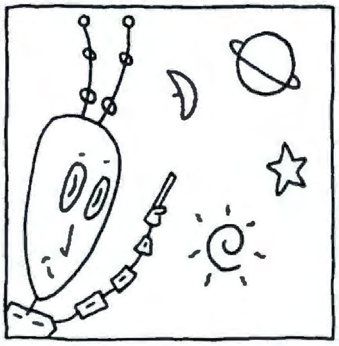
Software Advertising got this patent in 1992; so far, this is the first I've seen of an attempt to enforce it. It probably won't be the last, but I'll bet Software Advertising hasn't gone after Bill Gates, or anyone in a position to stand up to them and tell them what they deserve to hear.

I can't believe that demanding money from the Energizer bunny promotes the Progress of Science and the useful Arts; and I can't think Congress does either.

Photo CD hasn't caught on as well as I would have thought. In my own

case, I take lots of pictures and then can't ever find one when I want it; Photo CD seems like a splendid opportunity to get all my pictures organized and available on file.

Eastman Kodak has two programs, Arrange-It and Create-It, that let you do a lot with the pictures you've stored on a Photo CD. I haven't worked with them enough to give a definite opinion, but they look good to me as a presentation management tool. You can use these programs to create a scripting language for building your own Photo CD for presentations, including multimedia. I used to do lectures illustrated with slides. Now, many lecture halls have screen projection equipment. It would be very useful if I could get "Survival with Style" onto a CD I could then project. More on this another time, but it looks good to me.



The book of the month is Alvin and Heidi Toffler's *War and Anti-War* (Little, Brown, 1993). I recently had dinner with the Tofflers, who are as interesting in person as their books. This is one of their better ones, and I'd have been proud to have written it.

I've also recently discovered a series of novels by Patrick O'Brian. They're British Navy novels set in the Napoleonic era, and if you liked Horatio Hornblower, you'll love Jack Aubrey. It's best if you start with the first one, *Master & Commander* (Norton, 1970). Fair warning, there are 15 books in the series, and once you start, it will be hard to stop.

The first computer book of the month isn't precisely a book, but if you use Windows for Workgroups, you need Microsoft's Windows for Workgroups Resource Kit, which includes a book about resources and a disk of utilities. Microsoft also has a Windows Resource Kit, but I presume you already know that. If you don't, get it if you use Windows.

The first game of the month is for the Macintosh: Spelunx from Broderbund Software. This is another learning experience disguised as a game; it's advertised for ages 6–12, and that seems to be about right. There's a lot to explore. This isn't Myst, but then nothing is.

The PC game of the month is Gametek's Frontier Elite II. It's a space trader game, but if you're of a turn of mind to go fight pirates and shoot people, there's plenty of opportunity for that, too. It features literally thousands of worlds you can explore. Many are inhabited, and some are strange indeed. The graphics aren't as nice as Origen's Wing Commander series, nor is the action as hot, but the planets are more interesting. And how. Want to mine asteroids? Scoop fuel from a gas giant? Here's your chance.

Due to travel and a few minor complications, I didn't get as much done with the Pentium as I'd like. We have a new gigabyte rewritable glass disk for it. I'm also working on getting a PowerPC Mac; I've neglected Macs lately, and I shouldn't. Stay tuned. ■

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

Photo CD seems like a splendid opportunity to get all my pictures organized and available on file. Eastman Kodak also offers two programs, **Arrange-It** ($395) and **Create-It** ($245), that let you do a lot with the pictures you've stored on a Photo CD. Contact **Eastman Kodak Co.**, 343 State St., Rochester, NY 14650, (800) 235-6325 or (716) 724-4000; fax (716) 726-3108. **Circle 1146 on Inquiry Card.**

One of the best electronic-workbench software packages is **Electronics Workbench** ($299) from **Interactive Image Technologies, Ltd.**, 700 King St. W, Suite 815, Toronto, Ontario, Canada M5V 2Y6, (800) 263-5552 or (416) 361-0333; fax (416) 368-5799. **Circle 1147.**

The **Energizer Bunny Screen Saver for Windows** ($29.95) pops up the Energizer bunny doing odd things at random times. Contact **PC Dynamics, Inc.**, 31332 Via Colinas, Suite 102, Westlake Village, CA 91362, (800) 888-1741 or (818) 889-1741; fax (818) 889-1014. **Circle 1148.**

BSE **Flashdrives** (80 to 520 MB; from $399 to $1099) are a good deal for portables and sneakernets. For that matter, they make great backups. I have never lost a byte saved on a Flashdrive, and I haven't been particularly gentle with mine. Recommended. Contact **The BSE Co., Inc.**, 2114 North Fourth St., Flagstaff, AZ 86004, (602) 527-8843; fax (602) 527-1540. **Circle 1149.**

Frontier Elite II ($64.99) is a space trader game that features literally thousands of worlds you can explore. Many are inhabited, and some are strange indeed. Contact **Gametek, Inc.**, 2999 Northeast 191st St., North Miami Beach, FL 33180, (800) 426-3835 or (305) 935-3995; fax (305) 932-8651. **Circle 1150.**

Projects like the global classroom system collect and compare cultural and environmental data from all over the world. You can get information on the **Global Laboratory Project** from **TERC**, 2067 Massachusetts Ave., Cambridge, MA 02140, (617) 547-0430; fax (617) 349-3535. **Circle 1151.**

One of the ICTE sessions was on the use of videoconferencing in the classroom. The demonstration used **hardware compression boards** furnished by **Northern Telecom**, Saint Cloud Way, Maidenhead, Berkshire SL6 8XB, U.K., +44 628 812000; fax +44 628 21787. **Circle 1152.**

I wish every school teacher in the country could attend at least one **International Conference on Technology in Education.** Contact **The University of Texas at Austin**, College of Education, P.O. Box AA, Austin, TX 78713, (512) 471-4080; fax (512) 471-8786. **Circle 1153.**

The Madness of Roland ($59.95) is genuinely fun and is a real-live, no-question-about-it work of art for multimedia. Recommended. Contact **Hyperbole Studios, Inc.**, 1756 114th Ave. SE, Suite 204, Bellevue, WA 98004, (206) 451-7751; fax (206) 451-7844. **Circle 1154.**

Microsoft Word 6.0 for Windows ($495) is big, but it's fast, and the scaled-down laptop installation version works well enough on my Zenith Mastersport. Contact **Microsoft Corp.**, 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1155.**

Myst ($60) is an education disguised as a game. It's almost worth buying a Mac just to have it. **Spelunx** ($35) is another learning experience disguised as a game; it's advertised for ages 6–12, and that seems about right. Contact **Broderbund Software**, 500 Redwood Blvd., Novato, CA 94948, (800) 521-6263 or (415) 382-4400; fax (415) 382-4419. **Circle 1156.**

A good software series to increase vocabulary, **Wordsmart** ($59.95 to $64.95) covers lower grades to college level. Contact **SmartTek Educational Technology, Inc.**, 2223 Avenida De La Playa, La Jolla, CA 92307, (800) 858-9673 or (619) 456-5064; fax (619) 456-3928. **Circle 1157.**

What's New Hardware

STACKABLE ETHERNET SWITCH

The MADswitch stackable Ethernet switch ($2995) is part of Xedia's MADway series of media-access devices designed to increase Ethernet network throughput for clients/servers and workgroups. The unit has an integral expansion slot capable of supporting future network growth via Fat Pipe network cards operating at speeds of up to 155 Mbps. Additionally, the MADswitch has six 10-Mb switched Ethernet ports, each of which has thousands of user addresses, and provides the Spanning Tree protocol, out-of-band monitoring and configuration, and SNMP.

Contact: Xedia, Wilmington, MA, (800) 989-3342 or (508) 658-7200.

Circle 1319 on Inquiry Card.

REAL-TIME DISPLAY SCANNER

A font-independent, gray-scale hand scanner, the RollandRead Personal ($195) displays images in up to 256 shades of gray with selectable 100- to 400-dpi modes. From Recognita Corp. of America (Sunnyvale, CA), the scanner incorporates the company's Go-CR OCR software, which has a recognition speed of 4000 words per minute and 99.9 percent accuracy, according to Recognita. Able to recognize text in 80 languages, the scanner has an 8-KB on-board buffer and advanced rear stabilizers.

Phone: (800) 255-4027 or (408) 241-5772.

Circle 1322 on Inquiry Card.

PRINT ON THE SUNNY SIDE

The SPARCprinter II ($2695), from SunPics (Mountain View, CA), is targeted at networked and client/server workgroups involved with graphics-intensive applications, such as CASE and technical publishing. The SunReady printer has 600- by 600-dpi resolution, 12-page-per-minute production speed, image smoothing, and PostScript compatibility.

Phone: (415) 960-1300.

Circle 1323 on Inquiry Card.

TWO FOR THE FIELD ▼

In a lightweight, sealed, shock-resistant case, the In Lite notebook computer (from $6495) is designed for light-to-heavy industrial or military use. The notebook is configurable with up to two free PCMCIA Type I or Type II slots or one Type III slot, a free full-size AT card slot, and a passive or active color display. Distributed in the U.S. by Promark Technologies (Laurel, MD), the Kontron Elektronik (Eching, Germany) unit has an intelligent security system to protect your data from unauthorized access.

Phone: (800) 634-0255 or (301) 953-1120.

Circle 1325 on Inquiry Card.

The FW7500 portable ($7995) combines light weight with ruggedness and military-specification compliance for on-the-go industrial or military use. From FieldWorks (Eden Prairie, MN), the unit accepts six half-size, three full-size, or a combination of ISA expansion cards. Also featured are an integrated flat-panel mouse/signature pad, up to 64 MB of RAM, a PCMCIA expansion slot that handles Type I through Type IV drives, a dual-scan VGA color display, and an integrated CD-ROM drive option.

Phone: (612) 947-0856.

Circle 1326 on Inquiry Card. ▶

STACKED PCMCIA DRIVE

The latest of MiniStor's (San Jose, CA) More MB Drives, the Model MP260P3 ($499) is a preformatted 130-MB PCMCIA Type III drive with about 260 MB of disk-storage capacity, achieved with the Stacker Anywhere data-compression utility. The nitrogen-filled and sealed drive is supplied with the Pocket Socket transport-safe case that protects against shocks of up to 1200 g's.

Phone: (800) 943-0165 or (408) 943-0165.

Circle 1324 on Inquiry Card.

MAC WORKGROUP FAX SERVER

OneWorld Fax (from $999), from Global Village (Mountain View, CA), integrates hardware and software in a single device that lets you send faxes from your networked Mac. The unit transmits in the background and handles multiple faxes simultaneously, managing a queue and automatically retrying busy numbers as necessary. A menu-bar status display lets you monitor the progress of a transmission, and an audio call-progress feature lets you listen during the fax connection.

Phone: (800) 736-4821 or (415) 390-8200.

Circle 1335 on Inquiry Card.

MODULAR REMOTE ACCESS

For Ethernet and token-ring networks, Shiva's (Burlington, MA) LanRover/Plus (from $4299) is a dedicated, rack-mounted server that has a modular platform. The server allows you to change and upgrade configurations to support high-speed analog and digital communications, such as ISDN and V.fast. Available with integrated V.32bis modems or high-speed asynchronous serial ports, the LanRover/Plus gives remote DOS, Windows, and Unix users secured dial-in access to applications on the LAN.

Phone: (800) 458-3550 or (617) 270-8300.

Circle 1328 on Inquiry Card.

STACK YOUR CD-ROMS ▲

The Alpine Towers (from $1795) contain from four to 16 CD-ROM drives and provide up to 4.2 GB of storage with multiple and simultaneous access. The PCM Technologies (Anaheim, CA) units feature an auto-switching power supply, LEDs that indicate drive activity and power-on status, and software volume control.
Phone: (800) 232-1347 or (714) 961-7000.
Circle 1334 on Inquiry Card.

PCMCIA FAX CARD

The FM-288i ($495) V.Fast 28.8-Kbps data/fax modem from PreMax Electronics (Sunnyvale, CA) provides data-transmission-speed conversions of up to 115.2 Kbps. The Class-1 and Class-2, Group III–compatible PCMCIA Type II card sends and receives fax transmissions at 14.4 Kbps.
Phone: (408) 739-7000.
Circle 1065 on Inquiry Card.

SCSI DISK ARRAYS

Based on wide SCSI-2 drives, the MacinStor SpeedArray NuBus storage systems (from $4045) have 2- or 4-GB capacity. From Storage Dimensions (Milpitas, CA), the desktop digital-video storage systems support full-screen, full-motion capture and playback. The units use the company's fast and wide NuBus DataCannon RISC-based bus-mastering I/O card.
Phone: (408) 954-0710.
Circle 1329 on Inquiry Card.

The QuickArray (from $3610), a SCSI-to-SCSI disk-array subsystem, is available in 1-, 2-, and 4-GB capacities. From PLI (Fremont, CA), the units include the company's QuickSCSI-F card and are compatible with Macs, PowerPCs, and SCSI-equipped PCs.
Phone: (800) 288-8754 or (510) 657-2211.
Circle 1330 on Inquiry Card.

GAIN PERSONAL CONTROL

A personal digital controller, the Xplor-32 ($59.95) is designed for embedded control, limits monitoring, and data logging. The 2.15- by 2.2-inch board includes an 80C32 CPU, an 8-KB EEPROM, a serial port, and a 5-V regulator. From Blue Earth Research (Mankato, MN), the board's 12 digital I/O lines provide connections for interface components such as resistors, capacitors, and transistors.
Phone: (507) 387-4001.
Circle 1062 on Inquiry Card.

