

BYTE

THE WORLDWIDE COMPUTING AUTHORITY

Fractal Image Compression:
An Inside Look

Apple's Workgroup Server 95

Electronic Documents:
Acrobat vs. Common Ground

PDA REPORT CARD

Handwriting recognition - C+

Communications - Incomplete

Applications - D

Effort - A- (shows great potential)

Affordability - F



STATE OF THE ART

HOW WE'LL CONTROL TOMORROW'S COMPUTERS

PLUS

- **DOS Dilemma: Word or WordPerfect?** PAGE 145
- **OS/2 and NT Debugging** PAGE 209
- **CA-Realizer 2.0, Visual Basic 3.0** PAGE 141



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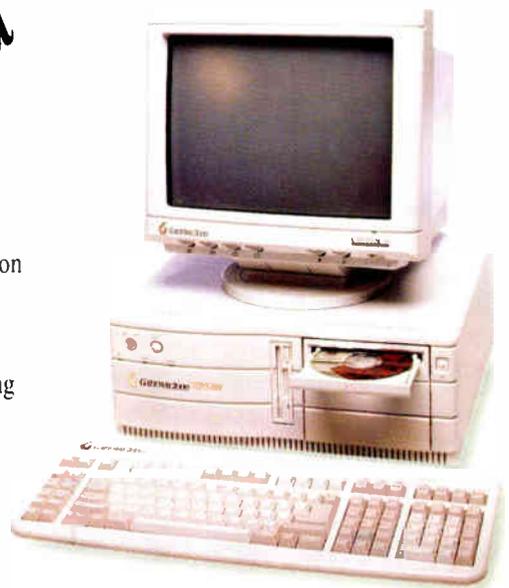
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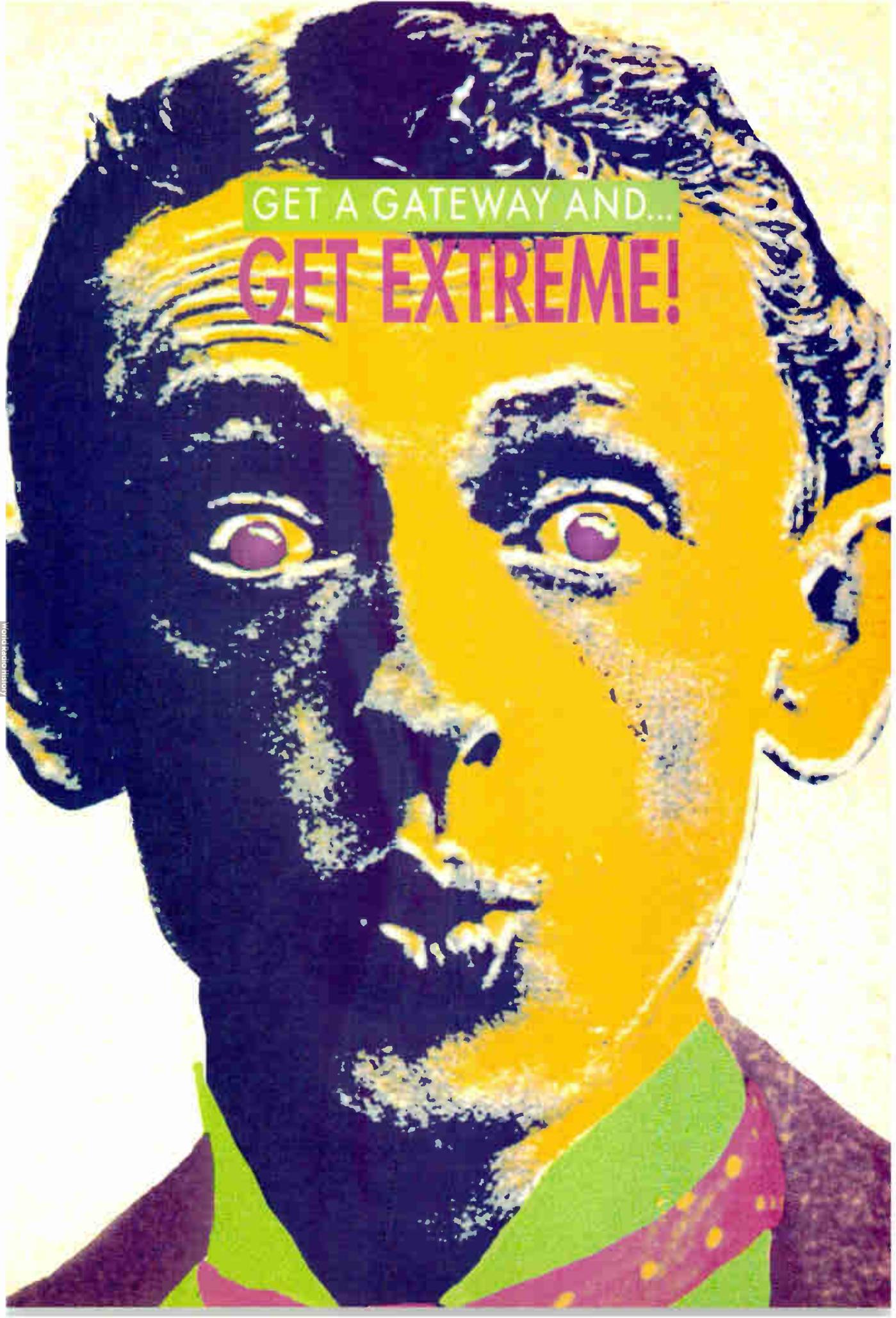
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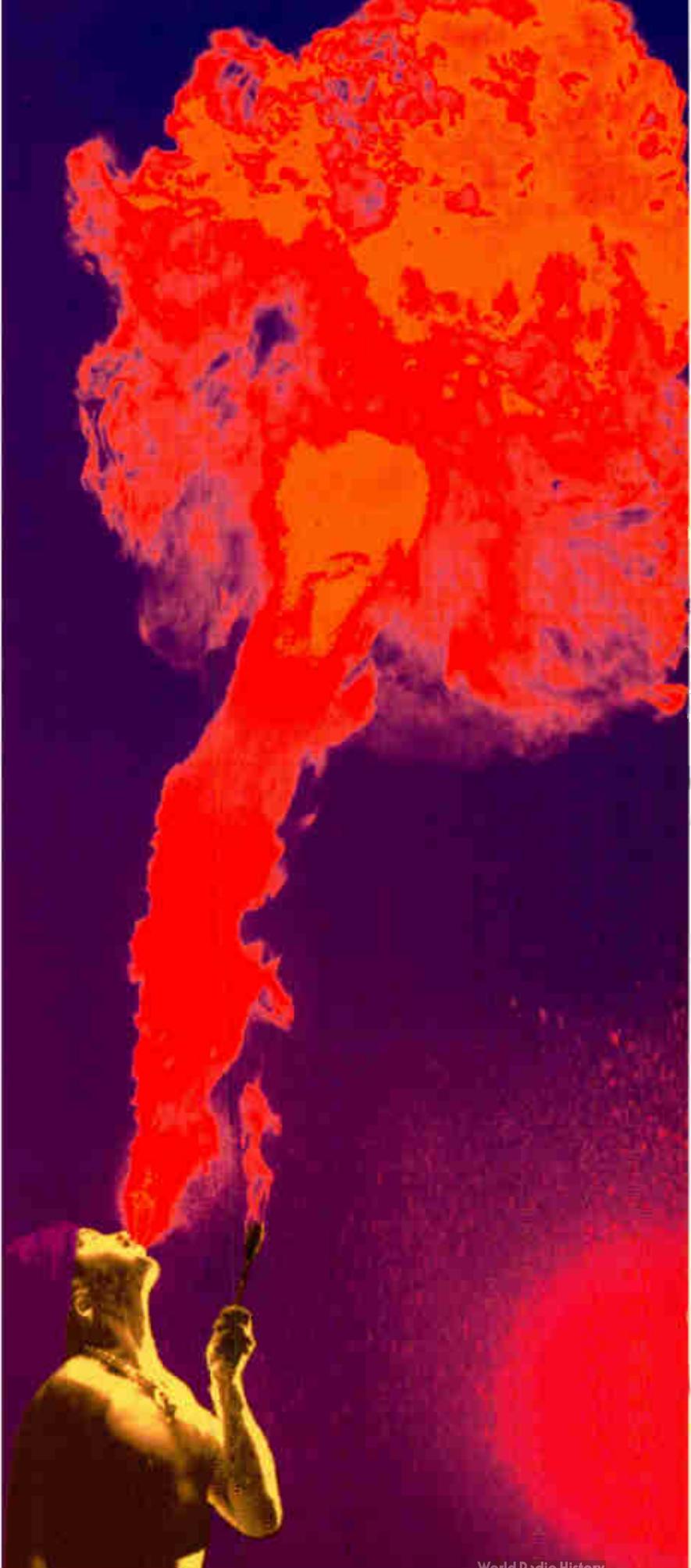


GET A GATEWAY AND...

GET EXTREME!

World Media History



A dramatic black and white photograph of a man breathing fire. The man is in the lower-left corner, shirtless and wearing a necklace, looking upwards. A massive, billowing plume of fire and smoke rises from his mouth, filling the upper two-thirds of the frame. The fire is bright orange and yellow, with dark smoke billowing around it. The background is dark, making the fire stand out.

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- Microsoft Mouse
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- Choice of Application Software

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- Microsoft Mouse
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66MHz Best Buy

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- New Baby AT Case
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- 124-Key AnyKey Keyboard
- Microsoft Mouse
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 - Microsoft PowerPoint for Windows™
 - Microsoft Project for Windows™
 - The MS Entrepreneur Pack(Works, Publisher, Money, and games)
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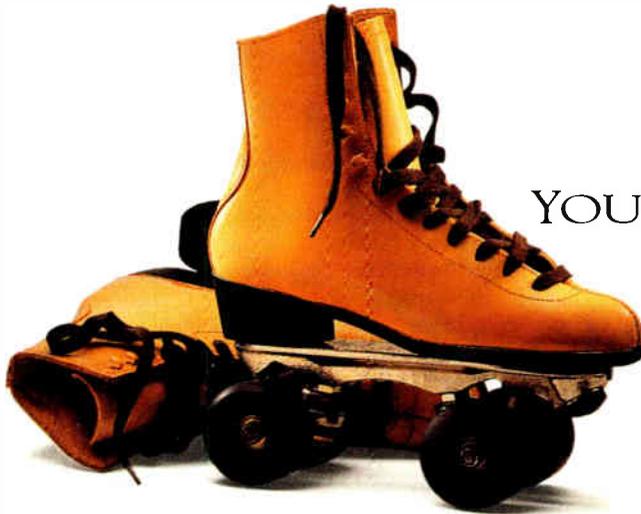


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Circle 178 on Inquiry Card.

World Radio History

News & Views

NETWORKS

High Stakes for High-Speed 22
Two proposals are competing to be sanctioned as the 100-Mbps standard.

SPREADSHEETS

Quattro Pro for Windows 23
Borland's newest spreadsheet tries to make life easier for new users and pros.

SOFTWARE DEVELOPMENT

Programming Tools Catch Memory Misuse 28
New Unix development packages help find a variety of memory-related errors.

SECURITY

PCs Catch Criminals Using Fingerprint Analysis 34
Companies in Taiwan and India have developed technology that uses image-processing techniques to identify suspects and prevent unauthorized entry.

EMERGING TECHNOLOGY

Optical-Computing Power Coming to Light 40
A researcher makes strides toward an OPLA (optical programmable logic array) computer.