NETWORK ADAPTERS

The EtherValue line of network adapters for PCs includes two single-media adapters for 10Base-T and 10Base-2 ($75 each) and a combination adapter ($85). From Alta Research (Deerfield Beach, FL), the units are fully software configurable and support operating systems such as NetWare, the AI version of LANtastic, and Windows for Workgroups. Compatible with the NE2000 driver, the adapters include LEDs for troubleshooting, as well as IRQ and I/O addresses.
Phone: (800) 423-8535 or (305) 428-8535.
Circle 1333 on Inquiry Card.

PENTIUM AND PCI

The Micron P90PCI PowerStation series of Pentium-based systems (from $2999) has a PCI local bus and 64-bit memory architecture that supports up to 192 MB of RAM. Micron Computer's (Nampa, ID) basic system includes 8 MB of RAM, 256 KB of write-back cache (expandable to 512 KB), a 420-MB IDE hard drive, a PCI graphics accelerator with 2 MB of RAM, and a double-speed CD-ROM drive.
Phone: (208) 465-3434.
Circle 1337 on Inquiry Card.

SHARE YOUR MAC MO CARTRIDGE WITH DOS ▲

The external Deltis magneto-optical subsystem for the Mac (from $1195) has a sustained read capability of up to 1.72 MBps with a 230-MB 3½-inch MO cartridge and up to 2.3 MBps with a 1.3-GB 5¼-inch cartridge. From Olympus Image Systems (Irvine, CA), the subsystem implements ISO-standard media that use zoned constant angular velocity. The unit lets you create DOS and Mac partitions, as well as share files across DOS and Mac platforms, on a single cartridge.
Phone: (714) 453-4472.
Circle 1327 on Inquiry Card.

PORTABLE LAN ADAPTER HOPS ACROSS THE FREQUENCY

The RangeLAN2/PCMCIA ($695) operates at distances of up to 500 feet in standard office environments and up to 1000 feet in open spaces. Based on frequency-hopping spread-spectrum technology in the 2.4- to 2.4835-GHz bandwidth, the wireless adapter has a data rate of 1.6 Mbps. The unit's average power output is 100 mW. With the RangeLAN2/PCMCIA, as many as 15 independent wireless LANs can operate within the same physical space.

Contact: Proxim, Mountain View, CA, (415) 960-1630.
Circle 1320 on Inquiry Card.

What's New Hardware

TAKE COMMAND OF YOUR PRESENTATIONS

Controlled by a PC, the VCR Commander Author ($729) and Editor ($595) models let you use your VCR and TV monitor or TV with an RF modulator when you need full-motion video to enhance a presentation or classroom instruction, as well as in TV and video research. With the unit, you can select and play multiple segments of videotape without having to manipulate a VCR's controls or reference its tape counter. You use your computer's mouse to indicate the beginning and end of each segment, and you use the keyboard to type in the segment's title. During the presentation, the VCR Commander automatically locates each selected segment and plays it when you click the mouse.

Contact: QualTech, Great Falls, VA, (800) 757-4472 or (703) 759-4472.

Circle 1321 on Inquiry Card.

DSP BOARDS

Targeted for such uses as high-quality speech processing, digital audio, and multimedia applications, the Eagle-56 DSP board (from $2695) is available in 40- and 66-MHz versions. The card has zero-wait-state SRAM in four banks of 64,000 24-bit words each. Each version of the Momentum Data Systems (Costa Mesa, CA) board has two 16-bit stereo codecs, daughter-card expansion with a fully buffered memory interface, a high-speed parallel host interface, and an on-board user-programmable I/O device. I/O expansion supports external serial I/O devices.

Phone: (714) 557-6884.

Circle 1338 on Inquiry Card.

The Model 310B DSP and data acquisition board (from $900) is based on the TMS320C31 floating-point DSP operating at 40 MHz. The board provides data acquisition for four differential channels at 14-bit resolution with programmable gain and a maximum sampling rate of 300 kHz. Two 12-bit, 250-kHz analog outputs are provided. From Dalanco Spry (Rochester, NY), the Model 310B can be populated with zero- or one-wait-state SRAM ranging in size from 32,000 to 512,000 words.

Phone: (716) 473-3610.

Circle 1339 on Inquiry Card.

ETHERNET PRINT SERVER ▼

A stand-alone pocket-size print server for Ethernet networks, the 4530 E/PS ($395) enables you to simultaneously print from NetWare and LAN Manager/LAN Server to a network printer attached via a parallel port. From Agile (Hercules, CA), the RISC-based unit has a print speed of 1200 Kbps. A software key permits upgrades to EtherTalk and TCP/IP.

Phone: (800) 538-1634 or (510) 724-1600.

Circle 1340 on Inquiry Card.

TRANSFORM YOUR PDA

Comprising a fax modem and expanded memory, the FMM Type II PCMCIA card (from $349) allows you to send binary files and fax messages over the telephone as well as send out your E-mail over the Internet and download messages. While the card is in its sleep mode, its power consumption drops to less than 2 milliamps. You can update the modem operating code on-line and send and receive faxes at 9600 bps. The card is from Smart Modular Technologies (Fremont, CA).

Phone: (510) 623-1231.

Circle 1341 on Inquiry Card.

PRINT HIGH-QUALITY LABELS

CoStar's (Greenwich, CT) LabelWriter XL and XL Plus label printers (from $249.95) feature built-in network support and a 203-dpi thermal print head to produce laser-quality output. Both can handle a large range of label sizes and have an AppleTalk option.

Phone: (203) 661-9700.

Circle 1343 on Inquiry Card.

INTERFACE ADAPTER

The Internal PCMCIA Interface Adapter ($295) from Quatech (Akron, OH) supports all Type I, II, and III memory and I/O cards, including modems and LAN cards. The adapter comes with CardSoft card and socket services and the CardView Windows-based PC card manager program.

Phone: (216) 434-3154.

Circle 1061 on Inquiry Card.

OS/2 STORAGE ▼

A portable parallel-port hard disk for OS/2 systems, the BSE Flashdrive 25 (from $499.95) is based on BSE's (Flagstaff, AZ) 16-bit parallel-port IDE controller and a 2½-inch hard disk. The 120- to 500-MB Flashdrive 25 weighs less than 1½ pounds and includes an AC adapter/charger.

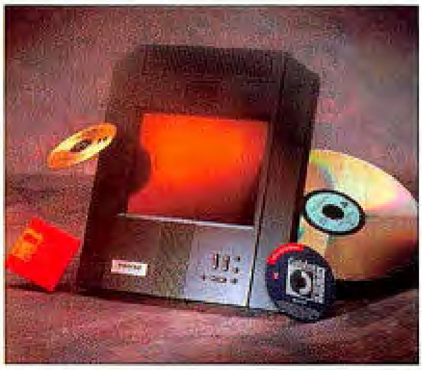
Phone: (602) 527-8843.

Circle 1345 on Inquiry Card.

BABY PC AT MOTHERBOARDS

The 60-MHz Bison II Pentium motherboard ($1295) comes with 512 KB of cache memory and four banks of 72-pin SIMMs, and it supports 64 MB of on-board RAM. From Ocean Information Systems (Covina, CA), the Bison II motherboard has seven ISA-bus slots with two VL-Bus extensions.
Phone: (800) 325-2496 or (818) 339-8888.
Circle 1063 on Inquiry Card.

Lion Computers' (Milpitas, CA) Nice Green 486/PCI motherboard ($419) uses the PCI bus to support up to four video, network, multimedia, and hard disk throughput cards. The board provides five 16-bit ISA slots and up to 128 MB of RAM, and it supports up to 512 KB of secondary cache memory.
Phone: (408) 943-1100.
Circle 1064 on Inquiry Card.



A WORKGROUP PANEL ▲

The $13,999 PowerView 950 active-matrix LCD projection panel from In Focus (Tualatin, OR) has a 10.4-inch-diagonal screen and can project more than 1.4 million colors simultaneously at a 1024- by 768-pixel resolution. Optional built-in video compatibility ($1000) in the PC-, Mac-, and workstation-compatible, 6-pound unit supports NTSC, PAL, and SECAM video standards.
Phone: (800) 294-6400 or (503) 692-4968.
Circle 1060 on Inquiry Card.

PORTABLE MULTIMEDIA

The CardStation ProMedia ($1295) combines a double-speed CD-ROM drive with the ability to record and play back 16-bit sound, so you can add MPC Level 2–compliant sound and CD-ROM capabilities to your Type II PCMCIA–based notebook. The 6-pound unit includes a two-third-length ISA expansion slot that will accept an Axonix NTSC video, Ethernet LAN, or modem card.
Contact: Axonix, Salt Lake City, UT, (800) 866-9797 or (801) 466-9797.
Circle 1342 on Inquiry Card.

WIRELESS ETHERNET ADAPTER

A battery-powered wireless Ethernet adapter, AirLAN/Parallel ($699) attaches to any parallel port to provide seamless compatibility between wired and wireless networks. From Solectek (San Diego, CA), the adapter has an operating range of up to 50,000 square feet in an office and up to 800 feet in an open area. Rechargeable batteries provide up to 10 hours of operation.
Phone: (800) 437-1518 or (619) 450-1220.
Circle 1336 on Inquiry Card.

REMOTE SCSI CONTROL ▼

The SCSI Switch Model ACI-2014 (from $1295) provides local and remote switching of multiple SCSI computer and peripheral buses. From Applied Concepts (Wilsonville, OR), the switch supports standard 8- and 16-bit SCSI devices on six independent SCSI buses, which you can electronically connect and exchange. Windows, Mac, and Unix software supplied with the unit lets you control selection via a serial port.
Phone: (503) 685-9300.
Circle 1331 on Inquiry Card.

HIGH-CAPACITY DRIVES

The internal SI4303 ($6149) and external MD4303 ($6249) SCSI-2 hard drives offer 4.3 GB of formatted capacity with an average access time of 8 ms. From Procom Technology (Irvine, CA), the drives are available for PCs, PS/2s, the Macintosh, and the PowerPC.
Phone: (714) 852-1000.
Circle 1066 on Inquiry Card.

INSTANT REFERENCE ►

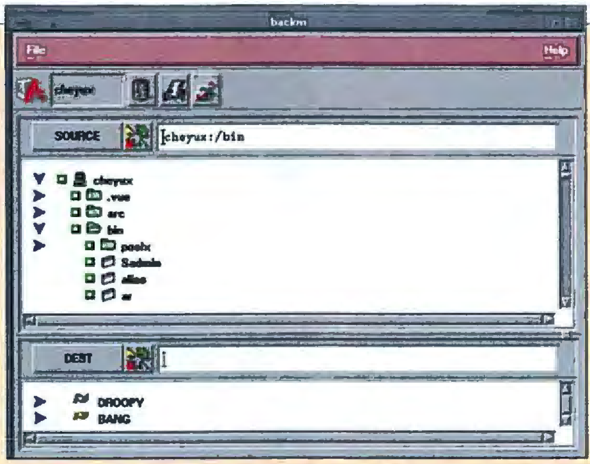
The F-1 ($22.95), a quick-flip organizer and reference pad, mounts on either side of your computer monitor to let you quickly retrieve often-used information. From Husco Engineering (Wilton, CT), the device has 48 snap-out pages and 12 tabbed separators.
Phone: (800) 752-3181 or (203) 762-3181.
Circle 1344 on Inquiry Card.

VOICE-INTERACTIVE MODEM

An internal voice-interactive data/fax modem, the 9624VF ($199) combines a 9600-bps send/receive fax modem with a 2400-bps data modem with voice recognition. From Cal Com Products (Placentia, CA), the modem distinguishes between incoming faxes and voice messages and provides group faxing.
Phone: (714) 961-1888.
Circle 1067 on Inquiry Card.

What's New Software

UNIX DATA MANAGEMENT



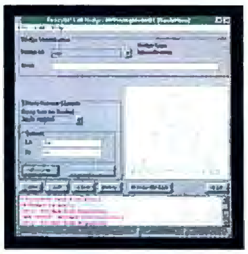
Part of a new family of advanced network backup and data management software for Unix, ARCserve/Open 2.0 for the HP-UX platform has a Motif interface with pull-down menus and graphical icons. ARCserve/Open ($1995 for up to 16 clients) includes a parallel streaming feature that enables it to simultaneously back up and restore data to and from several devices concurrently. System management features include AutoPilot, which intelligently rotates tapes, and Disk Grooming, which migrates dormant files from the server to tape to free up disk space. Compatible backup devices include 4- and 8-mm, QIC, and DLT SCSI tapes and changers.

Contact: Cheyenne Software, Roslyn Heights, NY, (516) 484-5110.

Circle 1271 on Inquiry Card.

FUZZY LOGIC FOR BUSINESS ▼

FuzzySP ($2995) from NeuralWare (Pittsburgh, PA) is an array of tools for building fuzzy information systems that provide solutions in the transportation, financial services, insurance, managed health care, biotechnology, marketing, and medical services industries. Its advanced decision-support capability helps you address critical issues in areas such as risk assessment, market share and sales analysis, portfolio mix optimization, and asset and resource allocation.



Phone: (412) 787-8222.

Circle 1275 on Inquiry Card.

ACCESS THE INTERNET VIA WINDOWS

MKS Internet Anywhere ($149) has a Windows interface to all components for easy access to the Internet through Usenet news and mail. From Mortice Kern Systems (Waterloo, Ontario, Canada), MKS Internet Anywhere provides network news capabilities that give you a forum for discussion and information on any subject. You can also send and receive mail between UUCP sites.

Phone: (519) 884-2251.

Circle 1276 on Inquiry Card.

WORK IN YOUR OWN STUDIO

MediaStudio ($299) gives you the ability to capture video, audio, and still images from external sources such as camcorders, VCRs, laserdiscs, scanners, and Photo CDs. After you have captured the images, you can touch up individual frames, edit an image, add text, and morph images or video frames. From Ulead Systems (Torrance, CA), MediaStudio also helps you create and edit the sound track for a production.

Phone: (310) 523-9393.

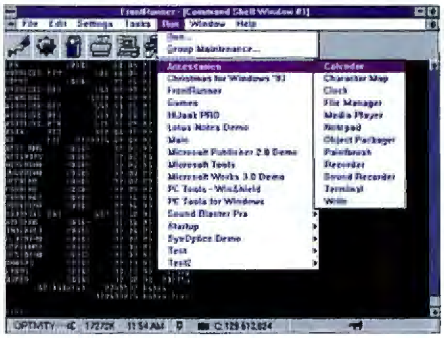
Circle 1277 on Inquiry Card.

AN INTERNET MOSAIC

An Internet application that displays information located on the World Wide Web in hypertext format, NCSA Mosaic (from $149) provides a single interface to the disparate services and databases on the Internet. You can use the Spry (Seattle, WA) application to search for and browse through documents, retrieve information, and locate resources. NCSA Mosaic runs over any TCP/IP transport.

Phone: (800) 777-9638 or (206) 447-0300.

Circle 1279 on Inquiry Card.



INTEGRATE DOS AND WINDOWS ▲

A Windows desktop that brings Windows features to your DOS shell and an improved DOS box to Windows, FrontRunner ($139) from Phar Lap (Cambridge, MA) lets you run Windows programs directly from the DOS prompt. You can scroll and view your entire DOS screen history and copy, paste, and print any part of your DOS session. As an alternative to Program Manager, FrontRunner lets you run programs from a customizable Launch Bar or from a run menu.

Phone: (617) 661-1510.

Circle 1281 on Inquiry Card.

END INCOMPATIBILITIES FOR VB APPLICATIONS

VersionStamper-VB ($129) from Desaware (San Jose, CA) lets you embed version information into a Visual Basic–based executable not only for the executable but also for all the DLLs and custom controls used by that executable. You can then instantly detect the presence of incompatible DLLs or VBXes on the target system.

Phone: (408) 377-4770.

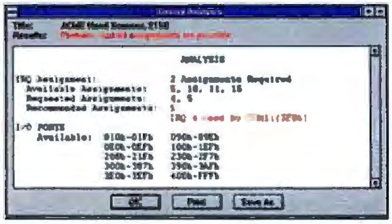
Circle 1280 on Inquiry Card.

THIS UTILITY HAS THE ANSWERS ▼

Setup Advisor ($29.95) helps you find existing configuration problems and be confident that the needed IRQs, DMA channels, I/O ports, and RAM and ROM addresses are available on your PC before you purchase or install a new device. The TouchStone Software (Huntington Beach, CA) utility uses the company's CheckIt Pro technology to collect the information and make hardware-setup recommendations for upgrades.

Phone: (800) 531-0450 or (714) 969-7746.

Circle 1282 on Inquiry Card.

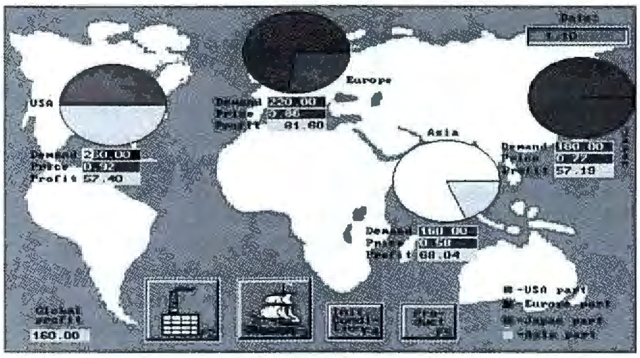


FINISH YOUR PHOTOS IN WINDOWS

Picture Window ($199) from Digital Light & Color (Cambridge, MA) combines advanced image-editing software with a digital print service to produce professional-quality prints overnight. The system handles Photo CD images and works with conventional 35mm color slide or negative film as well as black-and-white film. It can also process images created with digital cameras.
Phone: (617) 497-9027.
Circle 1283 on Inquiry Card.

A PIM WITH AN ADVANTAGE

More than a personal organizer, Polaris Advantage ($149) enables you to exchange data with your Windows applications as well as manage your addresses, phone numbers, meetings, appointments, and to-do lists. From Polaris Software (San Diego, CA), Polaris Advantage can also track and launch Windows and DOS files, including graphics.
Phone: (619) 592-7400.
Circle 1284 on Inquiry Card.



AUTOMATED MODELING ▲

Software that automates mathematical modeling and decision support, GMS 2.0 ($499) from Probots (Northampton, MA) automatically designs the sequence in which a model computes equations. Using technology developed by the Russian Academy of Science, GMS sets up a bidirectional computational network that lets you build a simulation that can run forward and backward through time without requiring you to change the model.
Phone: (413) 586-8929.
Circle 1287 on Inquiry Card.

3-D SITE DESIGN

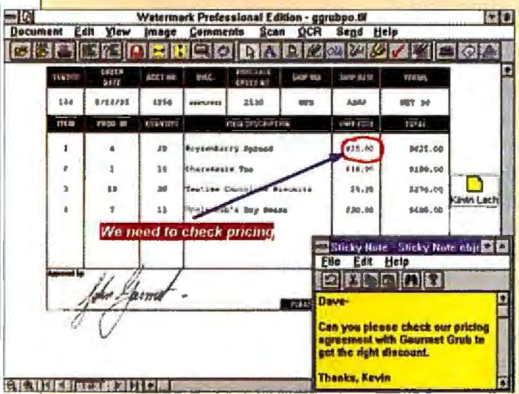
A stand-alone Windows CAD program, Site Designer ($795) addresses the land-planning needs of landscape architects, nurseries, contractors, and site designers and builders. The LandCADD International (Englewood, CO) package includes 3-D functionality with rendering capabilities and permits a bidirectional migration path to the company's AutoCAD-based products.
Phone: (303) 799-3600.
Circle 1285 on Inquiry Card.

DEVELOP A WINDOWS ENVIRONMENT

SingleStep++ (from $1700) is an integrated package of program-building, code-generation, debugging, and analysis tools that provide push-button and Windows control over a number of development tasks. From Software Development Systems (Oak Brook, IL), the package features full source-level simulation, access to all program objects, integration with a true C++ compiler, and support for background-mode debugging with 68300-family processors.
Phone: (708) 368-0400.
Circle 1286 on Inquiry Card.

IMAGING IN WINDOWS NT

Based on Windows NT, the Watermark Professional Edition and Image Server enable you to incorporate faxed or scanned paper documents into enterprise-wide client/server applications developed with products such as Notes, Visual Basic, and PowerBuilder. With the Professional Edition, which is integrated with Expervision OCR and supports OLE 2.0, you can mail an image directly from within Watermark using MAPI or VIM. The Image Server uses SQL Server, multithreading, and symmetrical multiprocessing to provide levels of throughput and performance that are normally found on large systems, according to the company. The price of the Professional Edition starts at $295 for one user and costs $1395 for five users; the Image Server starts at $2995 for up to 25 users.



Contact: Watermark Software, Burlington, MA, (617) 229-2600.
Circle 1272 on Inquiry Card.

Software Update

SQA TeamTest 3.0, Software Quality Automation (Woburn, MA), integrates with Gupta's SQLWindows through an API provided by Gupta. The API allows automated test procedures created in SQA TeamTest to directly communicate with SQLWindows GUI objects. $2495.
Phone: (617) 932-0110.
Circle 1303 on Inquiry Card.

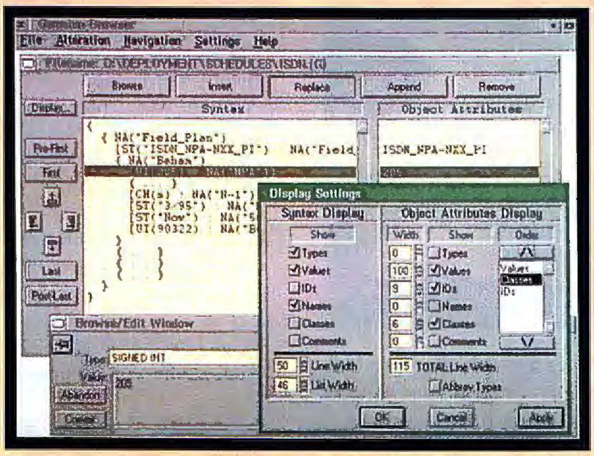
CommLib 5.0, Greenleaf Software (Dallas, TX), extends asynchronous communications programming for C to 32 bits, expands Windows features with two language-independent DLLs and message notification for communications events, and adds CompuServe B+ as a supported file transfer protocol. From $359.
Phone: (800) 523-9830 or (214) 248-2561.
Circle 1304 on Inquiry Card.

Easydlj 8.3, Geocomp (Golden, CO), now operates on NetWare, LANtastic, and One Man Lan; offers multiple configuration files; saves raw, planimetered coordinates into a DPT file; and has command-line direction into any menu routine of the program. $390.
Phone: (303) 233-1250.
Circle 1305 on Inquiry Card.

Wind/U 2.0, Bristol Technology (Ridgefield, CT), adds support for Microsoft's Win32s API, the 32-bit edition of the Visual C++ development system for Windows and NT, a color palette, and a Color Common dialog box; it also adds Xprinter 2.2 and Wind/U Spy. $9950.

Phone: (203) 438-6969.
Circle 1306 on Inquiry Card.

What's New Software



PROGRAM DATA AS OBJECTS

An object-based programming tool, the Gamelon file access library lets you store program data as objects. Available now for OS/2 ($495) and Windows ($395) and soon for Windows NT ($495), Gamelon allows multidimensional file structures via object nesting. Logical navigation and automatic object tracking permit object-based file access, self-documentation of files, and increased portability of file access code across platforms. You can create elementary data objects as well as aggregate objects. The Gamelon library helps you model and preserve data in objects and write file access code that looks similar from one program to another.

Contact: Menai, Menlo Park, CA, (415) 853-6450.

Circle 1273 on Inquiry Card.

DOCUMENT MANAGEMENT CHOICES

Windows-based information and document management software, Island InText ($395) from Island Software (San Rafael, CA) enables you to retrieve, analyze, and publish your Word, WordPerfect, and Ami Pro documents. The software package automatically sorts and categorizes documents, conducts natural-language and structured searches, and has a heuristic/learning architecture. A Unix version is planned for release later this year.

Phone: (800) 255-4499 or (415) 491-1000.

Circle 1288 on Inquiry Card.

The Chaos document management system (single user, $195), which combines Microsoft Access and Word, provides text searching, version tracking, document archiving, access control, and a full range of document-retrieval and reporting functions. The software package is from Compendium Research (Philomath, OR).

Phone: (503) 929-2776.

Circle 1289 on Inquiry Card.

DIAGRAM YOUR INFORMATION

CorelFlow ($99), a business graphics application for Windows, lets you organize information into diagrams and flowcharts by dragging predrawn shapes onto a page and connecting the shapes with lines and curves. From Corel (Ottawa, Ontario, Canada), the OLE 2.0–compatible software includes the Corel Gallery clip-art library and visual clip-art manager.

Phone: (613) 728-8200.

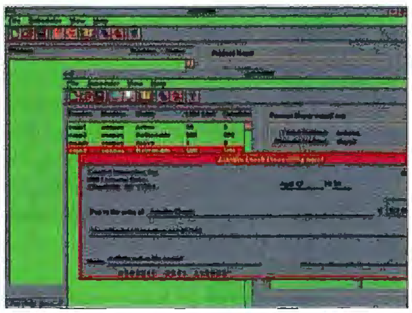
Circle 1291 on Inquiry Card.

NETWORK SCHEDULER ▼

The AshWin Windows-based scheduler (from $249) lets a network manager schedule and execute a variety of tasks using processing power from any workstation on the network. From Creative Interaction (Chapel Hill, NC), AshWin is available for Windows 3.1 and NT; the package supports TCP/IP, NetWare IPX/SPX, OLE 2.0, and ODBC.

Phone: (800) 545-2442 or (919) 489-6300.

Circle 1296 on Inquiry Card.



FAST 3-D GRAPHICS

For use with Windows, addDepth ($149) lets you quickly create original 3-D text and objects or create them from imported clip art and illustrations. From Ray Dream (Mountain View, CA), addDepth lets you fine-tune your artwork, view it from any angle, and import and export graphics to and from leading Windows graphics applications. The software is compatible with addDepth for the Macintosh.

Phone: (800) 846-0111 or (415) 960-0768.

Circle 1294 on Inquiry Card.

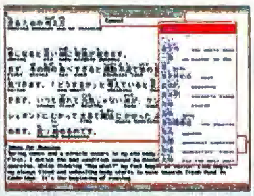
Software Update

INposition 1.5, DK&A (San Diego, CA), includes PostScript and EPS filters; enhances the offset tool to include EPS; has built in the capability to bring in multiple documents in one step; adds support for pin-register systems; and adds offset, scale, and rotation adjustments to multiple and single pages in reader and printer spreads. $1895.

Phone: (800) 598-8118 or (619) 488-8118.

Circle 1307 on Inquiry Card.

Smart Characters for Students 2.9, Apropos (Arlington, MA), removes copy protection, lets you edit in up to seven documents in Windows, supports additional printers, includes fractional point sizes, extends allowable dictionary searches, and provides transparent conversion between the Asian bopomofo and pinyin pronunciations so that you can use them interchangeably. $99.95.



Phone: (800) 676-4021 or (617) 648-2041.

Circle 1308 on Inquiry Card.