SYSTEMS

IBM's Ambra 42
Big Blue comes out with a new business model and a new line of low-end PCs.

EMBEDDED PROCESSORS

PowerPC Goes Underground 42
Embedded processors based on the PowerPC architecture could show up in printers, PDAs, and other products.

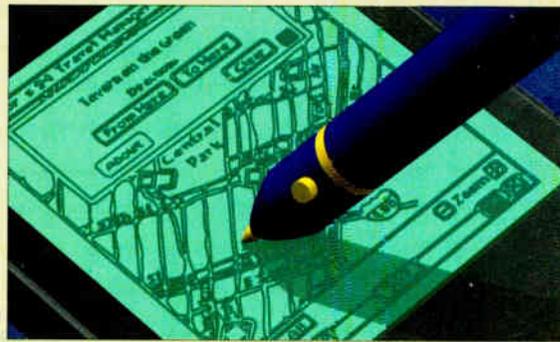
DESKTOP PUBLISHING

Frame Puts on a New Face 46
FrameMaker 4 shows valuable improvements.

NEW PRODUCTS

What's New 237
A self-moving hand scanner, pen computing on the desktop, PDA software, and more.

Cover Story



NEW TECHNOLOGY

PDA's Arrive But Aren't Quite Here Yet

 66

BY TOM R. HALFHILL The first Personal Digital Assistants from Apple and Tandy/Casio fall short in key areas such as price, handwriting recognition, and communications. But these systems are still an impressive first step toward an easy-to-use computing and communications device.

Sharp's Non-Newtonian PDA—69
Ink vs. ASCII—74
PDA CPUs: New Form Demands New Functions—80
The Wireless Factor—84

Ease of Use Is Relative

 89

BY TOM THOMPSON, TOM R. HALFHILL, AND MICHAEL NADEAU BYTE editors test drive the Apple Newton MessagePad, the Tandy/Casio Zoomer, and the Eo Personal Communicator 440.

Feature

PRACTICAL APPLICATIONS

Keeping Time on Your PC

 57

BY MICHAEL A. LOMBARDI For many tasks, your computer's clock isn't accurate enough. Here's how to make your PC a precision timekeeper.

State of the Art

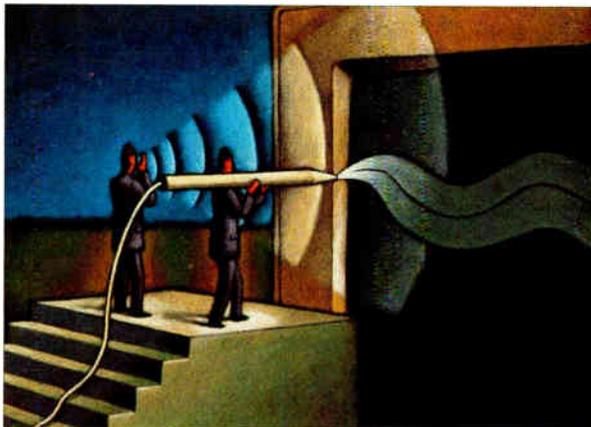
PEN AND VOICE INPUT

Pen and Voice Unite

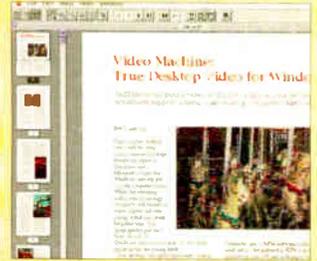
 98

BY HEWITT D. CRANE AND DIMITRY RTISCHEV The strengths of pen and voice technologies complement each other to create a powerful, natural user interface.

Matching the Input Mode to the Task—100



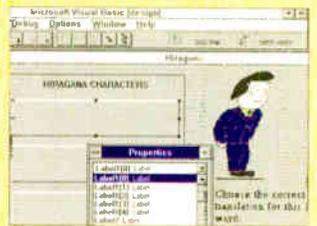
Reviews



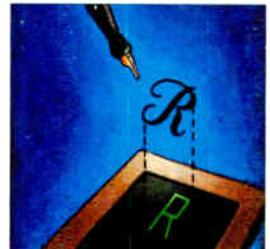
PAGE 133



PAGE 137



PAGE 141



Pen Computing Catches On

 105

BY DAN MEZICK Following much hype and great expectations, pen technology is finally beginning to deliver on its promise of mobile, intuitive data entry. Ink standards and good applications are helping to bring pen computing into the mainstream.

Jot Defines Electronic Ink—110

APPLICATIONS SOFTWARE

Personal Databases 124

BY MATT TRASK AND DON SORENSEN If you don't need the programmability of a high-end database, the new class of personal databases for Windows can do the job without all the hassle.

ELECTRONIC PUBLISHING

Acrobat vs. Common Ground 133

BY STANFORD DIEHL The age of digital highways demands a standard for platform- and application-independent electronic documents. Adobe's Acrobat and No Hands Software's Common Ground deliver two unique solutions.

NETWORKING

Mac for Workgroups 137

BY RAYMOND GA CÔTÉ Apple's Workgroup Server 95 sets a new performance standard for Macs and doubles the speed of AppleShare networking.

VISUAL DEVELOPMENT TOOLS

BASIC Windows Programming 141

BY MICHAEL C. WIGGINS Wiggins finds the latest upgrades of CA-Realizer and Visual Basic vast improvements: powerful, fast, and easy to use. And VB's database engine is a real knockout, although it has a few quirks.

WORD PROCESSING

DOS Dilemma: Word or WordPerfect? 145

BY SELINDA CHIQUOINE 6.0 of one, or half-dozen of another? Two DOS word processors launch new releases that are surprisingly similar. The choice boils down to one between features and simplicity.

DATABASE DEVELOPMENT

Integra VDB 151

BY JON UDELL Coromandel's Visual Database Builder is a powerful toolkit for building source-independent database applications using Visual C++ and Visual Basic. Udell uses Integra VDB to quickly build some applications under Windows.

PROGRAMMING TOOLS

Bounds Checker for Windows 159

BY STEVE APIKI Nu-Mega's debugging tool finds errors that other programs can't. Apiki uses Bounds Checker to snag elusive memory related problems in two programs, but he discovers that Bounds Checker, too, has its limits.

NOTEBOOKS

Lab Report: 62 High-Power Notebooks 162

Performance benchmarks, battery-life testing, and hands-on keyboard and screen evaluations find the best notebooks—from 25-MHz DOS systems to high-end Apple PowerBooks.

- The Best Windows Notebooks—154
- The Best Color Notebooks—166
- How We Tested—170
- Mac PowerBooks—174
- Notebook CPUs—178
- The Best DOS Notebooks—181
- How to Buy a Notebook—182
- Unix on a Notebook—184
- The Best Desktop Replacement Notebooks—189
- Honorable Mentions—190
- Dubious Achievements—190



Hands On



Talk to Your Computer 113

BY WILLIAM S. MEISEL Voice technology can add another dimension to the human-computer interface. Speech recognition will let you tell your computer what to do, and let your computer convert spoken words into text.

Voice Recognition over the Telephone—114



GRAPHICS TECHNOLOGY

Under the Hood: Fractal Image Compression 195

BY LOUISE ANSON An inside look at how it works.

PROGRAMMING TOOLS

Beyond DOS: The Visual Toolbox 205

BY MARK J. MINASI New tools expand OS/2's popular REXX programming language.

SOFTWARE DEVELOPMENT

Some Assembly Required: Windows NT, OS/2, and Debuggers 209

BY MATT PIETREK Good support at the operating-system level is essential to developing OS/2 and Windows NT applications.

Pournelle: The State of Multimedia 217

BY JERRY POURNELLE ScriptX and other software could give multimedia the push it needs.

Books & CD-ROMs: Hawking Returns 219

BY HUGHES PACK AND OTHERS Essays from Stephen Hawking, *Windows Internals*, the Beatles on CD-ROM, and other selections.

Commentary: Building Component Software 288

BY JON UDELL From GUIs to distributed objects, component software is evolving rapidly.

Editorial 10

BY DENNIS ALLEN

Letters 18

High-speed modems, the EMF controversy, and more.

READER SERVICE

- Editorial Index by Company 286
- Alphabetical Index to Advertisers 282
- Index to Advertisers by Product Category 284
- Inquiry Reply Cards 282A

BUYER'S GUIDE 247

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Hardware/Software Showcase
Buyer's Mart

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

DOS/WINDOWS

Quattro Pro for Windows23

The new version of Borland's spreadsheet program has features designed for users just moving to Windows. Quattro Pro 5.0's enhancements include Improv-like data modeling, new graph types, and more than 360 @functions.

I'll See Your Chip and Raise You One.....38

Cyrix has a new 486 pop-in upgrade chip for 386 machines. BYTE benchmarks show the processor could significantly jack up performance for DOS users.

IBM's Ambra.....42

Big Blue makes a big change with its new line of lower-than-low-end PCs.

Frame Puts on a New Face...46

FrameMaker 4 lands on several platforms at once. Changes specific to the Windows version include new document-import filters and the QuickAccess toolbar.

Keeping Time on Your PC57

Every DOS-based computer has a built-in clock—but it's not very precise. Here are some ways to turn your PC into a very accurate timekeeper.

Talk to Your Computer113

The Windows Sound System is one part of voice technology that lets you verbally command your computer or convert the spoken word to computerized text.

Personal Databases124

A review of seven relatively low-cost database packages for Windows, each tailored to meet the needs of an individual, a workgroup, or a small business.

Acrobat vs. Common Ground.....133

Publishing packages from Adobe and No Hands Software take two different approaches to creating electronic documents.

BASIC Windows Programming.....141

What's the fastest way to develop a professional-looking Windows application without driving yourself crazy? CA-Realizer 2.0 and Visual Basic 3.0 offer vastly improved visual programming tools.

DOS Dilemma: Word or WordPerfect?145

New releases of these two word processors provide powerful features and a Windows-style interface without requiring Windows-style resources.

Bounds Checker for Windows.....159

Nu-Mega's debugging tool tracks down errors no other Windows debugging tool can. If you're a C developer, tormented by those mysterious bugs symptomatic of memory violations under Windows, you should check this one out.

Lab Report: 62 High-Power Notebooks.....162

What's the best notebook PC for running DOS? For running Windows? Our exclusive tests reveal the answers.

OS/2

The Visual Toolbox205

Here's a tip on how to quickly build small OS/2 GUI applications: use a visual programming tool for the REXX language. HockWare's VisPro/REXX and Watcom's VX-REXX let you construct Workplace Shell applications using REXX and a few extra DLLs.

Windows NT, OS/2, and Debuggers.....209

A developer of programming tools talks about the issues involved in debugging under OS/2, from address-space considerations to multithreaded processes. Understanding debugger support in an operating system is essential to writing many types of tools and applications.

Pournelle: The State of Multimedia217

The big news at Chaos Manor: Jerry is becoming fond of OS/2. He's not sure IBM knows how to market it, but in the course of migrating applications to OS/2 2.1, he's learned they sure know how to support it.

Macintosh

Frame Puts on a New Face...46

The new version of the high-end, multiplatform publishing package has several features just for Mac users, including support for Publish/Subscribe, QuickTime, and Apple Events.

PDAs Arrive But Aren't Quite Here Yet66

Apple's Newton technology is impressive. It lays the foundation for a whole new style of portable communications device. But the first PDAs fall short of

matching the marketing hype surrounding them.

Ease of Use Is Relative89

What's it like to use the new MessagePad? Here's a first-hand report from BYTE editors who test-drove the first PDAs.

Talk to Your Computer113

Apple's PlainTalk, which lets a Mac understand verbal commands, is one of the technologies bringing speech recognition into the mainstream.