Enfin 4.0, Easel (Burlington, MA), provides a new development workspace with icons organized by functional group and color-coded; includes a Main Desktop Apprentice feature, a SQL Editor, and connectivity features; and adds a generic EHLAPPI interface. Windows version, from $3995; OS/2 version, from $5995.

Phone: (617) 221-2100.

Circle 1312 on Inquiry Card.

SCIENTIFIC IMAGE PROCESSING

An extensible image-processing system, Easy Image lets you rapidly display, enhance, manipulate, and analyze images using Windows. The $595 program has a Rectification feature to align images so that North is at the top of the screen; this feature also transforms image coordinates to remove distortion. Histogram Equalization enhances low-contrast images, Classification (also known as thematic mapping) extracts information from remotely sensed data, and False Color lets you assign a color to a gray-scale value. A Statistics feature provides instant statistics for an image, an area of an image, or a transect through an image.

Contact: PenMetrics, Corvallis, OR, (800) 537-3322 or (503) 757-3076.

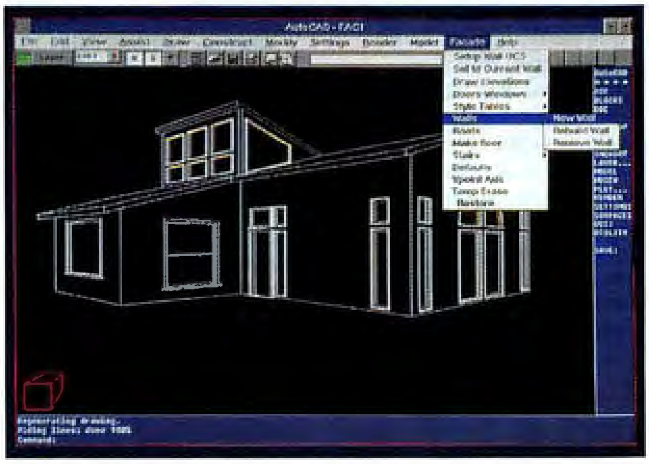
Circle 1274 on Inquiry Card.

BUILD 3-D MODELS IN 2-D ▼

Facade 2.0 ($189) from Eclipse Software (Bellingham, WA) is a face-based 3-D building modeler for AutoCAD release 12. With Facade, you can construct 3-D buildings while working in only two dimensions; Facade automatically converts the images into finished 3-D models.

Phone: (206) 676-6175.

Circle 1298 on Inquiry Card.



OLE FOR UNIX

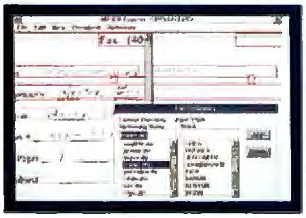
Application-to-application linking and embedding are available with Affinity ($7500) from Software Pundits (Burlington, MA). The Unix package includes the Affinity client and server library, daemon, and Network Manager; the OLE API and specifications; the Presentation Format Adapter, which includes support for metafiles and bit maps; and communications adapters for Tooltalk and TCP/IP.

Phone: (617) 229-6655.

Circle 1299 on Inquiry Card.

DOCUMENT ROUTER ▼

A Windows utility, N'Route ($1995) automatically routes scanned images or incoming faxes on E-mail systems such as Notes, cc:Mail, and Microsoft Mail. From Nestor (Providence, RI), N'Route finds and identifies a handwritten or machine-printed recipient name in a document that has been dropped into a scanner or fax batch. The document image is then attached to a mail message and delivered to the recipient via the mail system.



Phone: (401) 331-9640.

Circle 1295 on Inquiry Card.

MAPS ON CD-ROM

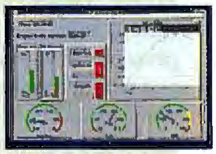
The six-cartridge Base Map CD-ROM ($1500) contains maps of the entire continental U.S. The more than 50,000 maps, which are in AutoCAD DWG format, provide street-level detail, showing roads, rivers, lakes, streams, railroads, pipelines, transmission lines, and airports. The CD-ROM set is from Micro Map & CAD (Lakewood, CO).

Phone: (303) 988-4940.

Circle 1302 on Inquiry Card.

Software Update

Visual Designer 2.0, Intelligent Instrumentation (Tucson, AZ), adds 14 function blocks, including Serial Communications, DDE Client, X/Y Plot, Load, Audio Annunciator, and Random Noise; supports analog data capture at a rate of up to 10 MHz with 12-bit resolution and up to 500 kHz with 16-bit resolution; and adds display-control capabilities that let you control which displays appear on the Run screen. $595 until July 31; $995 thereafter.



Phone: (800) 685-9911 or (602) 573-0887.

Circle 1309 on Inquiry Card.

DynaZIP Data Compression Toolkit for Microsoft Windows 2.0, Inner Media (Hollis, NH), adds multiple-disk support with automated disk wiping/formatting, data encryption/decryption with user-defined passwords, creation of easy-to-use Windows-hosted self-extracting ZIP files, improved speed and smaller DLL sizes, and cancelable operations. $249.

Phone: (603) 465-3216.

Circle 1310 on Inquiry Card.

TeleFinder 3.3, Spider Island Software (Irvine, CA), adds support for the Macintosh PowerPC running in native mode using System 7.1.2. $425.

Phone: (714) 669-9260.

Circle 1311 on Inquiry Card.

ProdeaSynergy 2.0, Prodea Software (Eden Prairie, MN), adds OLE 2.0 support, enhanced process logic, and a LAN version. Single-user license, $495.

Phone: (612) 942-1000.

Circle 1314 on Inquiry Card.

What's New Software

TRACK TIME AND EXPENSES ON THE MESSAGEPAD

A business application for the Apple Newton MessagePad, the Iambic TimeReporter ($129) records and reports time and expenses for billing purposes. Since you record time on-the-fly, you don't spend hours on time-sheet input, and you can instantly resummon information by code number, first word, or lists of current clients. The package is from Iambic Software (Sunnyvale, CA).
Phone: (408) 746-3709.
Circle 1297 on Inquiry Card.

MPEG COMPRESSION FOR WINDOWS

MPEG-I-compliant, XingCD ($995) produces MPEG video streams from TGA, AVI, or BMP formats. The software transcodes full-motion video captured by motion JPEG cards with AVI output, 3-D animation files, and rendered video. From Xing Technology (Arroyo Grande, CA), the software's CD-quality MPEG audio compression produces a single interleaved audio/video stream that supports CD-ROM data rates of 150 KBps. XingCD supports full I, B, and P frames with user-selectable distribution of frame types.
Phone: (800) 294-6448 or (805) 473-0145.
Circle 1300 on Inquiry Card.

HELP YOURSELF TO A WINDOWS TOOL

Help Yourself ($299) is a fully integrated authoring tool for developing Windows help files for programs and on-line information systems based in Windows Help. The SoftLogic Solutions (Manchester, NH) tool features a WYSIWYG editor, help compiler, spelling checker, thesaurus, and project manager.
Phone: (603) 627-9900.
Circle 1301 on Inquiry Card.

SIMULATE MOVING OBJECTS

A set of simulations for courses dealing with the physics of moving objects, Objects in Motion ($84.95) lets you create and run computerized experiments that help students learn about the subject being studied. From Physics Academic Software (North Carolina State University, Raleigh, NC), the interactive PC or Mac software covers such topics as kinematics, rotational motion, projectiles, and relative motion.
Phone: (919) 515-2524.
Circle 1278 on Inquiry Card.

DEVELOPMENT KIT

The Saber LAN Workstation Software Developer's Kit ($495) lets software developers integrate applications into the Saber LAN Workstation Console Windows-based application. From Saber Software (Dallas, TX), the kit provides the APIs and documentation necessary for developers to complete the integration.
Phone: (800) 338-8754 or (214) 361-8086.
Circle 1290 on Inquiry Card.

NETWORK CHEMISTRY

Network versions of ChemWindow and ChemIntosh ($599 each) chemistry-drawing software permit unlimited access over a network and the ability to download the software to local hard drives. The products are from SoftShell International (Grand Junction, CO).
Phone: (303) 242-7502.
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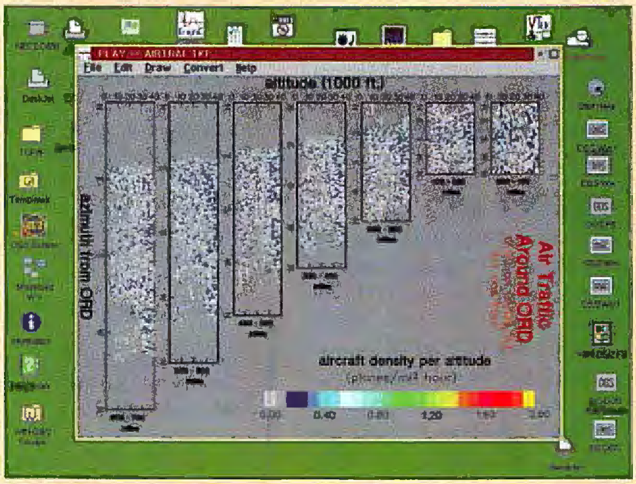
GRAPHICS LIBRARY FOR OS/2



GraphiC 7.0 ($495), now available for OS/2, is a true multithreaded, 32-bit Presentation Manager application that lets you create visualizations of your scientific or engineering data in all environments. New features in the software include 3-D filled contour plots, patch plots, staircase plots, angled string labels, box and whiskers plots, and support for PostScript Level 2.

Contact: Scientific Endeavors, Kingston, TN, (800) 998-1571 or (615) 376-4146.
Circle 1293 on Inquiry Card.

Software Update

Milestones, Etc., 4.0, Kidasa Software (Austin, TX), adds support for OLE 2.0 and MDI and includes basic drawing tools, Drag & Drop, custom import, an additional level of time detail, and Print All, which lets you print all open schedules. $149.95.
Phone: (512) 328-0167.
Circle 1313 on Inquiry Card.

Energize 3.0, Lucid (Menlo Park, CA), adds major performance improvements and a shared-database feature that lets developers work on a subset of a project without having to manage the entire project within their workspace. $4250 for one unit.
Phone: (415) 329-8400.
Circle 1315 on Inquiry Card.

VisionPoint 8.0, SBT Accounting Systems (Sausalito, CA), upgrades all 16 modules with ReadyView technology, which includes file browsers, the SBT Business Status Report, and instant inquiries. $295 per module.
Phone: (800) 944-1000 or (415) 331-9900.
Circle 1316 on Inquiry Card.

FastTrax 5.0, FastTrax International (Berkeley, CA), adds directory sorting, surface testing, and free-space creation functions. $70.
Phone: (510) 525-3510.
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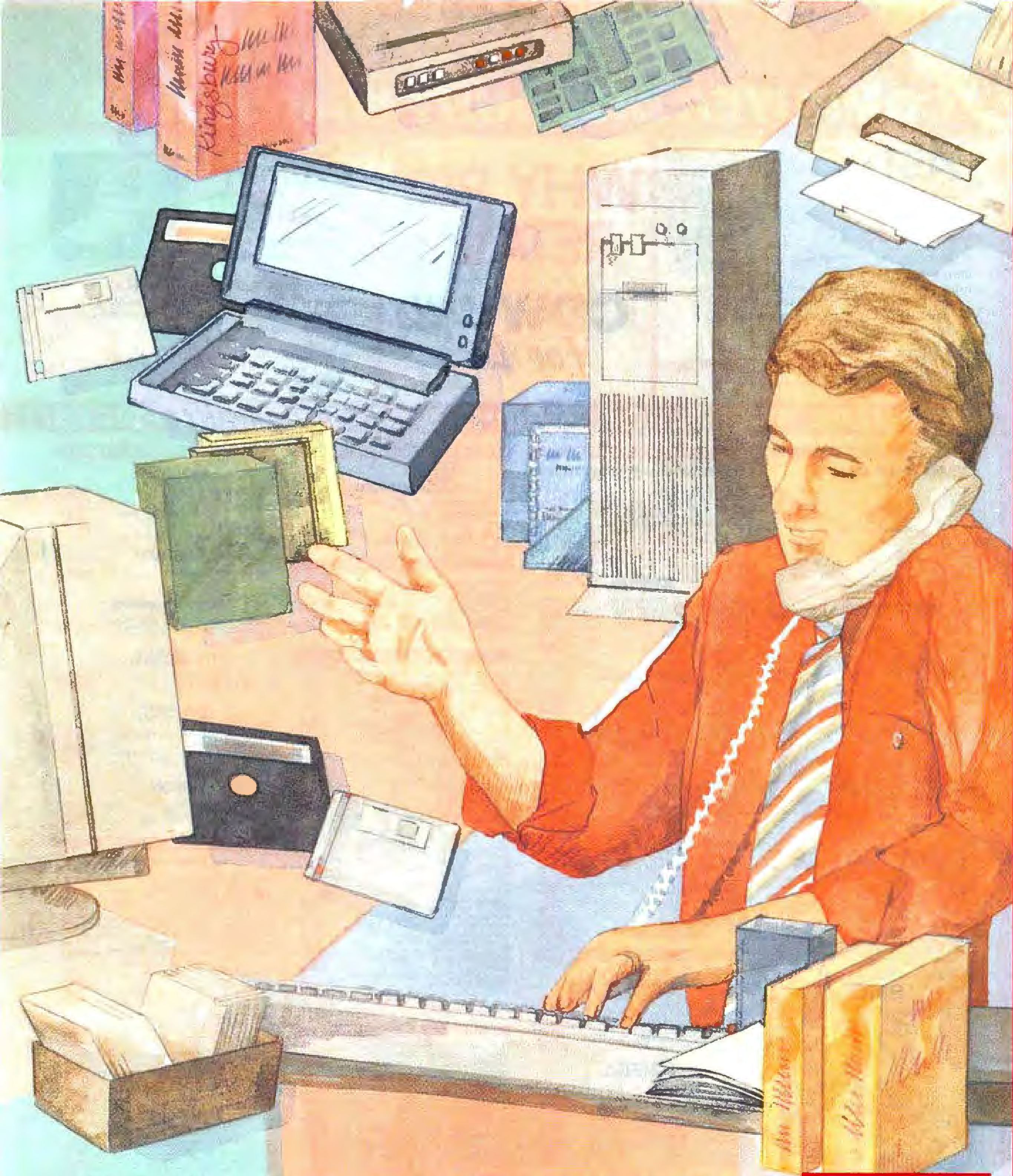
WordScan Plus 3.0, Calera Recognition Systems (Sunnyvale, CA), includes the Chameleon Toolbar and support for OLE 2.0 and Hewlett-Packard's AccuPage 2.0. $595.
Phone: (408) 720-8300.
Circle 1318 on Inquiry Card.