Acrobat vs. Common Ground.....133

Two programs for the Mac take different approaches to assembling and distributing electronic documents.

Mac for Workgroups.....137

Apple's new Workgroup Server 95 is a souped-up Quadra that's the fastest Mac yet and doubles the speed of AppleShare networking.

Lab Report: 62 High-Power Notebooks.....162

Our test team puts PowerBooks through benchmark and battery-life evaluations.

Unix

Programming Tools Catch Memory Misuse28

Development packages from Centerline Software and Purify from Pure Software can help test programs for errors, such as code that refers to illegal parts of memory.

Frame Puts on a New Face...46

For Unix users, the new version of FrameMaker features several enhancements, including import/export through the XClipboard utility and support for double-click file launching.

Lab Report: 62 High-Power Notebooks.....162

Our report looks at Tadpole's notebook and 486-based portables to find the best solution for taking Unix with you.

Client/Server

Integra VDB.....151

Coromandel's Visual Database Builder is a set of tools that lets you quickly create Windows database-oriented applications. The kit comes with Integra, a single-user SQL engine that natively supports ODBC (Open Database Connectivity).

AppleShare137

BASIC141

C28, 151, 159

CD-ROM49, 217

Compression195

Databases.....124, 141, 151

DOS.....145, 181, 217

Debugging28, 209

Digital ink74, 108, 110

Electronic documents133

Ethernet.....22

Fractals.....195

Handwriting recognition66, 89, 105

JPEG.....195

Multimedia49, 217

Networks....22, 84, 137, 217

Newton10, 66, 89

Notebooks162

Objects66, 288

ODBC141, 151

Optical technology40

OS/2205, 209, 217

PCMCIA66

Pen input.....66, 98, 105

PDA.....10, 66, 89

PowerPC42

Processors80, 178

Programming.....28, 141, 151, 159, 205, 209, 288

REXX205

RISC288

Spreadsheets.....23

Speech recognition113

Timekeeping.....57

Unix.....28, 46, 184

Voice98, 113

Windows23, 46, 105, 124, 133, 141, 151, 159, 164, 209

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Who Will Define the PDA?



Apple has the Newton, but AT&T has the technology

At the recent official rollout of Apple's Newton technology in Boston, I spoke to a couple of folks that were more than just a little excited about Apple's new PDA (Personal Digital Assistant) (our coverage starts on page 66). One was a doctor who had traveled from Long Island just to buy one of the first machines—an event for which he had waited six months. After seeing the real thing, however, he decided to go home Newtonless, saying there just wasn't enough memory in the MessagePad to do anything useful. Another fellow who wanted desperately to buy a Newton so that he could develop software for it, talked at length about the virtues of Apple's gadget. He couldn't buy one, though, because the price was too high. I asked him, "If someone gave you the money, would you buy one then?" He thought a moment and said, "No" and that he would rather use the money to upgrade his desktop Mac first. That's the problem with the first PDAs—they stir the imagination but fail to deliver. The MessagePad, like its distant cousin, the Tandy Zoomer, has too little memory, and its communications ability falls short of being truly useful.

Strangely, though, the Newton devices and other PDAs have succeeded in drawing attention to the Eo Personal Communicator. The Eo—developed with the assistance of AT&T—is much larger than true PDAs, and it doesn't have Apple's Intelligent Assistance software. In fact, compared to the Newton and the Zoomer, the Eo doesn't look like a PDA, and it doesn't try to be one—it's the size of a notebook and costs between \$2000 and \$3000. Nonetheless, the Eo comes closer than the MessagePad or the Zoomer to fulfilling the promise of PDAs.

Consider what the Eo offers. It has enough memory to do things. Because the Eo has enough memory, it doesn't have to put its Hobbit processor through hoops managing memory like the Newton does to its ARM (Advanced RISC machine) processor. Its extra memory and storage provides the capacity to handle multiple applications.

Even more important is the Eo's communications ability. It has real cellular phone support—not the gimmicked infrared "beaming" link offered on the Newton that so far works about as well as the original IBM PC Jr. wireless keyboard. (You do remember the IBM PC Jr., don't you?) With cellular phone support, your faxing and data communications become, well, portable.

It's the latter point that interests me most. Communications is the essential link to making a portable computer worth carrying. If you remember the highly regarded AT&T Safari laptop, you'll know that the Eo is not the company's first attempt at wireless mobile computing. To the contrary, AT&T has been at this for a very long time, and, frankly, I doubt that any company knows communications better than AT&T.

So what about AT&T? It has tried to be a player in the computer arena before and failed—such as with the famed Unix-based 3B2 in the 1980s, for example. Now, AT&T seems to be headed in the right direction, and it's not happening by accident.

First was the merger with NCR, the underrated computer giant. While IBM wavered with worries of how to keep its mainframe business alive, NCR dumped its mainframe business in favor of a microprocessor-based, multi-CPU file server strategy. Some may fault NCR with making the change prematurely, but few, if any, fault it for its vision. Add to that NCR's point-of-sale and transaction-based knowledge, and NCR's vision looks pretty good from any corporate viewpoint. Next, consider AT&T's recent deal with McCaw Cellular. If the deal goes through, AT&T's stake in the cellular business will be bigger than Dallas. To put it another way, AT&T will virtually own mobile communications, per se, and PDA makers will be standing in line to make communications deals with AT&T. That puts AT&T in a very enviable position—and places it several steps ahead of the competition.

My point is simple: AT&T is the company to watch. It has the technology (just think about all those Unix-based phone systems that run in overheated closets without errors), and it now has the breadth to make things happen.

If you haven't seen the Eo yet, you ought to check it out. No, I'm not saying that the Eo is the ultimate PDA, and it doesn't *really* compete with the Newton. But the Eo is more of what a PDA ought to be than the Newton or the Zoomer—it has portable communications.

The Eo also provides a glimpse of bigger things to come from one of the biggest companies in the world. If you have written off AT&T as a computer provider, it's time to rethink your position. Meanwhile, Apple has a formidable foe in defining what a PDA ought to be.

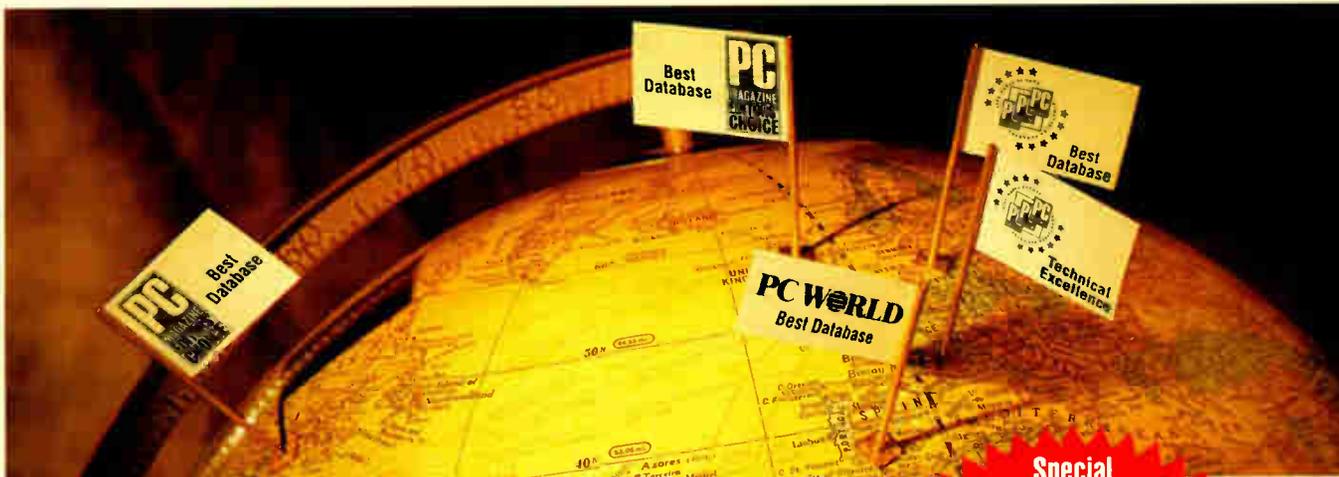
A stylized, handwritten signature in black ink, likely belonging to Dennis Allen. The signature is fluid and cursive, with a prominent initial 'D' and 'A'.

DENNIS ALLEN, EDITOR IN CHIEF

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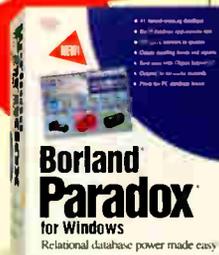
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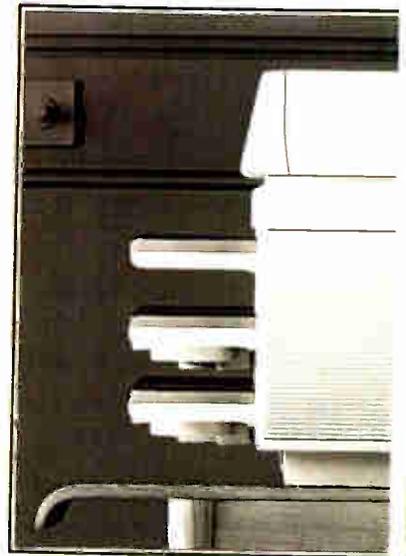
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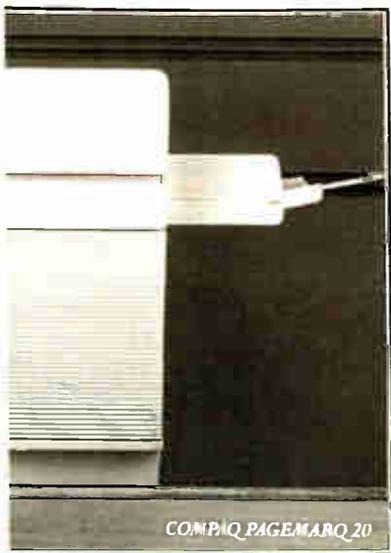
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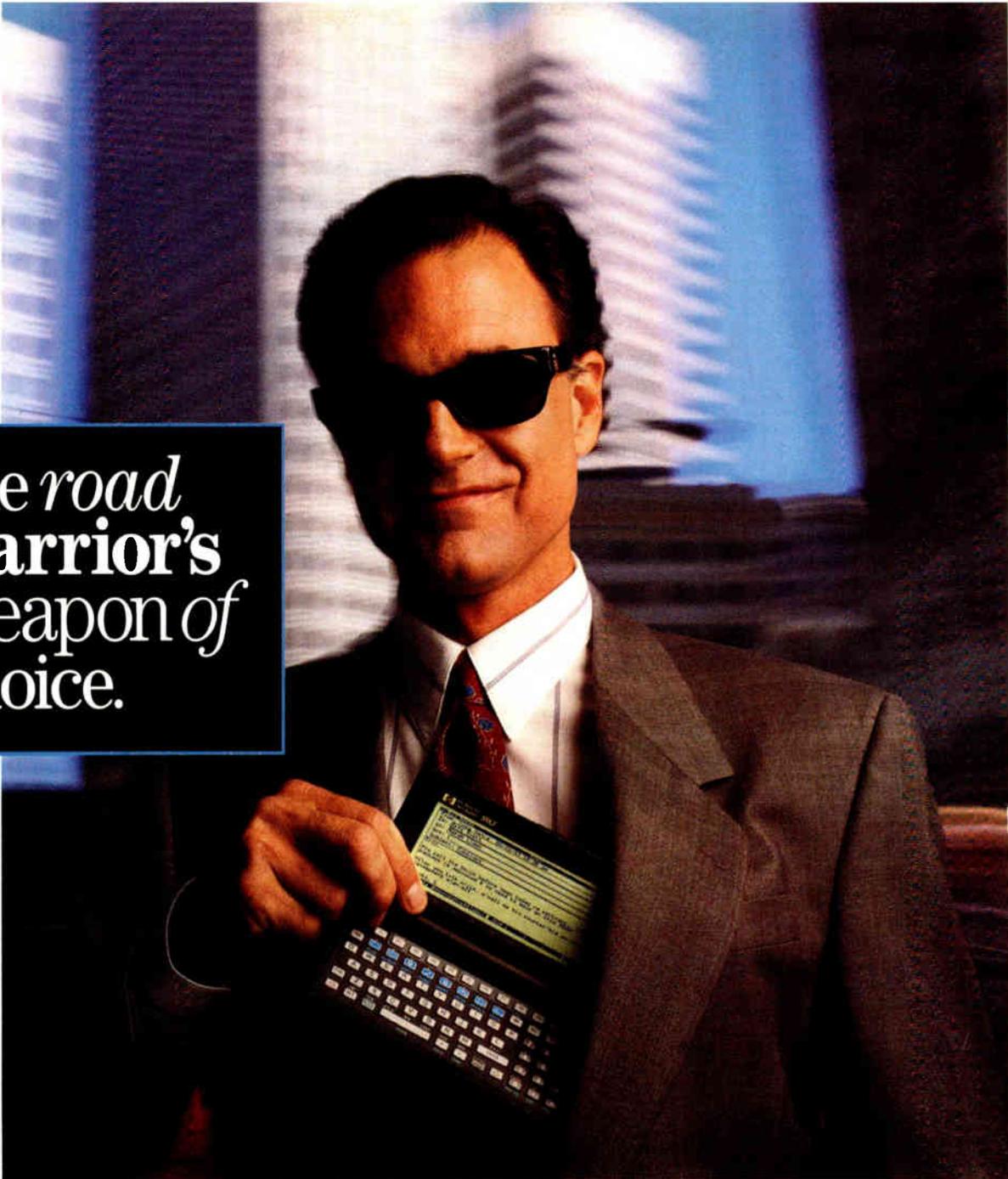
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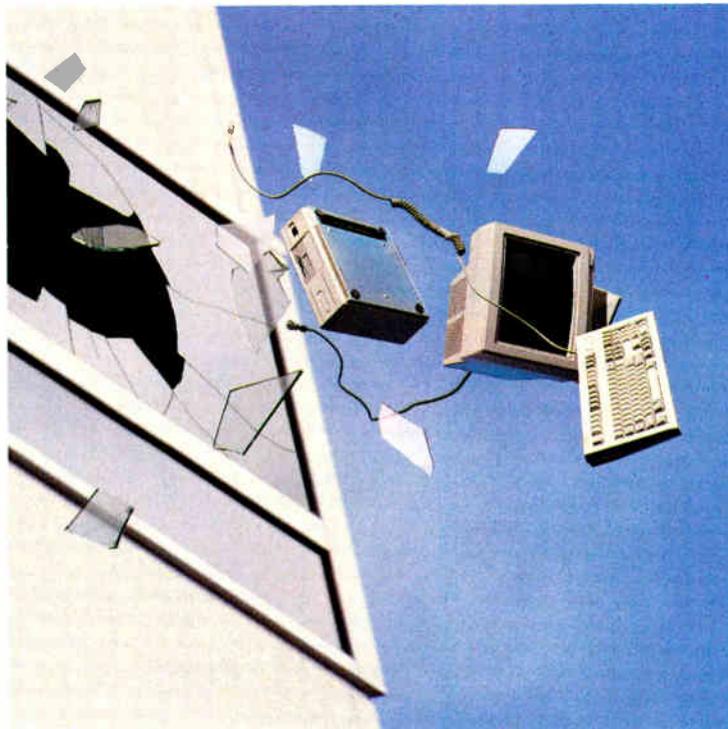
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Two w make a



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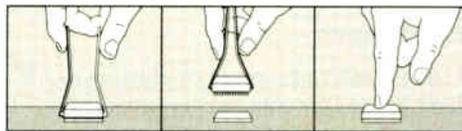
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High-Speed Modems

Your Lab Report on modems was superb ("V.32 or Better: 69 Modems," July).

I noticed you forgot to mention one thing: purchase from a reliable source. My fax modem broke two months after I purchased it. It took the manufacturer eight months to return my modem, and the reseller claimed that the 30-day warranty was past. The repaired modem failed in less than two weeks. The modem manufacturer has since gone out of business. Nobody will claim liability.

Ricardo Landrau
Carolina, Puerto Rico

With regard to your article on modems, nowhere could I find reference to the type of line service available. Most "real" modems can operate in programmed mode or permissive mode.

Your article talks about the most common problem in analog communications: the local loop. How do you ensure that your signal reaches the central office at the optimum signal level of -12 decibels above 1 milliwatt? Permissive operation means that the modem transmits at either -9 or -10 dBm. Programmable units can vary their transmission level such that the signal reaches the central office at the optimum level. This ensures that A/D converters in the central office handle the signal in an optimum manner.

Your failure to even mention this feature is not acceptable.

Calvin E. Reames Jr.
Boyd's, MD

You are right in noting our testing focused exclusively on two-wire dial-up configurations. This is by far the most common application of these modems, though many of these modems can also be used in two- and four-wire leased-line configurations for special applications like networking automated teller machines and remote data acquisition tasks. Thanks for your feedback. — Eds.

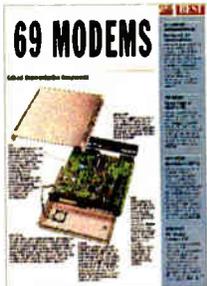
Conspiracy Theories

Paul Saffo's Commentary on dangerous EMF (electromagnetic field) emissions from CRTs ("A Conspiracy of Silence," July) really revved me up. The U.S. takes

so much pride in being humanity's crusader. It's really a shame that the same government has to wait for its own citizens to become sick and even die before any action is taken.

I doubt that EMF radiation will be regulated any time soon, unless more scientists and health officials get involved and raise public awareness.

Paul Bourmatov Jr.
Tappan, NY



Would you please refrain from giving space to ecocrazies like Paul Saffo. His Commentary is

a complete piece of rubbish. He has no idea what he is talking about and has no concept of statistical relevance.

David L. Hanson
Naperville, IL

For more information on EMF:

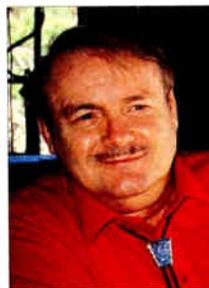
Becker, Robert O. Cross Currents: The Perils of Electropollution, the Promise of Electromedicine. New York: J. P. Tarcher, 1991.

Foster, Kenneth R., David E. Bernstein, and Peter Huber, eds. Phantom Risk—Scientific Inference and the Laws. Cambridge, MA: MIT Press, 1993.

Microwave News/VDT News, New York, (212) 517-2800.

NUTEK (for information on government labeling in Scandinavia), +46 8 681 91 00; fax +46 8 681 95 85.

—Paul Saffo



Pournelle's Inferno

I can't thank you enough for bringing me Jerry Pournelle's column every month. As a Mac user, it often distresses me to see the meager percentage of shelf space devoted to Mac software in stores. But all it takes is one look at Jerry's monthly Danteish descent into the hoary netherworld of PC hardware incompatibilities, software incompatibilities, EMM configurations, aborted installation attempts, and cryptic modifications to SYSTEM.INI, AUTOEXEC.BAT, and CONFIG.SYS to realize what a bargain my Mac is.

John Arft
San Antonio, TX

Jerry's article on whether to go to MS-DOS 6 or not ("The DOS 6 Question," July) exemplifies the attitude of most PC magazines, and it's costing the industry and business millions.

Jerry's preferred solution is DOS 5, QEMM, and WinStore. Sure, spending the extra \$300 is no problem if you're a single user. But what about business installations with 500 or more machines? MS-DOS 6 gives you the \$300 solution for \$30 (with bulk licensing). On 500 machines, that's a \$150,000 solution for \$15,000. And the savings are much higher because you also get backup in MS-DOS 6.

I'm moving my organization to MS-DOS 6 ASAP, not because it is something brilliantly new, but because it gives the best value for the money.

A very large chunk of sales go into organizations that manage more than five or 10 machines. Your recommendations should take that into account.

Stephen Norton
Victoria, British Columbia, Canada

I said that I wouldn't quarrel with those who like MS-DOS 6, and I won't; on that scale, it makes a great deal of sense. In my case, where my time and work have a value that's largely compared to the cost of computers and software, I have a different solution. Incidentally, by the time this comes out, they may have fixed some of the MS-DOS 6 compression difficulties; but it still doesn't make optimum use of fragmented disk space,

as Stacker does. If I couldn't use hardware solutions for file compression, I'd use Stacker. — Jerry Pournelle

Fixes

In the August What's New section, the telephone number for Laptop Solutions was incorrect. The correct number is (713) 789-0878.

The correct phone number for information on Hewlett-Packard's OmniBook 300 (News&Views, July) is (800) 443-1254. ■

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

A MESSAGE FOR DEVELOPERS WHO COULD USE A BUNDLE.

Something big is happening.

It's called CD-ROM. And it's the only way to handle the tons of information you need these days—without filling up your hard drive.

And since a development system can now fit on a single disc, that's where we put the Microsoft® Visual C++™ development system for Windows™ and Windows NT.™

It comes with over 8,000 pages



of our Books Online. And for a limited time, it also comes with a pre-paid coupon for a double-speed, Windows NT™-compatible Chinon™ CD-ROM 535 Series drive, featuring an average access time of 250 ms.

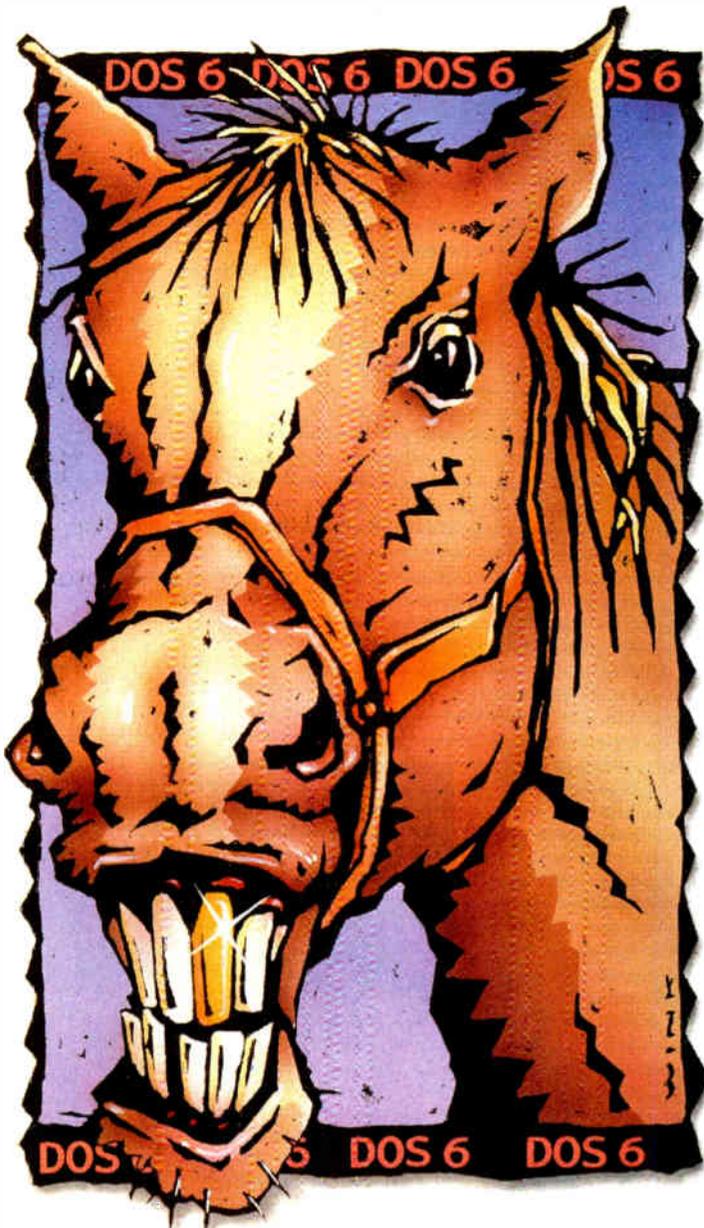
Better yet, when you get this package, you save a bundle. Which is to say \$200* at the very least.