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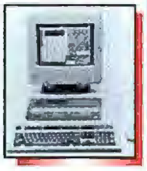

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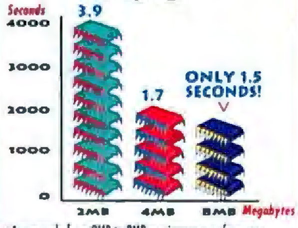

- An upgrade from 2MB to 8MB can increase performance
- Memory allows Windows to run faster
- Reduces your system's need to access the hard disk
- Speeds up programs which use virtual memory
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The graph displays the amount of time it takes to run one specific Windows application with the indicated amount of memory.

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	16MB	N/A	$648
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4010 RISC/6000 (16MB) $768, 4033 (32MB) $1598, 4036 (64MB) $3298

IBM Laptop Memory

MODEL	MEMORY	PART#	PRICE
Thinkpad 300, Ambra Treka	2MB	33G9288	$128
	8MB	33G9289	$409
Thinkpad 350, 350C	8MB	6060378	$358
	16MB	6060379	$668
Thinkpad 500	4MB	53G6959	$228
	8MB	53G6960	$449
CL57SX	4MB	07G1420	$188
Thinkpad 700, 700C, 720, 720C	8MB	07G1421	$318
	16MB		$998
Thinkpad 710T, 750, 750C	4MB	N/A	$188
	8MB	N/A	$318
PS/Note N45SL	2MB	92F8804	$108
PS/2 Model N51, Notebook SLC, SX	2MB	07G1826	$98
	4MB	07G1827	$188
	8MB	07G1828	$418
Laptop N33SX, L40SX & PSNOTE 182	2MB	79F0999	$98
	4MB	79F1000	$184
L40SX, PSNOTE 182 ONLY	8MB	79F1001	$348

In Touch with Tomorrow TOSHIBA Laptop & Notebook Memory

MODEL	MEMORY	PART#	PRICE
T1000	1MB	PA8311 4	$29
T1000SE/LE/XE	2MB	PA8312U	$73
T2000/T2000SX	2MB	PA8317U	$93
T2000SX/T1000LE	4MB	PA8314U	$188
	8MB	PA8315U	$368
T1200XE	2MB	PA8306U	$98
T1600	2MB	PA8302U	$98
T2000SXE/T2200SX/T1800			
T1850,C	2MB	PA2000U	$94
	4MB	PA2001U	$188
	8MB	PA2002U	$368
T3100	2MB	PA7135E	$138
T3100E	2MB	PA8341U	$118
T3100SX	2MB	PA8308U	$108
	4MB	PA8310U	$204
T3200SX	2MB	PA8307U	$118
	4MB	PA8309U	$214
T3200SXC	2MB	PA8318U	$108
	4MB	PA8319U	$204
T3200	3MB	PA7137U	$186
T3300SL	2MB	PA2006U	$118
	4MB	PA2007U	$238
	6MB	PA2008U	$258
	16MB	PA2009U	$698
T3400CT	4MB	PA2019V	$238
	8MB	PA2020V	$458
	16MB	PA2021V	$878
T4400SX, SXC, T6400SXC, DXC	2MB	PA2003U	$125
	4MB	PA2004U	$198
	8MB	PA2005U	$378
	16MB	PA2010U	$698
	32MB		$1999
T4500, T4600, T1900C 3.3VOLTS	4MB	PA2012U	$208
	8MB	PA2013U	$418
	16MB	PA2014U	$868
T5100	2MB	PA8301U	$94
T5200/T5200C/T8500	2MB	PA8304U	$109
	8MB	PA8313U	$418

AST Memory

MODEL	MEMORY	PART#	PRICE
PREMMIA	4MB	501159001	$168
	8MB	501159002	$348
	16MB	501159003	$734
ADVANTAGE 386SX/20,25, PRO SX/25 BRAVO 3/33'S	2MB	500962001	$88
	8MB	500962002	$348
BRAVO NB486	4MB		$198
	16MB		$798
ADVANTAGE PRO 486DX/33 SX/25, BRAVO LC 4/25S, 33, 335, 500, 4/66D	2MB	500987001	$88
	4MB	500987002	$178
PREMIUM 386/25, 33, 33 II 386SX/16 20 25	1MB	500780003	$48
	1MB	500780002	$48
ADVANTAGE 486/25, 33 33P SX20, BRAVO 4/33 486/25 PREMIUM 4/25, 33TE SE 4/33	2MB	500718004	$84
	2MB	500780005	$84
ADVANTAGE 486/25,33,33P,SX20, POWER PREMIUM 3/33 4.33, 335, 500, 660 PREMIUM 386/33TE 486/25E 25TE, 33, 33TE PREMIUM II 386/25, 33 486/33 486SX/20 PREMIUM SERVER SE 4/33	4MB	500780004	$178
	4MB	500780001	$330
POWEREXEC 3/25SL 3/25SLC, EL	4MB		$178
	16MB		$758
POWEREXEC 4/25SL	4MB		$178
	16MB		$768
PREMIUM EXEC 286 386SX/20, 25, 25C	4MB	500814003	$178

COMPAQ Memory

MODEL	MEMORY	PART#	PRICE
Deskpro 386/16	1-2MB	108069-001	$238
	2MB	108069-W71	$448
	4-8MB	108070-001	$398
Deskpro 286E; 386-20; 20E; 25, 25E	1MB	113131-001	$59
	4MB	113132-001	$208
Deskpro 386S	4MB Board	113634-001	$278
	4MB Module	112534-001	$218
Deskpro 386-20E, 25E	4MB	113645-001	$278
Deskpro 386/33/33L 486/25, 33L, 50L; Systempro	2MB	115144-001	$104
	8MB	116561-001	$428
	32MB	116558-001	$1458
Systempro, Deskpro 6 SKT EXP BRD W/2MB		116569-001	$279
Compaq "M"	2-64MB	129160-001	$278
Deskpro 286N, 386N; 386SX/20, 20N, Portable 486c, Deskpro M, Systempro LT Series 129160-001 Pro Signia	1MB	118688-001	$49
	2MB	118689-001	$84
	4MB	118690-001	$178
	8MB	128877-001	$348
Prolinea 3/25 & 25Z	2MB	141738-001	$98
	8MB	141742-001	$318
Prolinea 4/25si, 4/33, 4/50	2MB Module	141683-001	$94
	4MB Module	141684-001	$178
	8MB Module	141685-001	$354
Compaq Pro Signia	16MB	149320-001	$684
	32MB	149147-001	$1524
DeskPro 5/60, 5/66M	8MB	149911-001	$388
Prosignia PC Server, 486/33/66	8MB	141685-001	$348
	16MB	149320-001	$698
	32MB	149147-001	$1498
Prosignia 5/60	16MB	149949-001	$738
Proliant 100 5/60	32MB	149912-001	$1598
Proliant 2000 4/30, 5/66	64MB	149913-001	$2698
Proliant 4000 4/50 5/66	128MB	149914-001	$5848

Compaq Laptop & Notebook Memory

Concerto 486 4MB $218 8MB $418 16MB $998

MODEL	MEMORY	PART#	PRICE
Contura 320, 325	2MB	139497-001	$98
	4MB	139498-001	$178
	8MB	139499-001	$348
Contura 4/25CX	4MB	146520-001	$178
	8MB	146521-001	$338
	16MB	146532-001	$768
SLT/286	1MB	110235-001	$75
	4MB	110237-001	$218
SLT386	1MB	118303-001	$79
	2MB	118304-001	$108
	4MB	118305-001	$218
Lte 286	1MB	117081-001	$79
	2MB	117081-002	$99
	4MB	117081-004	$178
Lte 386S/20	1MB	121125-001	$98
	4MB	121125-002	$208
Lte Lite/20, 25, 25C	2MB	129769-001	$138
	4MB	129769-002	$208
	8MB	129769-003	$388
	16MB	129769-004	$808
LTE Lite 486/25C	4MB	142337-002	$188
	8MB	142337-003	$378
	16MB	142337-004	$768

MAJOR LAPTOP & NOTEBOOK MEMORY

MODEL	MEMORY	PART#	PRICE
AT&T Safari	2MB	37650	$148
	4MB	37651	$248
Bondwell B-310	1MB	23030-09100	$108
Dec pc 320 Notebook	2MB Mod	FR-PCIM-BA	$149
	4MB Mod	FR-PCIM-BB	$298
	8MB Mod	FR-PCIM-BD	$498
Dell Laptop 212, 320N, 320N+	2MB Mod	310-3204	$129
Dell 325N, NC	2MB Mod	310-3210	$139
Dell N120 & N125	2MB Mod	310-3213	$142
Epson NB-3 Notebook	4MB	A808511	$198
Epson NB-SL/	2MB Mod	A808771	$108
EPSON 25C Notebook	4MB Mod	A808781	$228
Everex Tempo LX, LX20	2MB	00160	$98
Everex Carrier	2MB	00263-00	$108
Grid 1500	2MB	52587	$238
Grid 1450SX	2MB	6200233	$148
Goldstar GS520, 386SX16	1MB	N/A	$98
	4MB	N/A	$298
NCR 3120 Notebook	4MB Mod	3120K104	$298
NCR 3170 Notebook	4MB Mod	3123K104	$398
Packard Bell, Magnavox, Mitsuba	1MB	N/A	$108
	4MB	N/A	$198
Panasonic CF170/270/370	1MB	CF-BA165	$64
Samsung Notemaster 386S	2MB	SNM002	$198
	4MB	SNM004	$398
Sanyo 17NB; 18NB & ZEOS	2MB	MBC-NBMEM2	$98
Sharp 6220	1MB	CE-621B	$98
Sharp 6640, 6781, 6681, 6785	1MB	N/A	$198
Sharp 4700/4200	1MB	CE-471	$198
Sharp 8501 Colorster	4MB	N/A	$398
TI Travelmate 2000	1MB	2568034-0011	$78
TI Travelmate 3000SX; WINSX	2MB	2566996-0001	$88
TI Travelmate 4000, WINDX/25 SX/16, SX25, DX2/40	4MB	2581265-001	$198
DX2/50	16MB	AVAILABLE	$1498

Laser Printer Memory

MODULE	1MEG	2MEG	3MEG	4MEG	5MEG	8MEG
Canon LBP4, 4 Lite & 4+	$108	$144				
Epson Action Laser II, 8000	$198		$238		$288	
Epson + 6000 and many more	$118			$198		
Epson Action Laser 1000 & 1500	$138			$276		$399
Fujitsu 7100 & 7200		$199	$279			
HP DeskJet 500, 500C and 550C	$38 (256K)					
HP 2, 2D	$98			$164		
HP 3, 3D, 3P, 2P, 2P+	$98			$168		
HP LaserJet 4, 111Si, XL300, 1200C				$174		$348
IBM Laser 4019, 4019E (3.5MB)	$118			$164		
IBM Laser 4029 ALL MODELS	$104			$158		
NEC 90, 290	$104					
NEC 95	$78					
OKI400		$68	$94			
Packard Bell PB9500	$125			$208		
Panasonic 4410/4430	$108			$164		
Panasonic 4420/4450	$118			$168		
Panasonic 4450		$105				
Panasonic 4455			$129			
QMS 410	$119	$159		$249		
Toshiba Page Laser 6		$99		$168		
TI XL/PS17/PS35	$44			$98		

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8KX8	4.95	4.45	3.95	64x4	10.00	5.95	4.95
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4Meg x 9	–	–	179.00	177.00	168.00	–
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	40NS	50NS	60NS	70NS	80NS	100NS
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2 x 32 8Meg	–	–	349.00	329.00	329.00	–
4 x 32 16Meg	–	–	659.00	639.00	639.00	–
256 x 36 1Meg	–	–	–	–	59.00	–
512 x 36 2Meg	–	–	–	94.00	89.00	–
1 x 36 4Meg	–	–	189.00	179.00	168.00	–
2 x 36 8Meg	–	–	379.00	345.00	340.00	–
4 x 36 16Meg		–	719.00	689.00	689.00	–
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	8Meg	500987-003		419.00
	16Meg	500987-004		619.00
	32Meg	500987-005		1399.00
Premium 486/25, 25E, 33, 33E				
Premium 386/33TE, 486/25TE, 33TE				
Prem. Serv., Prem. II 386SX/20, 25				
Prem. II 386/25, 386/33, 486/33, 486SX/20	8Meg	500780-001	64 pin	398.00
Premium 386/33T, Prem. 386SX/16				
Prem. II 386SX/20, 25		500780-004		189.00
Premium 386/25, 33, 386/33T, 386SX/16		500780-003		59.00
Prem. II 386SX/20, 25		500780-001		59.00
Premia 4/33S, 4/33, 4/50D, 4/66D	4Meg	501158-002		379.00
Premia	16Meg	501158-003		789.00
Premia	32Meg	501158-004		1489.00
Premia	64Meg	501158-005		3111.00
AST Cupid Bd	5-40Meg	500818-001		179.00