See your local reseller today and ask about our remarkable offer. It'll make your life easier. And richer.

*Based on current suggested retail pricing. Offer consists of software package and an enclosed prepaid coupon that can be redeemed by mail for CD-ROM drive. Offer good only in the 50 United States and Canada. Offer good until February 28, 1994 or while supplies last. Visual C++ 32 Bit Edition is available only in CD format. © 1993 Microsoft Corp. All rights reserved. In the 50 United States, call 1-800-426-9400; in Canada, call 1-800-387-9048. For information only. Outside the United States and Canada, call your local distributor at (206) 936-7000. Microsoft is a registered trademark and Visual C++, Windows, Windows NT and the Windows logo are trademarks of Microsoft Corp. Chinon is a trademark of Chinon America, Inc.

CHINON

Microsoft
Making it easier



Even a *free* memory manager may not be a bargain—especially if it can't give you all the memory you need.

Introducing QEMM 7 The Memory Manager Worth Paying For

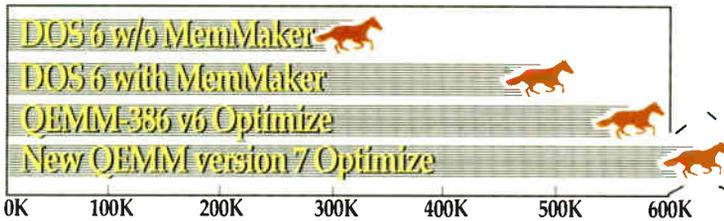
The newest version of the Quarterdeck Expanded Memory Manager (QEMM), version 7, once again is extremely innovative in using the critical area between 640K and 1024K. It finds space for more TSRs and drivers in this area than anyone thought possible. It optimizes this area, taking into account the many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

Instant Riches

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



How to Look a Gift Horse in the Mouth



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

DOS 6 Giveth; DOS 6 Taketh Away

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

New QEMM 7 takes the best of the new DOS 6 features into account, finding ways to give you more free memory for your program while taking full advantage of DOS 6. One new QEMM 7 feature, DOS-Up, moves the DOS 6 kernel, its data and resources to memory above 640K (this feature also works with DOS 3-5), freeing 770K. Another new QEMM 7 feature, Stealth DoubleSpace, frees 40K of the memory addresses used by DoubleSpace and makes them available for other drivers and TSRs. Both features ensure that the all-important memory below 640K is free for your programs. And QEMM 7's seemingly small feature of supporting multiple configurations gives you the flexibility and ease of setup that you expect. (MemMaker doesn't work well with this important DOS 6 feature.) That's why it makes more sense than ever to put your money on the best memory manager.

Page Frame: the Key to Your Future

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

The key to Stealth is its use of a 64K reserved area above 640K called the page frame. Besides being used by Stealth, the page frame is used by Lotus 1-2-3 r2.x for larger spreadsheets and WordPerfect 5.x for larger documents, DESQview for multitasking, Novell Netware, IBM LAN Server and DECnet for reducing the network driver memory footprint, plus games like Wing Commander, Car and Driver, Ultima Underworld II, Wolfenstein and others for fast action.

You sacrifice all this when you turn off the page frame (which other memory managers do to maximize available memory above 640K). It's this use of the page frame by Stealth that lets you set up your PC with a mouse, CD ROM, sound board, a network such as Novell NetWare, reserve 8-24K of extra memory for optimal MS Windows performance, use all of DOS 6's memory-hungry utilities and still have more than 630K available for your programs. (Compared to DOS 6's 527K available in the same configuration, after using MemMaker).

There's lots more to QEMM 7:

- Tuned for MS Windows
- New ability to use Vidram inside MS Windows
- DPMI Host
- Pentium Support
- Laptop suspend / resume support
- PS/2 micro channel adapters
- Compaq support
- Fine tuning tools for power users
- 32-bit architecture for speed
- Enhanced compatibility in response to hardware needs of our millions of users:

Detects adapter RAM and ROM and bus-mastering hard drive controllers

Monitors DMA access into memory

Supports Shadow RAM



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

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

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

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

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

Quarterdeck

Quarterdeck Office Systems, 150 Pico Boulevard, Santa Monica, CA 90405 (310) 392-9851 Fax (310) 314-4219
 Quarterdeck International Ltd., B.I.M. House, Crofton Terrace, Dun Laoghaire Co. Dublin, Ireland Tel. (353) (1) 284-1444 Fax: (353) (1) 284-4380

QEMM Users: upgrades are available from dealers.

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

How we got the chart numbers: CPU—486/33 ALR Power/business VEISA machine equipped with 16 megs of RAM and running MS-DOS 6. Comparisons were done using the following memory managers: QEMM 7, QEMM 6.02, MS-DOS 6 MemMaker. In addition to the driver (or drivers) required by each memory manager, the following drivers, DOS resources and programs were loaded for all comparisons: in the CONFIG.SYS file: SETVER.EXE, DOS-HIGH, FILES=20, BUFFERS=10, STACKS=0, MVSOUND.SYS, SNDIRK12.SYS, SLCD.SYS, DOS SHELL, statement, in the AUTOEXEC.BAT file: VSAFE, MSCDEX, UNDELETE, LSL.COM, NE200.COM, IPXODL.COM, NETX OR EM-NETX, MOUSE.COM, SMARTDRV.COM, PRIS-CAP.COM.

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Circle 131 on Inquiry Card.

World Radio History

News & Views

NETWORKS

High Stakes for High-Speed Ethernet

Two sides couldn't agree. Now, the battle lines are drawn in the 100-Mbps Ethernet showdown, and the market will decide the winner.

DAVE ANDREWS

You go your way, and I'll go mine. And may the better high-speed Ethernet networking standard win. That's the position many networking companies are taking in the high-stakes, 100-Mbps Ethernet competition. This is happening because the high-speed study group of the IEEE 802.3 committee, which is the official gatekeeper of the Ethernet standard, decided in July after months of vigorous debate to proceed with two separate and competing proposals.

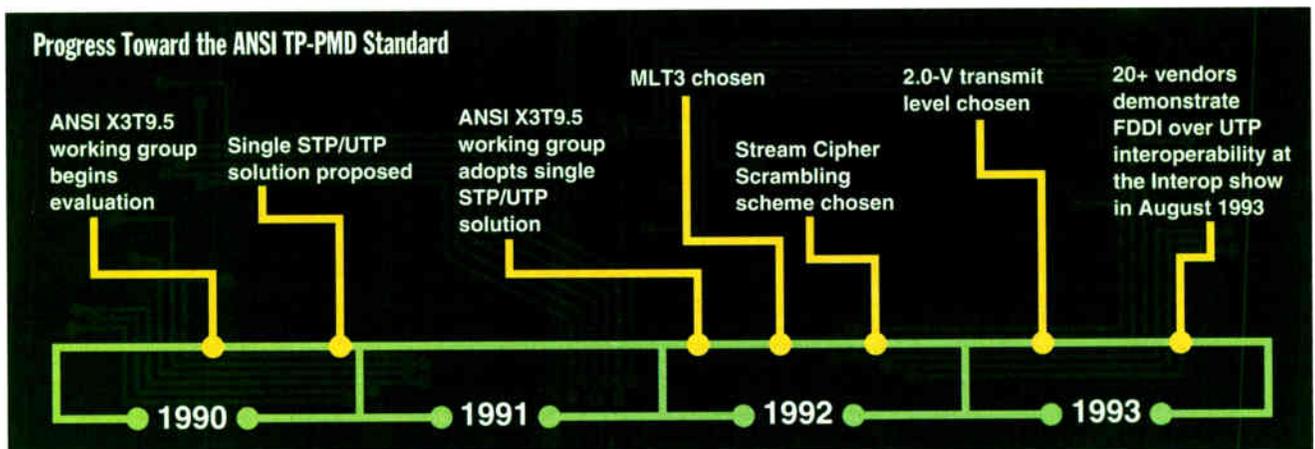
The 100BaseVG proposal, based on technology originally developed at AT&T and Hewlett-Packard, is under the guidance of the 802.12 committee. This proposal preserves the Ethernet frame but discards traditional Ethernet's CSMA/CD data-transmission technique for a demand priority method that proponents say better serves time-sensitive applications like full-motion video. A second proposal is supported by 17 companies, including Synoptics Communications, 3Com, Grand Junction Networks, and Sun Microsystems. It preserves CSMA/CD and mates it to the FDDI

(Fiber Distributed Data Interface) physical-medium-dependent layer. Proponents of the second proposal (which is now in the 802.14 committee) argue that its fast Ethernet solution will let developers quickly come to market with low-cost 100-Mbps networking products. The two sides could not agree on how to proceed. Now the market will decide which technique it favors.

Both 100-Mbps schemes will require changes to your adapter cards and hubs. Both preserve different parts of the traditional 10-Mbps Ethernet specification. But neither one will likely reach the draft stage until 1994. (For more information on 100-Mbps proposals, see "Pumping Up Ethernet," August BYTE.)

Standardization can take years—an eternity in this business—which is why numerous companies are introducing pre-standard 100-Mbps NICs (network interface cards) and hubs. Customers who run data-intensive CAD, desktop publishing, and other applications and don't want to deal with the added complexities of implementing 100-Mbps FDDI over copper wiring can't afford to wait months for a formal standard. "Our customers have an extreme need to send a lot of data back and forth," says Neil Mehta, president and CEO of Fremont, California-based MicroAccess, which already sells 100-Mbps Ethernet hubs and \$399 16-bit ISA cards. "Our philosophy is to give them what they want now."

The lengthy standardization



process is equally incompatible with companies that are funded by venture capitalists. "The cycle time is much longer than a commercial enterprise can usually tolerate, especially a start-up company," says Jack Moses, who is vice president of marketing at Grand Junction (Union City, CA). "When the [802.14] standard is done, we'll make our products compatible with it."

In the networking world, the shipping of prestandard products has numerous precedents. The FDDI-UTP (unshielded twisted-pair) standard for implementing FDDI over UTP and shielded copper wires is only now inching toward finalization (see the figure). Yet Crescendo Communications (Sunnyvale, CA) has been shipping 100-Mbps FDDI-UTP hubs and \$995 adapter cards since January 1992. Jayshree Ullal, vice president of marketing, says that when the standard is final, Crescendo will upgrade its adapters and hubs.

The Race Is On

Grand Junction's FastSwitch 10/100 (\$7250, expected to ship by the end of the year) is an SNMP-manageable workgroup switching hub that provides two switched 100-Mbps Ethernet ports for servers and 24 private 10-Mbps Ethernet ports. The company will complement its affordable hub with its FastNIC 100-Mbps EISA card, which at \$395 is about four times as expensive as a low-end 16-bit Ethernet card while offering roughly 10 times the performance.

As for the 100BaseVG proposal, you can expect companies like Kalpana, HP, AT&T Microelectronics, Proteon, Ungermann-Bass, and Accton Technology to begin shipping products in 1994.

Down the Road

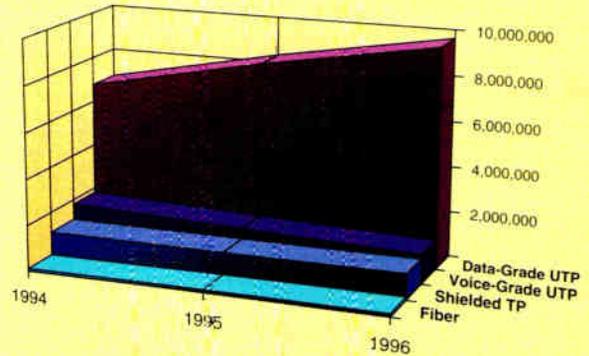
What's a network administrator to do? Todd Dages, director of data communications at Boston-based Yankee Group, advises you to determine what your requirements are going to be five years from now. Make sure your hub vendors can sup-

port the various emerging schemes, like switched and fast Ethernet, FDDI, ATM (Asynchronous Transfer Mode), and beyond. Companies like 3Com and Cabletron recently outlined broad strategies encompassing networking connectivity and management solutions designed to bring their customers into the twenty-first century.

But unless you really need 100-Mbps performance now, you probably want to wait a year, according to Dages. "I'd say if you can wait a year, you're going to have a bonanza of choices." With International Data estimating that the number of worldwide Ethernet installations will double from 20 million in 1992 to over 40 million by 1995, the competition is sure to be fierce.

Down to the Wire

Estimated U.S. Cable Connection Shipments
Source: Forrester Research (Cambridge, MA)



Along with different medium access and physical layers, the various 100-Mbps network schemes support differing types of wires. The main difference between Voice-Grade (Category 3) and Data-Grade (Category 5) copper wire is in resistance to crosstalk, or unwanted signals that interfere with a wire's signal. Category 5 cable has a higher resistance to crosstalk than Category 3 cable does. The FDDI-UTP and Grand Junction fast Ethernet proposals work over Category 5 UTP and shielded TP. The 100BaseVG proposal works over those two wire types and Category 3. However, Santa Clara-based 3Com says it will roll out a family of CSMA/CD-based 100-Mbps Ethernet products for all cable types in 1994.

SPREADSHEETS

Quattro Pro for Windows Pulls Ahead

Borland's Quattro Pro 5.0 for Windows packs enough new features to drive users to distraction. You'd expect features like the new Scenario Manager, help facilities, and @functions, given the strength of Lotus 1-2-3 release 4.0 for Windows and Microsoft's forthcoming Excel 5.0 for Windows. Other features, like the Improv-like Data Modeling Desktop, might surprise you. Whatever the case, QP5W moves, temporarily at least, into the lead in the Windows spreadsheet feature wars.

News for Beginners

One type of customer that spreadsheet vendors are competing for is the new user moving from a DOS spreadsheet to Windows. Conventional wisdom is that if you have the easiest spreadsheet to use, beginners will choose your spreadsheet over the others. QP5W (Borland has brought the Windows version's numbering conventions in line with the new DOS version) tries to make life easy for new spreadsheet users, as well as seasoned pros, through its context-sensitive help facility. Ob-

ject Help and Function Help, Interactive Tutors, and Experts.

In QP5W, if you're not sure about the purpose of an object (e.g., a cell, a notebook page, or any other spreadsheet control), you can place the cursor on that object, hold down the Control key, and click on the right mouse button. A box of text appears to explain the object. Along with this Object Help feature, Borland's Interactive Tutors offer more than 20 short on-line lessons in how to use various features. For those who don't want to learn how to use the spreadsheet but just want to get something done quickly, Experts might prove liberating. An Expert is a canned procedure for building a graph, creating scenarios, and consolidating spreadsheets.

Subtle Changes

QP5W offers nifty changes at the most fundamental levels. For example, the automatic graphing capability that's standard in spreadsheets is intelligent in QP5W. The software evaluates the size of a selected cell block and the types of entries in the block and draws a graph

QUATTRO PRO 5.0 FOR WINDOWS

- Lotus Improv-like Data Modeling Desktop
- 10 new graph types
- Control + Right Click Object Help
- Intelligent graphing
- Multiuser computing
- Consolidation Manager merges disparate 3-D worksheets
- More than 360 @functions

If managing your server eats up all

Introducing the new HP NetServer LM and LE.

More than just two new servers, we're introducing a profound improvement in the way you monitor and manage them.

Continuous Assistance.

We've put server management right where it belongs. At your fingertips. The HP NetServer Assistant software lets you easily monitor and manage your network servers from a single console—either locally or remotely. So your server stays up and running. Not you.

What's more, you can quickly diagnose and solve problems with its intuitive

interface and troubleshooting tools. And the HP Support Assistant, a CD-ROM-based library, is included to provide lots of valuable technical information.

Maximum Uptime.

These new HP NetServers lead the pack in reliability. RAID-based disk arrays on the LM provide advanced fault tolerance. And, thanks to our hot-swap capabilities, you can now replace an internal drive without bringing the server—or your network—down. The array will also automatically rebuild data on a failed drive. And for maximum protection, the LM even supports Error Correcting Code memory. In fact, the more critical your data, the more critical these servers become.

Investment Protection.

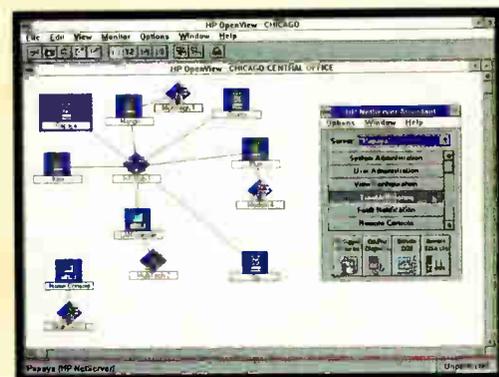
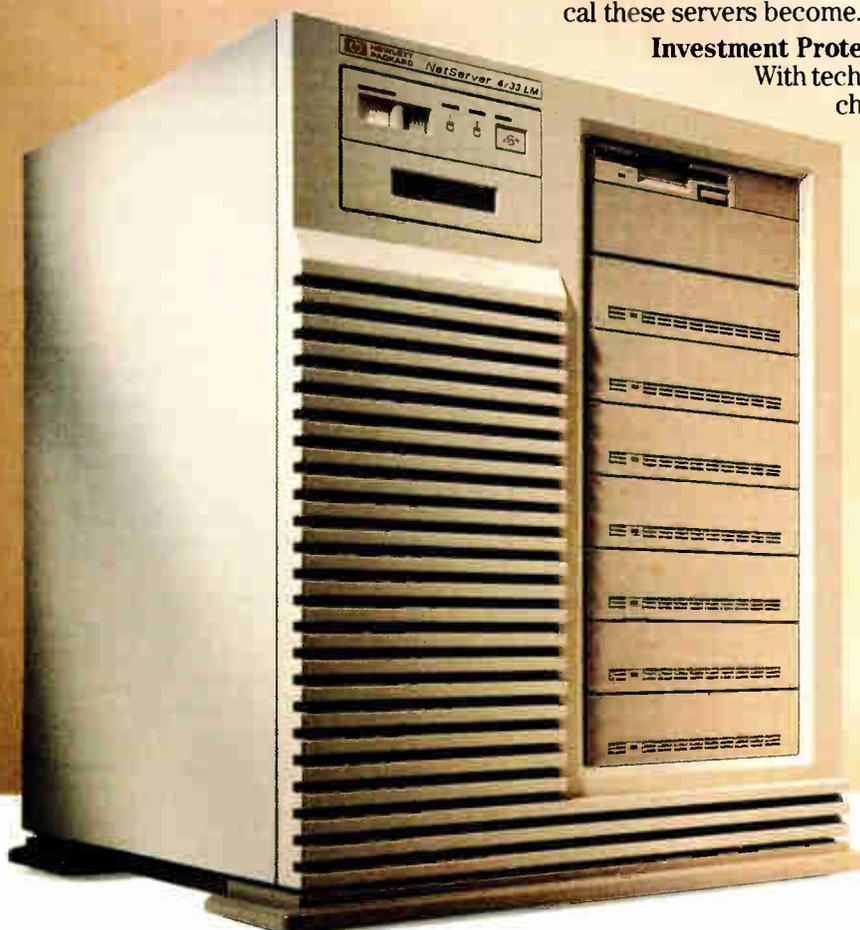
With technology changing

faster than the weather, you'll be happy to know that HP's NetServers are designed to keep pace. And keep your investment protected. Both the LE and LM fit smoothly into multivendor environments. The LE is the ideal entry-level server. Upgradable to the future Intel OverDrive Pentium™ technology-based processor, it provides affordability, exceptional serviceability and future scalability.

Built to meet the full demands of the Pentium processor, the LM will also support dual symmetric multiprocessing. Its Power Cabinet allows room for expansion with nine front-accessible mass storage shelves, eight expansion slots and maximum memory capacity of 384 MB.

HP Service and Network Expertise.

All this is backed by HP's complete range of support services. And by HP's 20+ years of network



HP NetServer Assistant

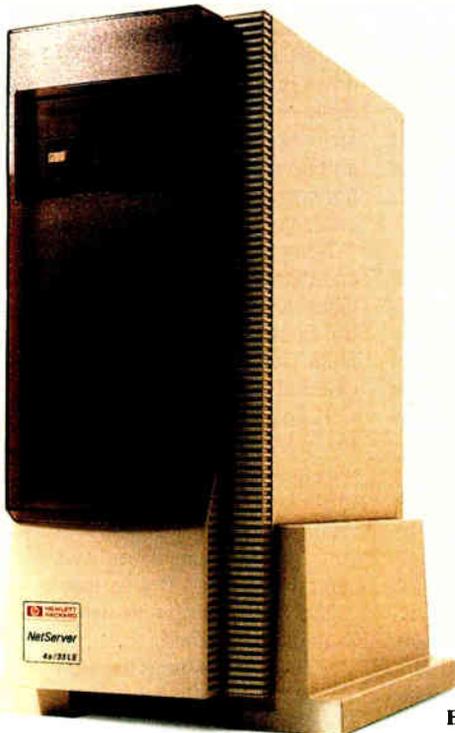
HP NetServer LM

your time, you need an assistant.

systems experience. You can choose support from HP directly, or from your local authorized HP dealer. HP NetServers come standard with a three-year, on-site limited warranty. And a host of 24-hour at-your-service support programs, such as our fax information retrieval service, automated phone support and electronic bulletin board service, ensure easy manageability around the clock.

If all this sounds good, call 1-800-964-1566.

We'll be happy to provide you with fast assistance. And, chances are, without the HP NetServer LM or LE, that's exactly what you need.