ZENITH MEMORY MODULES

MODEL	AMT. UPGRADED	AST PART #	PRICE
Z386/33, 25, 20, 33E	1Meg	ZA3800ME	59.00
Z386/33, 25, 20, 33E, 486/25E	4Meg	ZA3800MK	180.00
Z386SX	2Meg	Z-605-1 modules	119.00

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30F5360 (2Meg)	30-286, 25-286, 50 MTHR BD.	104.00
6450375 (1Meg)	80-041	79.00
6450379 (2Meg)	80-111, 311-121, 321, 081, 161	84.00
6451060 (4Meg)	80-A21, A-61, 80-A31, 80-111, 80-311	189.00
6450604 (2Meg)	70-061, E61, 121, 50Z, 55SX, 65SX, P-70, 55LS, 65LS, X-Station 120 & 130, 35SX, 35LS, 40SX	89.00
6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 40SX, 35SX, 35LS, 40SX, Val Pt. 325T	90.00
78X8955 (128K)	25	35.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 55LS, 65LS	175.00
87F9977 (4Meg)	55SX, 55LS, 65SX, 40SX, 35SX, 35LS	175.00
1057035 (512K)	P/S1-286	49.00
92F9935 (2Meg)	P/S1 & P/S1/386SX-2121	109.00
92F9694 (4Meg)	P/S1 & P/S1/386SX, Model-2121	189.00
6450902 (2Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	90.00
6450128 (4Meg)	57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Mod-2123, 2133, 2155, Val Pt 77, 486CS2, 486SX, SVR85 Value Point 77 486DX2, 486SX, SVR 85	175.00
6450129 (8Meg)	35SX, 40SX	339.00
6450130 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	339.00

IBM NOTEBOOK & LAPTOP MEMORY

——— (4Meg)	Thinkpad 500	230.00
——— (8Meg)	Thinkpad 500	459.00
79F0999 (2Meg)	LX40, N33SX, PS Note, Thinkpad 710T	103.00
79F1000 (4Meg)	LX40, N33SX, PS Note, Tkpd 350, 350c, 710T, PS Note 425	199.00
79F1001 (8Meg)	LX40, N33SX, PS Note, Thinkpad 710T	369.00
07G1826 (2Meg)	N51 (all)	103.00
07G1827 (4Meg)	N51 (all)	199.00
07G1828 (8Meg)	N51 (all)	419.00
07G1415 (4Meg)	Thinkpad 750, 750c	199.00
07G1416 (8Meg)	Thinkpad 750, 750c	389.00
66G0094 (16Meg)	Thinkpad 750, 750c	849.00
07G1420 (4Meg)	CL57LSX LpTp, Thinkpad 700, 700C, 720, 720C	199.00
07G1421 (8Meg)	CL57LSX LpTp, Thinkpad 700, 700C, 720, 720C	389.00
60G0378 (8Meg)	Thinkpad 350, 350c, PS Note 425	359.00
60G0379 (16Meg)	Thinkpad 350, 350c, PS Note 425	669.00
92F6804 (2Meg)	N45SL	109.00

COMPAQ MEMORY MODULES

MODEL	AMT. UPGRADED	CMPQ PART #	PRICE
DeskPro 386/33, 386/33L, 486/25, 486/33L, 486/50L, System Pro	2Meg Module	115144-001	139.00
	8Meg Module	116561-001	429.00
	32Meg Module	116568-001	1459.00
DeskPro 386/33L, 486/33L	(Exp Bd)	116569-001	279.00
DeskPro 386/25, 386/20	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	199.00
DeskPro 386S-16MHz	1Meg Exp Bd	113633-001	149.00
	4Meg Exp Bd	113634-001	279.00
	1Meg Module	113646-001	79.00
	4Meg Module	112534-001	199.00
DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	279.00
	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	219.00
DeskPro 286N, 386N, 386SX/20, 386/25M, 486/33M, 486S/25M, 486S/16M	1Meg Module	118688-001	59.00
	2Meg Module	118689-001	89.00
	4Meg Module	118690-001	169.00
Port. 1 Series 486C	8Meg Module	128877-001	389.00
M Series Exp Bd	0-64Meg	129160-001	189.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	299.00
	1-2Meg Exp Bd	108069-001	239.00
	4-8Meg Exp Bd	108070-001	437.00
DeskPro 286	512K Kit	113012-001	49.00
DeskPro 5/60, 5/66M, 5/66M (ALL OF THESE MACHINES USE THESE MODULES)	8Meg Kit	149911-001	389.00
Prosignia 5/60	16Meg Kit	149949-001	707.00
Proliant 100 5/60	32Meg Kit	149912-001	1299.00
Proliant 2000 4/30, 5/66	64Meg Kit	149913-001	2700.00
Proliant 4000 4/50, 5/66	128Meg Kit	149914-001	5900.00
Prolinea 386 3/25S, 3/25ZS	2Meg	141738-001	109.00
	8Meg	141742-001	338.00
Prolinea 486 4/25S, 4/33, 4/50, 4/66, CDS Prosario series	2Meg	141683-001	95.00
	4Meg	141684-001	175.00
	8Meg	141685-001	339.00
Prosignia PC Server, 486/33, 486 DSX/66	8Meg	141685-001	339.00
	16Meg	149320-001	699.00
	32Meg	149147-001	1525.00

COMPAQ LAPTOPS & NOTEBOOKS

LTE/286	2Meg Bd	117081-002	99.00
LTE/286	4Meg Bd	117081-003	179.00
LTE/386S/20	4Meg Module	121125-002	209.00
LTE LITE/20, 25, 25C	4Meg Module	129769-002	209.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	419.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	809.00
LTE LITE 4/25C, 4/23E, 433C	4Meg Module	142337-002	179.00
LTE LITE 4/25C, 4/23E, 433C	8Meg Module	142337-003	349.00
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Contura 320, 325	2Meg	139497-001	99.00
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	8Meg	139499-001	349.00
Contura 4/25, 4/25C, 4/25CX	4Meg	146520-001	179.00
	8Meg	146521-001	339.00
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	8Meg	190597-001	433.00

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T2000/T2000SX	2Meg	PC18-PA8317U	94.00
T2000SX/T1000LE	2Meg	PC-PA8314U	189.00
T2000SX/T1000LE	8Meg	PC14-PA8315U	359.00
T2000SXE/2200SX/T1800, 1850, C	2Meg	PC-PA2000U	94.00
T2000SXE/2200SX/T1800, 1850, C	4Meg	PC-PA2001U	189.00
T2000SXE/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	359.00
T4400SX, SXC T6400, T6600	4Meg	PC-PA2004U	199.00
T4400SX, SXC T6400, T6600	8Meg	PC-PA2005U	379.00
T4400SX, SXC T6400, T6600	16Meg	PC-PA2010U	699.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	209.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	409.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg	PC-PA2014U	839.00
T3300SL	6Meg	PC-PA2008U	268.00
T3300SL	16Meg	PC-PA2009U	699.00
T3400CT	4Meg	PC-PA2019V	199.00
	8Meg	PC-PA2020V	399.00
	16Meg	PC-PA2021V	819.00
	32Meg		1599.00
T1200XE	2Meg	PC13-PA8306	99.00
T1600	2Meg	PC8-PA8302U	99.00
T3100	2Meg	PC3-PA7135E	139.00
T3100e	2Meg	PC9-PA8340U	109.00
T3100SX	2Meg	PC15-PA8308U	109.00
T3100SX	4Meg	PC15-PA8310U	199.00
T3200	3Meg	PC6-PA7137U	185.00
T3200SX	2Meg	PC12-PA8307U	119.00
T3200SX	4Meg	PC12-PA8909	199.00
T3200SXC	2Meg	PC19-PA8318U	119.00
T3200SXC	4Meg	PC19-PA8319U	199.00
T5100	2Meg	PC7-PA8301U	95.00
T5200/T8500	2Meg	PC10-PA8304U	114.00
T5200/T8500	8Meg	PC10-PA8313U	419.00

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MODEL	AMT. UPGRADED	MANU. PART #	PRICE
ACER 730	2Meg/4Meg/8Meg		109/209/449
ACER 750	4Meg/8Meg/16Meg		199/459/869
ALR Venture	4Meg	12407980	249.00
AST Bravo & Explorer	4Meg/16Meg	501255-001, -002	199.00/789.00
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500814-003	189.00
AST Power Exec 3/25C, 425EL	4Meg		199.00
AST Power Exec 3/25C, 425EL	16Meg		819.00
AST Power Exec 425SL	4Meg	501166-001	199.00
AST Power Exec 425SL	16Meg	501166-003	819.00
AST Power Exec 4/33SL	4Meg/16Meg	501318-001,002	194.00/769.00
AT&T Safari NSX/20	4Meg	PEC 37651	259.00
Bondwell B310, Plus	1Meg	73050-09100	109.00
Bondwell B310V, SX	1Meg		109.00
Bondwell B310V, SX	4Meg		229.00
Canon Ionova 486	2Meg/4Meg/8Meg		109/209/449
Canon Notejet 486	4Meg/8 Meg		219.00/419.00
Chicony, Ultra, Hyundai 386	4Meg		199.00
Epson NB3	4Meg	A800611	199.00
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Gateway 2000 Nomad 425 DXL/SXL	4Meg/16Meg		199.00/1549.00
Gateway 2000 486 Handbook	4Meg/16Meg		199.00/799.00
Goldstar GS528 386SX/16	4Meg	S386-4M	249.00
Grid 1720, 1750, 1755	1Meg		49.00
Magnavox Metalis	1Meg/4Meg	286, 386SX	139.00/199.00
NEC Prospeed 286, 386SX-16	1Meg	PC21-21	79.00
NEC Prospeed 286, 386SX-16	4Meg	PC21-22	199.00
NEC Prospeed 386	2Meg	PC31-21	119.00
NEC Prospeed 386	8Meg	PC31-22	399.00
NEC Prospeed 386SX-20	1Meg	PC43-21	79.00
NEC Prospeed 386SX-20	4Meg	PC43-22	199.00
NEC Ultralite Versa	4 Meg/8Meg/16Meg/20Meg	OP4104	183/359/799/988
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Panasonic CF170, CF270, CF370	1Meg	CF-BA165	49.00
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Tandy 1510, 2810, 3810	1Meg		49.00
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Twinhead, Altima, Compudyne, 486SX, DX, Tandy 4850	4Meg/16Meg		199.00/859.00
Ultra 486	2Meg, 4Meg, 8Meg		CALL
Zeos 386SX Notebook (not the + version)	2Meg		109.00
Zenith Master Sport 386SX	2Meg	ZA-300-1	114.00
Zenith Master Sport SL, SLE	2Meg	ZA-4-4	119.00
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Epson Action Laser II	–	–	89	–	228	–	–	367	–	–	–	–
Epson 8000	–	–	89	–	228	–	–	367	–	–	–	–
Epson 1000, 1500	–	–	–	129*	–	–	258*	–	Call	*IN STOCK		
HP 2, 2D+	–	–	–	109	–	–	189	–	–	–	–	–
HP 3, 3D, 3P, 2P, 2P+	–	–	–	149	–	–	169	–	–	–	–	–
HP 4, 4M, 4SI, 4SIMX, 4P, 4MP	–	–	–	89	–	–	189	–	–	349	–	–
HP 4L	–	–	59	–	–	–	–	–	–	–	–	–
HP 3SI	–	–	69	–	–	–	169	–	–	349	–	–
HP 4SI	–	–		69	–	–	169	–	–	349	–	–
HP Design Jet 600, 650	–	–	–	–	–	–	109	–	–	349	–	–
HP Deskjet 500, 500C, 510, 550	–	55	–	–	–	–	–	–	–	–	–	–
HP Deskjet 1200C, 1200C/P	–	–	–	89	–	–	189	–	–	349	–	–
HP Paintjet XL300	109	–	–	–	–	–	289	–	–	469	637	–
IBM Laser 4019, 4019E	–	–	–	–	–	169	–	–	–	–	–	–
IBM Laser 4029	–	–	–	–	–	–	169	–	–	–	–	–
IBM Laser 4039, 4079	–	–	–	99	–	–	169	–	–	359	–	–
NEC 90, 290	–	–	–	139	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	–	99	–	–	–	–	–	–	–	–
Oki 400	–	–	–	89	–	–	–	–	–	–	–	–
Oki 400 E	–	–	135	189	–	–	–	–	–	–	–	–
Oki 830, 840	–	–	–	109	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	139	–	–	227	–	–	–	–	–
Packard Bell 9815	–	–		180	–	–	299	–	–	–	–	–
Panasonic 4420/4450i	–	–		129	–	–	209	–	–	–	–	–
Panasonic 4410/4430	–	–		126	–	–	195	–	–	–	–	–
Panasonic 4450	–	–	99	–	–	–	–	–	–	–	–	–
Panasonic 4400/5400	–	–	Call	Call	–	–	Call	–	–	–	–	–
Panasonic 4440, 5410	–	–	Call	Call		–	Call	–	–	–	–	–
Sharp 9400, 9460, 9600	–	–	Call	Call	–	–	–	–	–	–	–	–
TI XL/PS17/PS35	–	–	55	-	–	–	–	–	–	–	–	–
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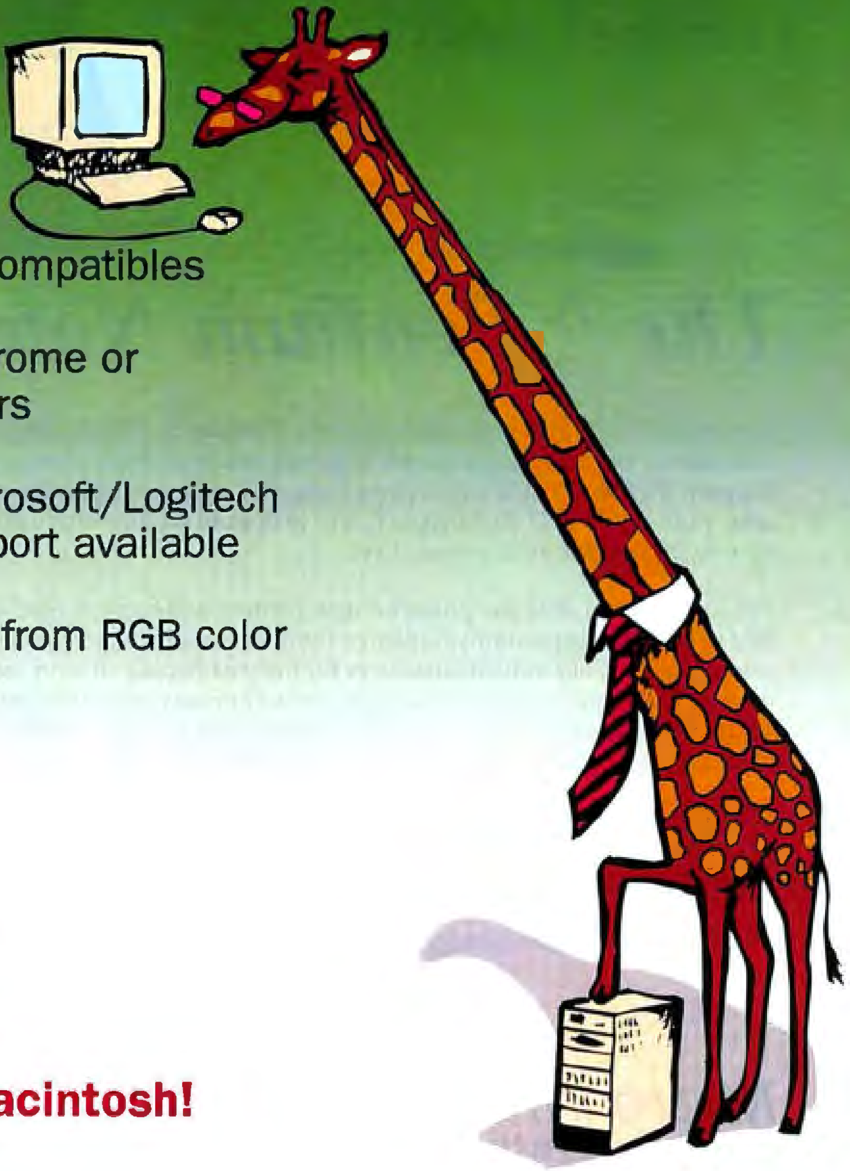