HP NetServer LM

\$4,849*

- 60-MHz Intel Pentium™ processor, 33-MHz Intel 486 DX and 66-MHz Intel 486 DX2 processors
- Support for dual Pentium symmetric multiprocessing
- High fault tolerance with internal RAID disk array option (RAID 0, 1, 5, 6)
- 16-MB standard RAM, 384-MB maximum memory, ECC memory support
- 128-KB and 256-KB external cache
- 9 mass storage shelves, 3.5" floppy disk drive standard, maximum 8-GB internal storage
- 8 EISA-2 with Enhanced Master Burst bus-master I/O slots
- Integrated Fast SCSI-2, IDE and video controllers
- HP NetServer Assistant software included
- 3-year on-site, next-business-day limited warranty
- Tested and certified on major network operating systems

HP NetServer LE

\$2,649**

- 33-MHz Intel 486 SX, 33-MHz Intel 486 DX and 66-MHz Intel 486 DX2 processors
- Upgradable to Intel OverDrive Pentium technology-based processor when available
- 4-MB and 8-MB standard RAM, 128-MB maximum memory
- 256-KB external cache
- 4 mass storage shelves, 3.5" floppy disk drive standard, maximum 3-GB internal storage
- 5 EISA bus-master I/O slots
- Integrated Fast SCSI-2, IDE and video controllers
- HP NetServer Assistant software available as an option
- 3-year on-site, next-business-day limited warranty
- Tested and certified on major network operating systems

HP NetServer Assistant

Easy-to-use centralized management based on HP OpenView's leading network management environment allowing multiple servers in multiple sites to be managed from a single graphical map.

Problem identification and resolution tools including diagnostics, configuration information (whether the network operating system is up or down), disk capacity planning and technical information via a CD-ROM-based library.

Remote management capabilities allow administrators to use the same tools whether at their local console or a remote PC.

Open architecture facilitates adding specialized third-party or HP management utilities.

*U.S. list price for HP NetServer LM Model 530, including 486/33DX processor, 16-MB RAM and 535-MB SCSI hard drive. **U.S. list price for HP NetServer LE Model 240, including 486/33SX processor, 4-MB RAM and 240-MB IDE hard drive. Prices subject to change without notice. Pentium and the Intel Inside logo are U.S. trademarks of Intel Corporation. © 1993 Hewlett-Packard Company. PPG688

HP NetServer LE



**HEWLETT
PACKARD**

using the graph type most appropriate to the selected data. The same graphing tool in QP5W might draw a bar chart



The object inspector for a selected spreadsheet block offers quick access to settings that affect the appearance of the cells and the data they contain. Through its Object Help and Function Help, Interactive Tutors, and Experts, Quattro Pro makes it easy to do things.

for one data set and a pie graph for another set.

Once you have created a graph, you can call on a feature called Analytical Graphs. Here, QP5W automatically calculates a moving average, exponential fit, linear fit, or aggregation of a data series and graphs the result. This means you don't need to perform analytical calculations in the spreadsheet to plot statistical projections of your data series. Analytical Graphs don't return their calculations to the spreadsheet, but they enable users without a statistics background to produce visually impressive reports.

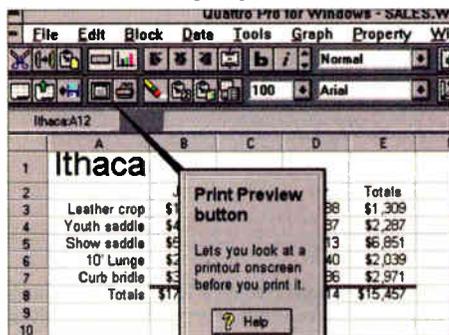
You might overlook one of QP5W's most generally useful improvements: As you type an @function for use in a formula, a function template appears at the bottom-left corner of the display, identifying the function's syntax. If the function requires multiple arguments, the template shows each argument highlighted in turn as you create the formula. What's more, QP5W highlights unmatched parentheses and macro command braces, so you spend less time tracking down these common errors.

Once you've built formulas, you might decide to compile them. This concept has been around for years in stand-alone products like Frontline Systems' 3-2-1 Blastoff, but it has not been built into a spreadsheet package. An on-line Expert can help decide whether you'll get an advantage from compiling the formulas. If the answer is yes, compiling can significantly reduce the spreadsheet's recalculation time.

Multiuser Computing

QP5W lets you share notebooks, or portions of notebooks, with other users on your network. It also lets you share data via MCI Mail. The capability is especially useful in conjunction with the Scenario Manager, a tool that lets you create several versions of a model within a single workbook, so you can quickly switch from one version to another without having dozens of files running at once.

Borland will likely release two versions of QP5W, one for \$99 that can query databases like dBase and Paradox, and a \$495 workgroup version that



When you point at a control in one of the SpeedBars and click on the right mouse button while holding down the Control key, QP5W rewards you with an Object Help box. If the information in the box doesn't satisfy you, you can click on the box's help button for more details.

can also issue SQL queries. But at press time, pricing wasn't finalized.

The Assault on Improv

When Lotus Development generated a lot of hoopla over its release of Improv for Windows, it was only a matter of time before Microsoft and Bor-

land would answer the call. A new facility in QP5W called the Data Modeling Desktop lets you zap spreadsheet data into an Improv-like environment and instantly flip categories around to provide alternative views of the information.

		Jan	Feb	Mar	
Enfield	10' Lunge	883.00	748.00	570.00	
	Curb bridle	1582.00	1308.00	1305.00	
	Leather crop	1087.00	1158.00	1208.00	
	Show saddle	904.00	1038.00	1252.00	
Ithaca	Youth saddle	3388.00	2984.00	2805.00	
	10' Lunge	1722.00	1985.00	1558.00	
	Curb bridle	4135.00	4373.00	3857.00	
	Leather crop	1284.00	1032.00		
Newfield	Show saddle	5748.00	4365.00		
	Youth saddle	4272.00	4436.00		
	10' Lunge	1722.00	1985.00		
	Curb bridle	4135.00	4373.00		
Newfield	Leather crop	1471.00	1542.00		
	Show saddle	5748.00	4365.00		
	Youth saddle	4272.00	4436.00		

land would answer the call. A new facility in QP5W called the Data Modeling Desktop lets you zap spreadsheet data into an Improv-like environment and instantly flip categories around to provide alternative views of the information. Once you create a multi-dimensional table in the Data Modeling Desktop, a quick drag or two with the mouse completely transforms the table. When you discover a useful view of the data in the Data Modeling Desktop, you can quickly copy it back to the spreadsheet notebook. There, you can apply formatting and styling options, add formulas, and graph the information in its new configuration. To go from the arrangement on the left to the one on the right took about a second and a half.

Data for the Data Modeling Desktop originates from a QP5W notebook, but you can't write formulas within the Data Modeling Desktop, nor does the module offer extensive formatting and reporting capabilities. In a sense, Data Modeling Desktop is a cut-rate data slicer and dicer. As such, it's a handy new tool, but it takes practice to organize data appropriately.

The Suite Spot

I've barely scratched the surface of QP5W's new features. Borland has added a spreadsheet spelling checker, a host of new @functions, a formula auditing facility, and a utility that rapidly consolidates data from several disparate notebooks or notebook pages into a single page.

QP5W's heavy reliance on objects—each with its corresponding object inspector, context-sensitive help, SpeedBars, and so on—conspires to make it feel as if you are working in several software programs

rather than in one package. You can use the product extensively and still be surprised at the object inspectors that come to light when you right-click on a data element. Until you get used to it, the environment is disorienting.

When compared one-on-one to Lotus 1-2-3 release 4.0 for Windows and Excel 4.0, the new features put QP5W ahead in the Windows spreadsheet contest. But don't let this in-

fluence your purchasing decision too strongly. Microsoft and Lotus each produce a suite of Windows products—spreadsheet, word processor, presentation graphics, and E-mail programs designed with similar user interfaces and sold in a single package. Borland's Windows bundle includes WordPerfect for Windows. It also includes Paradox for Windows, a database manager you may not need in 1-2-3 or Excel because you can use DataLens in 1-2-3 or Q+E in Excel to create and manage external database tables. QP5W's Database Desktop external database management facility can't create new external tables.

If you're already a Quattro Pro user, Borland's upgrade will make it worth your while to stick around. The new version offers a host of features for the first-time Windows spreadsheet user. But its integrated offering is not as strong as the competition's.

—Daniel Gasteiger

Borland International, Scotts Valley, CA, (408) 438-8400.

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World Radio History

SOFTWARE DEVELOPMENT

Programming Tools Catch Memory Misuse

One of the hardest problems in writing software, particularly in languages like C and C++ that depend heavily on pointers, is finding the places where you misuse memory. If you're programming in such languages, you're all too familiar with pointers that don't point to legal memory or, even worse, point to the wrong block of memory. These types of errors are often nonfatal—at first. When undetected, however, memory-related bugs can eventually cascade to cause fatal errors that are virtually impossible to diagnose in isolation.

Current debuggers provide limited help in finding memory problems because they are tied to the source code. When you know which part of a program is misbehaving, you can zero in on the problem. However, when your program is misusing memory, you generally have only a vague idea of which section of your code you should examine.

Two new Unix software development tools let you automatically discover a wide variety of memory-related errors. They will flag code that refers to illegal parts of memory, fails to free memory that is no longer being referenced, or deallocates the same memory several times.

CenterLine Software, a major developer of programming tools for Unix systems, provided some help in its earlier products. CodeCenter, a C environment that first shipped in July 1988, and ObjectCenter,

a C++ environment that first shipped in November 1990, include source language interpreters as well as compilers. The interpreter flags a variety of memory-usage errors, including nonfatal ones, which are difficult to discover and track down. The drawback to interpretation is that it is much slower than compiled code, making it impractical to use on large or time-consuming applications.

After CenterLine had whetted programmers' appetites for development tools, Pure Software released Purify (\$1298 per user), demonstrating that many of the same error-checking benefits could be achieved more efficiently. The key is a technique Pure calls object code insertion, but it's more often known as code-patching. (Although code-patching appears to be the technology of choice for Unix systems, PC error-checking tools like Nu-Mega Technologies' Bounds Checker—for Windows and DOS—can also achieve high efficiency by using built-in features of the 80x86 processor family to insert breakpoints and memory page protection; see our review of Bounds Checker on page 159.)

Purify intervenes between compilation and linking, patching the instructions that allocate and reference memory with error-checking code. This lets Purify work with libraries you don't have the source code for (e.g., system libraries or libraries bought from another

vendor). You simply add the command "purify" before the invocation of the compiler, and Purify creates the debugging version of the program automatically. Purify calls the compiler, looks at the machine code, and inserts instructions that catch memory errors in both libraries that you link in and the code you wrote and compiled. Typically, the problem of misusing memory occurs when you pass a bad memory block to a library routine.

When you run a "Purify'd" application, it prints a message whenever an illegal memory reference or other run-time error occurs. The message gives the source code location of the error as well as a stack trace to help track it down. When the application has finished, Purify prints a list of *leaks*—memory blocks that have been allocated and can no longer be deallocated.

CenterLine has responded with TestCenter (\$1295; \$2995 for a floating license that lets you share the program on a network), which provides the same features together with a GUI and a code-coverage tool. TestCenter is currently available for Sun Microsystems' workstations running Solaris 1.x; a version slated for release later this year will support So-

laris 2.x. TestCenter's code-coverage tool shows you which lines of the program have and have not been executed. The system can also combine coverage results from multiple executions. This is helpful in developing a comprehensive test suite that thoroughly exercises the application. An advantage to the TestCenter interface is that it simplifies archiving, comparing, and browsing execution error logs.