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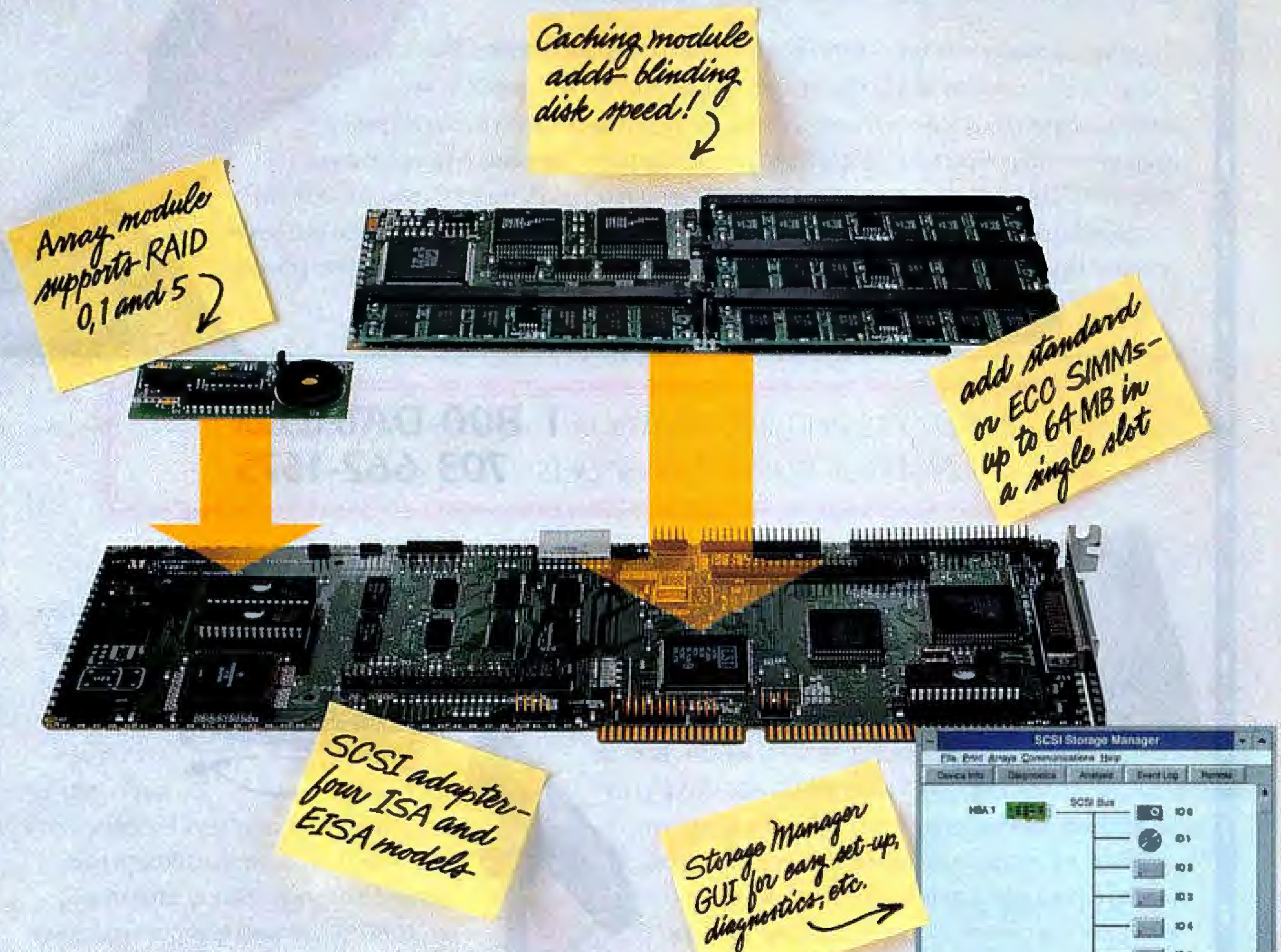

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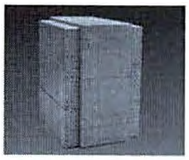

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ST42100N*	1900	FH	13	
✓ST12550N*	2145	3.5	8	
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ST43400N*	2912	FH	10	
✓ST15150N-W*	4100	3.5	8	
ST410800N-W*	9080	FH	11	
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ST3145A	130	1"	16	$ 172
ST3243A	212	1"	16	$ 193
ST3290A**	260	1"	16	$ 217
ST3391A	341	1"	12	$ 260
ST3550A	452	1"	12	$ 308
ST3655A**	545	1"	12	$ 377

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TYPE	MB	SIZE	SEEK	PRICE
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CFS210A	212	1"	12	$ 194
CP30254H	250	1"	14	$ 222
CFA340S-A	340	1"	12	$ 279
CFS420A	420	1"	14	$ 272
CFP1060S	1060	1"	9	$ 748

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TYPE	MB	SIZE	SEEK	PRICE
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LPS340S-A	340	1"	12	$ 261
LPS540S-A	540	1"	10	$ 402
PD1225S	1225	3.5	10	$ 884
PD1800S	1800	3.5	10	$ 964

WESTERN DIGITAL 2YR WARRANTY

TYPE	MB	SIZE	SEEK	PRICE
IDE				
WD2340	340	1"	13	$ 268
WD2420	420	1"	13	$ 275
WD2540	540	1"	13	$ 385

DEC ✓7200RPM 5YR WARRANTY

TYPE	MB	SIZE	SEEK	PRICE
SCSI				
DSP31D7L	1050	1"	9.5	$ 720
✓ VP3107	1075	1"	8	$ CALL
DSP3210	2100	3.5	9	$ 1300
✓ VP3215	2150	1"	8	$ CALL
DSP5400	4000	FH	12	$ 2452
✓ SP3430	4300	3.5	9	$ CALL

MICROPOLIS 5YR WARRANTY

TYPE	MB	SIZE	SEEK	PRICE
SCSI				
4110	1005	1"	9	$ 725
2217	1750	3.5	10	$ 940
1936	3050	FH	12	CALL!!
4410	4100	3.5	8	PRICES
1991	9080	FH	11	TOO GOOD
IDE				TO PRINT
2210A	1035	3.5	10	
2217A	1750	3.5	10	
AUDIO VIDEO				
2210AV	1050	3.5	10	
2217AV	1750	3.5	10	

SPECIALS 5YR WARRANTY

MB	SIZE	HT	PRICE
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1.7GB	3.5	HH	$ 930
2GB	3.5	HH	$ 1275
3GB	5.25	FH	$ 1950

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DRM-1804X	18 CD MINICHANGER	4X SPEED	$ 1990

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OPTICAL JUKE BOX	40 GIGABYTE	$14500
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RMD 5200S	256MB	35MS	$ 925

TAPE DRIVES

TYPE	MB	SIZE	SEEK	PRICE
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WANGDAT	3200	4-8 GB	4MM	$ 930
WANGDAT	3400	8-16 GB	4MM	$ 1040
SONY	SDT2000	2 GB	4MM	$ 780
SONY	SDT4000	2-4 GB	4MM	$ 840
SONY	SDT5000	4-8 GB	2MM	$ 988
DEC	DLT 4060	20 GB	DLT	$ 3175
EXABYTE	8205	2.5 GB	8MM	$ 1357
EXABYTE	8505	5 GB	8MM	$ 2070

MULTI MEDIA CD-ROM Bare Drives

TYPE	MS	SIZE	SEEK	PRICE
CHINON CDS535	280	2X	256 K cache	$ 320
TOSHIBA 4101	280	-	-	$ 219
TOSHIBA 3401	200	2X	256 K cache	$ 315

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4.01 + 4.0	25 USER	$2612
4.01 + 4.0	50 USER	$3500
4.01 + 4.0	100 USER	$4894
V 3.12	5 USER	$ 609
V 3.12	25 USER	$2056
V 3.12	50 USER	$2779
V 3.12	100 USER	$3892
INTEL		
ETHERNET EXPRESS	16 COAX	$ 98
ETHERNET EXPRESS	10 B-T	$ 98
ETHERNET EXPRESS	16 COMBO	$ 115
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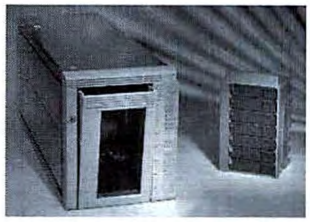
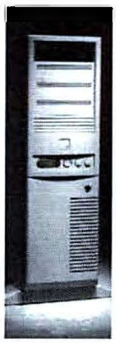


MICRONICS EISA/PCI File Servers



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URGENT—YOUR INPUT NEEDED

Dear Reader—The BYTE State of the Art section is devoted to delivering in-depth information about specific topics in computing on a monthly basis. In the December 1994 issue, the State of the Art section will cover the technologies and strategies involved with Agents and Smart Software.

Agents are software objects that encapsulate your needs and preferences, allowing them to act independent of your direct supervision. In the future, you could be using agents to schedule meetings, access information resources, and manage complex processes.

To ensure that our coverage is in tune with your needs, we request that you fill out the following questionnaire and fax it back to us. It will tell us about your needs and interests, and help us focus our coverage of agent technology to best address your concerns.

Of course, questionnaires such as this are necessarily limiting. If you want to tell us your ideas about agent technology, please contact one of the SOTA section editors at the following E-mail addresses. Thank you.

Bob Ryan, b.ryan@bix.com
Russ Kay, russellk@bix.com
Scott Wallace, swallace@bix.com

AGENTS AND SMART SOFTWARE

Does your company or department use any AI-based software?

____Yes ____No

Does your company or department currently use a network-based document management system such as SoftSolutions or PC Docs?

____Yes ____No

Do you use a text-retrieval system such as Folio Views?

____Yes ____No

Do you receive personally more than 20 E-mail messages per day?

____Yes ____No

Do you make use of on-line information database services such as Dialog?

____Yes ____No

Are you connected to an on-line news service?

____Yes ____No

Do you own a PDA (e.g., Newton MessagePad) or plan to buy one within 12 months?

____Yes ____No

Does your company or department use a group scheduling package?

____Yes ____No

Are you involved in either process reengineering or process control?

____Yes ____No

For the following, please rate each topic using this scale:

Not at all interested 1 — 2 — 3 — 4 — 5 **Very interested**

____ **document image processing with OCR**

____ **information search and retrieval**

____ **information mining/refining**

____ **distributed computing**

____ **PDAs**

____ **wireless communications**

____ **AI-based process control**

____ **on-line information services**

____ **group scheduling**

____ **automated work flow**

Comments:________________________________

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Name ________________________________

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Company ________________________________

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BYTE December '94 SOTA Survey
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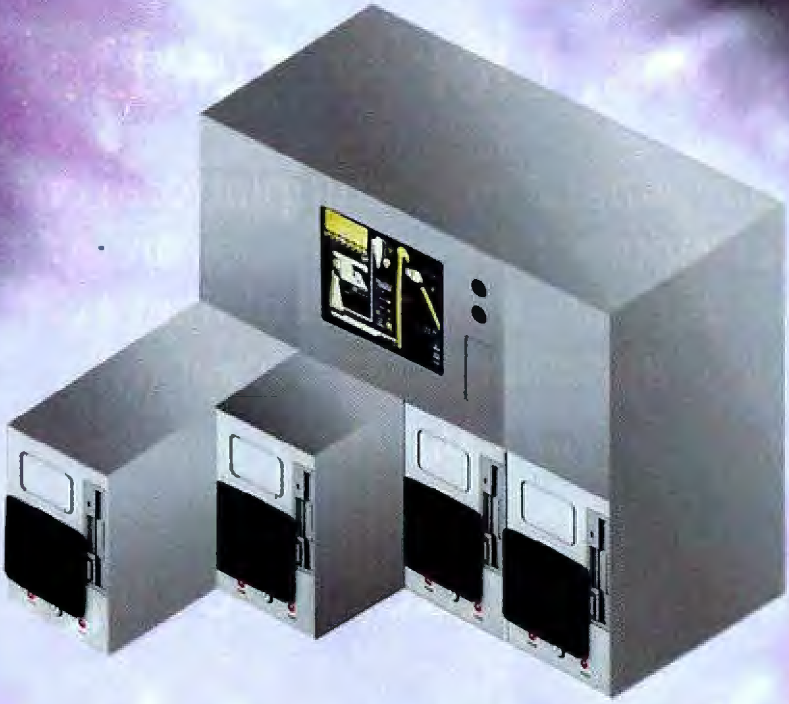

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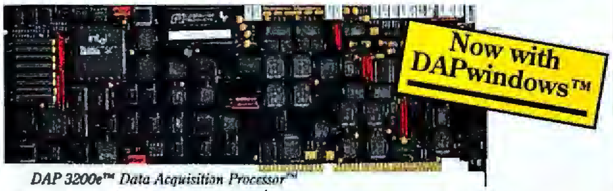

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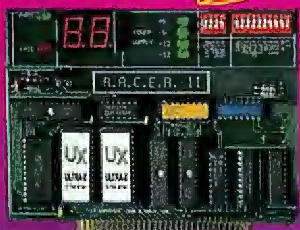

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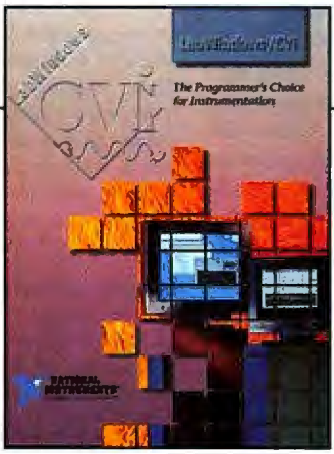

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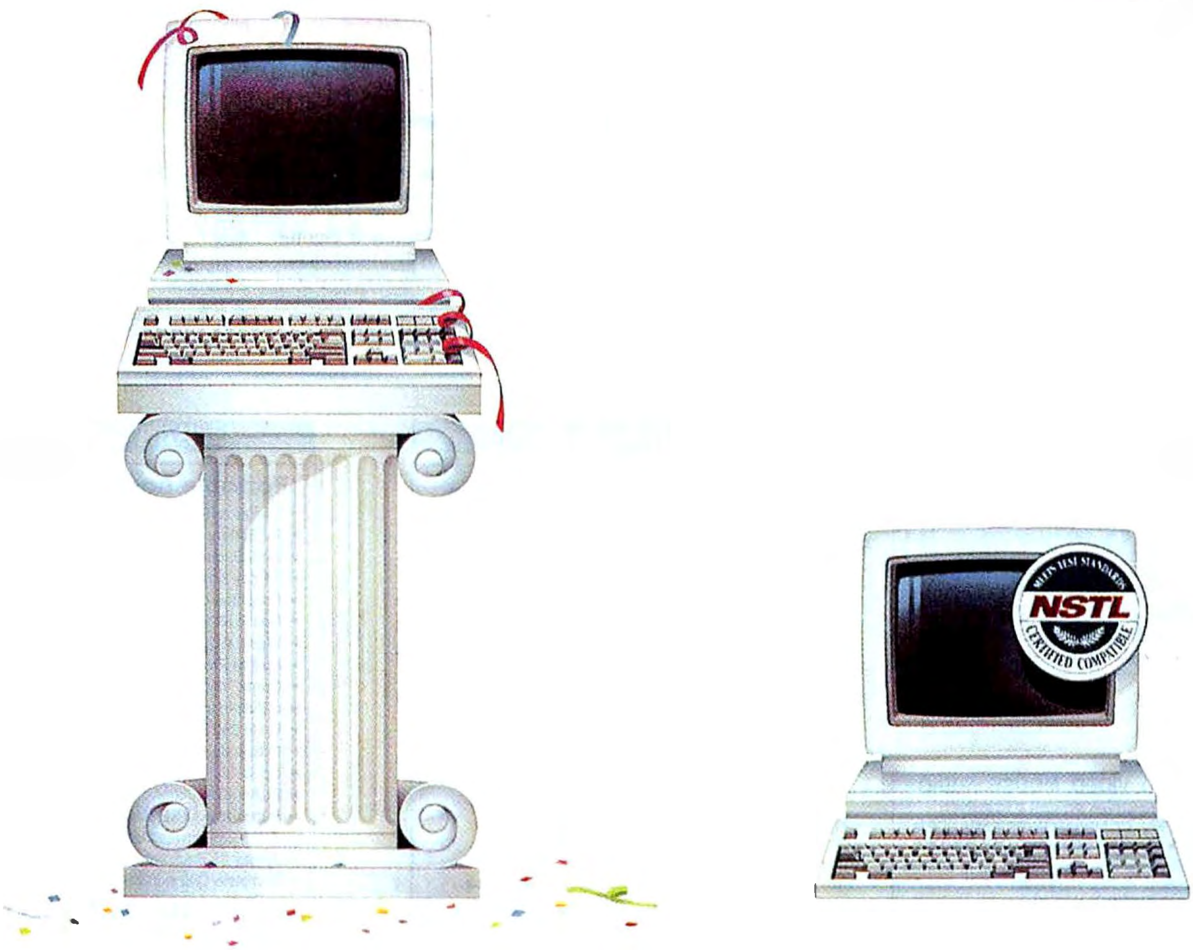

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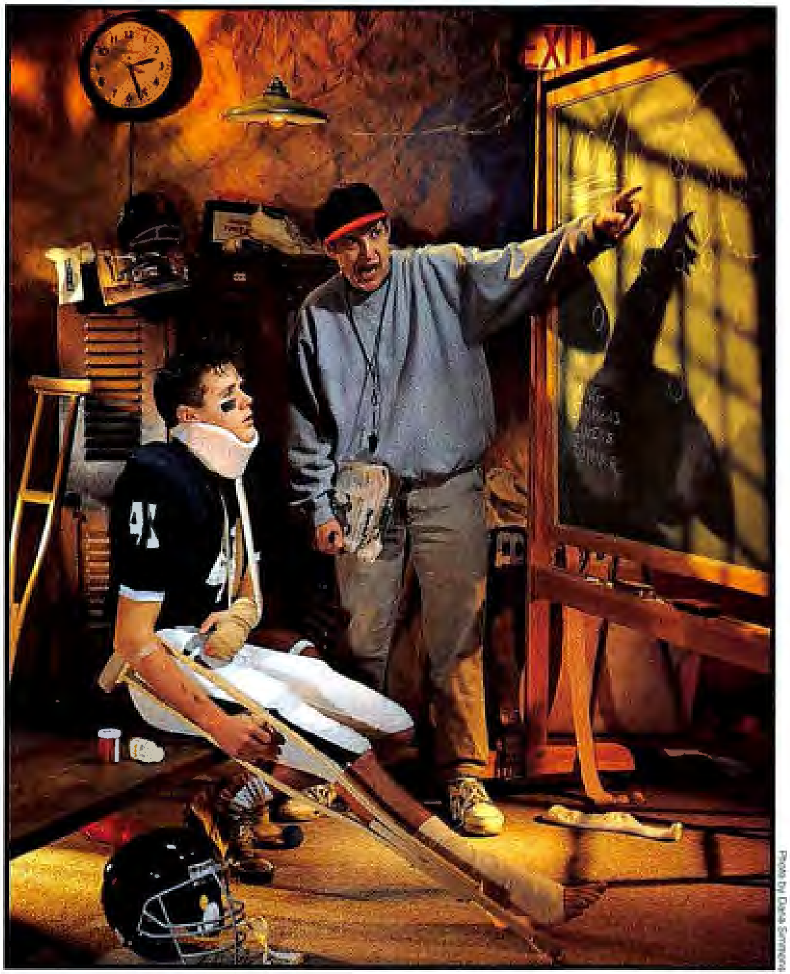

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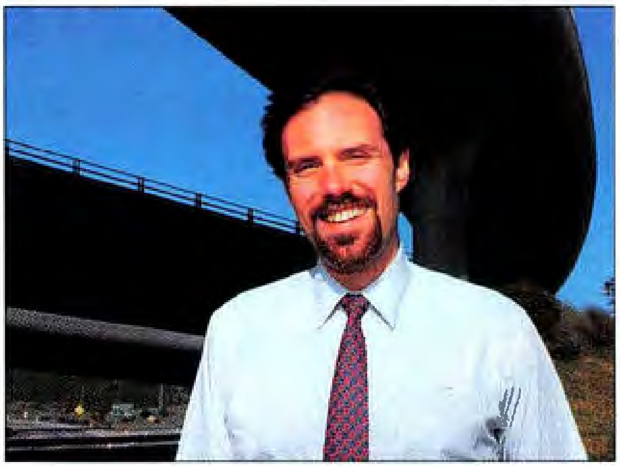
Commentary Andy Reinhardt

Call in the Feds

The U.S. government must not shirk its regulatory responsibilities regarding the data highway



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Many of the letters I received about my article on the data highway ("Building the Data Highway," March BYTE) said that the government shouldn't be involved. Sharing the assumption that the government is incompetent, they argued that the Feds shouldn't create, manage, or even regulate the data highway. Nowhere did I glean any historical perspective: That the very concept of a data highway wouldn't be in the offing if not for government-funded research of previous-generation projects, which launched the Internet and helped create many of today's communications systems. Nor did anybody acknowledge other successful federal projects, such as the interstate system or the space program.

Clearly, the federal government *is* capable of massive projects. In fact, its involvement may be essential when an undertaking is larger than any state, corporation, or consortium can manage. Yet, from President Clinton on down, policymakers in Washington are taking a "pragmatic" approach to the data highway, promoting a private model with public oversight. By granting such a huge opportunity for power and profits to the private sector, we have a right as a society to demand, in return, conformance with certain standards and practices.

What ought to be the proper role of the government in the data highway? It's a threefold proposition: helping to set technical specifications, protecting constitutional rights, and ensuring equality of access. All three are well founded in media and telecommunications law. The government's role need not expand. The current relationships among the government, private enterprise, consumers, and nonprofit groups will persist.

Given its power of regulation, especially over communications channels, the government could employ a number of business models. The Bell System grew up as a regulated monopoly and is now an oligopoly, cable franchises are renewable monopolies, and cellular rights are duopolies. But for the data highway, the model should be diversity. The promise of a switched, digital world is freedom of choice: One moment you might be hooked into a free government database, the next to a private mail carrier, and the next to an unregulated, premium-priced entertainment channel. There will be low-cost and high-cost services, the equivalent of choosing between the U.S. Postal Service and Federal Express.

The trickiest policy question is how to ensure universal access. If data-highway access requires something more sophisticated than an inexpensive telephone, the cost of getting on-line may be prohibitive for some. Telephones and TVs aren't subsidized today, but if using the data highway becomes an essential aspect of citizenship, devices will need to be made available to everybody, regardless of means.

As for service access, the dilemma is what level ought to be considered an acceptable minimum. The solution is to follow the lead of cable, where differing rungs of service range from a mandated minimum through premium and pay-per-view. Very inexpensive services might include access to community BBSes, use of a local library, the ability to contact government agencies (e.g., for permits), and the ability to access commercial services paid for by the provider (e.g., dial-a-pizza). And you could send the electronic equivalent of a postcard or letter or, for more money, multimedia or encrypted mail.

Some people won't be able to afford the combined cost of an access device and service, or won't want the data highway reaching into their homes. For them, today's pay telephones and bars showing sports channels will be supplemented by neighborhood information kiosks. The data highway will be far more diverse than anything we can imagine today.

But Washington policymakers must be the ultimate arbitrators between possible conflicting private interests. I believe the profit opportunities are so great, the potential for power so strong, that the government could extract greater concessions from data-highway players than it has proposed over fear that stringent regulation will cripple private initiatives in building the data highway. If this scares off some potential players, so be it: Creating a new information infrastructure for the twenty-first century is not a job for the faint of heart. If we are to fully enjoy the benefits of the data highway, without sacrificing an unacceptable amount of social control, we need to set the terms now and be vigilant that they are adhered to. ■

Andy Reinhardt is BYTE's West Coast bureau chief. He can be reached on MCI Mail at 536-9124 or on the Internet or BIX at areinhardt@bix.com.

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- MS-DOS 6.2/MICRC WINDOWS 3.1/MO