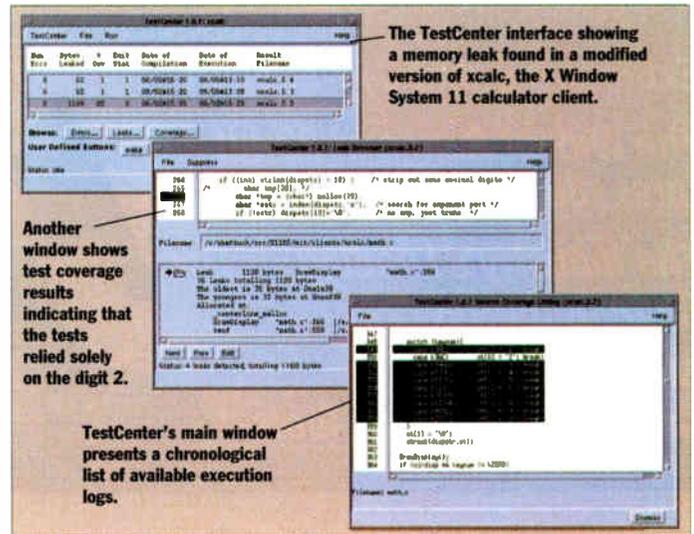
As these two companies fight over the market for testing tools, developers are sure to benefit. Expect significant improvements in both product lines during the upcoming months. Both companies will also be using the technology in these tools as a basis for other products. Pure has already done so with Quantify, a performance profiler, and PureLink, a fast incremental linker.

—Othar Hansson

CenterLine Software, Inc.,
Cambridge, MA, (617) 498-3000; fax (617) 868-5004.

Pure Software, Sunnyvale, CA,
(408) 720-1600; fax (408) 720-9200.

Nu-Mega Technologies,
Nashua, NH, (603) 889-2386;
fax (603) 889-1135.



The TestCenter interface showing a memory leak found in a modified version of xcalc, the X Window System 11 calculator client.

Another window shows test coverage results indicating that the tests relied solely on the digit 2.

TestCenter's main window presents a chronological list of available execution logs.

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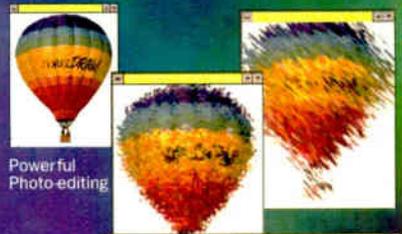
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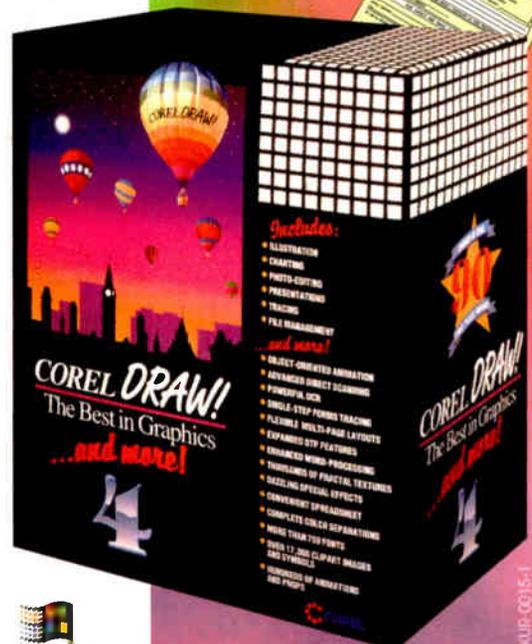


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SMALL OFFICE/HOME OFFICE SOFTWARE

SOHO Software Follows Low-Cost Hardware

While most large and midsize companies began computerizing their offices a decade or more ago, many small offices and home-office workers are just now getting started. That presents new challenges, not only for these SOHO users but also for software publishers accustomed to dealing with experienced, well-heelied corporate customers.

Increasingly, publishers are discovering that SOHO users are a different—and in some ways more demanding—breed when buying software. They want programs that are easy to use, work well together, and don't cost hundreds of dollars apiece. Big-business users want these qualities in their software, too. But unlike their corporate counterparts, many SOHO buyers will stand on the sidelines until they get what they want.

"People in small businesses and home offices want solutions to very specific problems, and the money is coming out of their own pockets," explains Kevin Howe, president of DacEasy, which has been selling accounting programs primarily to small businesses since 1985. "If you don't give them what they want, they won't computerize."

While there's been no dramatic shift in the types of programs that software publishers are producing, many companies have begun introducing new products or tailoring old ones to meet the demands of SOHO customers. DacEasy, for instance, borrowed pieces of its namesake accounting program to fashion streamlined

subsets dubbed Instant Accounting, Instant Payroll, and Instant Rolodex. Intuit crafted small-business bookkeeping (QuickBooks) and payroll (QuickPay) programs from its popular Quicken personal-finance software.

Larger companies (e.g., Microsoft and Computer Associ-

introduced programs through its Bothell, Washington-based retail products division that generate 2-D floor plans for homes, decks, kitchens, and landscapes. It is competing with companies like Abracadata, Expert Software, and Green Thumb Software. Judy McNary, president of Green Thumb (Boulder, CO), said programs like her company's DOS-based LandDesigner landscaping program offer capabilities for the home user that aren't possible using a pencil and a pad of paper (e.g., in buying materials, quickly calculating the number of cubic yards and cost of a needed material).

In addition to their problem-solving approach, these products have something else in common: They're inexpensive—generally less than \$100, sometimes less than \$50, and in rare cases, free! Companies like Computer Associates and Central

Computer Products (Fillmore, CA) have promoted their respective home-finance and double-entry accounting programs by literally giving these

programs away for a limited time.

DID YOU KNOW?

- In 1993, the estimated total number of home workers in the U.S. grew 5.4 percent to 41.1 million, more than double the growth rate of the prior 12-month period.
- Telecommuters, company employees who work from home part- or full-time during normal business hours, increased by 1 million from 1992, a 15 percent growth rate.
- The PC penetration rate into the homes of workers who do company work at home after normal business hours is 70 percent.

Source: Link Resources (New York City)

SOFTWARE DEVELOPERS HEAD FOR HOME

CATEGORY		PERCENT OF REVENUE
Word Processing	Small Business ...	19.2
	Home Office	11.2
Spreadsheets	Small Business ...	22.7
	Home Office	14.5
Graphics	Small Business ...	25.6
	Home Office	18.8
Desktop Publishing	Small Business ...	12.5
	Home Office	11.7
Integrated	Small Business ...	18.8
	Home Office	25.5
Communications	Small Business ...	22.3
	Home Office	25.5
Database	Small Business ...	16.4
	Home Office	9.2

Source: BIS Strategic Decisions (Norwell, MA)

The SOHO market accounted for 34.8 percent of the overall estimated \$3.06 billion of 1993 U.S. sales for these seven software categories. BIS defines a small business as being outside a home, with under 100 employees.

programs away for a limited time.

"Price is really the second battlefield," says AbhiJeet Rane, a research analyst who follows SOHO trends for Link Resources in New York City. "Software prices may not come down as quickly as they have with hardware, but they are definitely dropping."

To some extent, price-conscious SOHO users were already being served by the many integrated or "works" packages on the market (e.g., Microsoft Works, LotusWorks, and ClarisWorks). For those who need more than the basics of word processing, spreadsheet, graphics, database, and telecommunications functions, the latest trend in integrated packages is "office" or "suite" bundles that put three to five applications in one box for less than \$500. These include Lotus's Smart Suite, Microsoft Office, and Borland's Office.

—Christopher O'Malley

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The latest version of Quicken for Windows adds a host of features. One of the most interesting is the Financial Calendar. This feature provides the ultimate in intuitive financial management, as it lets you work in something with which everyone can identify: a daily planner.

Intuit (Menlo Park, CA, (415) 322-0573) should have released its Quicken 3.0 for Windows and Quicken 7.0 for DOS (about \$69.95 each) by now. Both will include improved investment-tracking and financial-planning tools and the Financial Calendar. Both still let you work in the familiar checkbook metaphor that makes it easy to balance your checkbook. The new versions of Quicken let you enter one-time or recurring transactions directly in the Financial Calendar; once you do this, the transaction is recorded to the register. You can also add reminders in the calendar. Based on my use of a prerelease version of Quicken for Windows, Intuit is on-track when it comes to home finances.

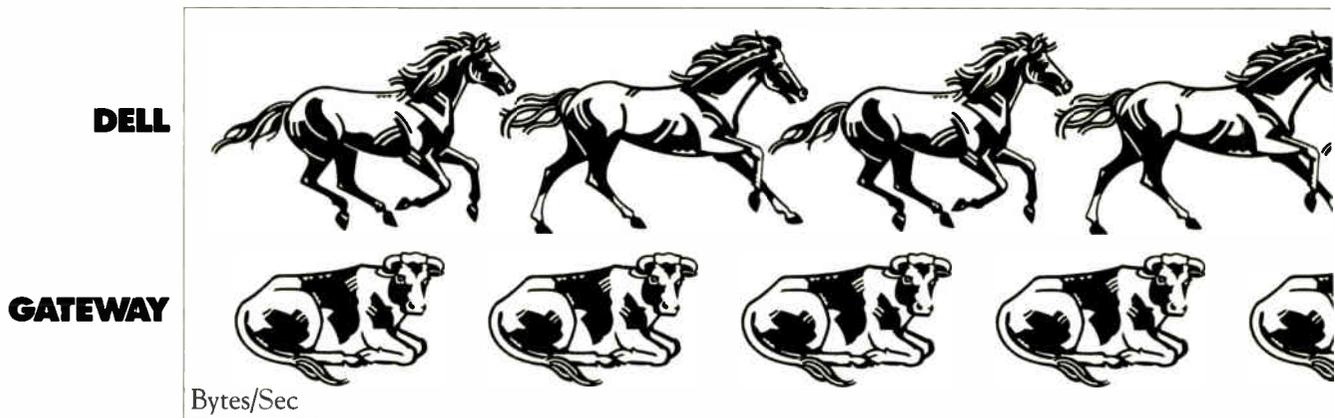


—Dave Andrews

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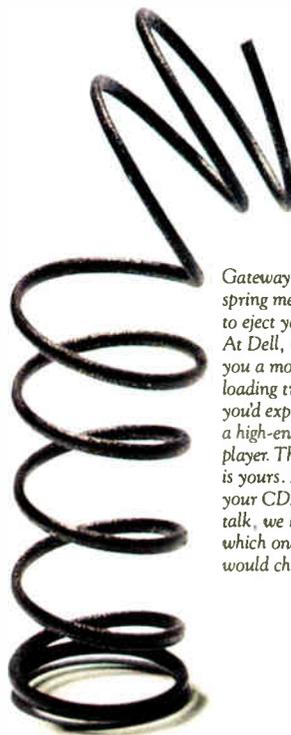
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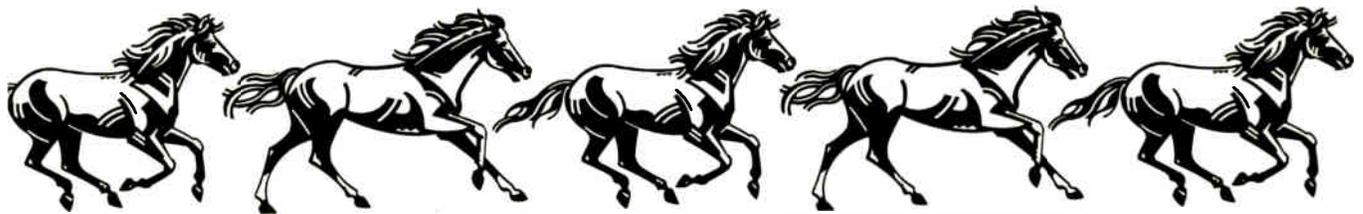
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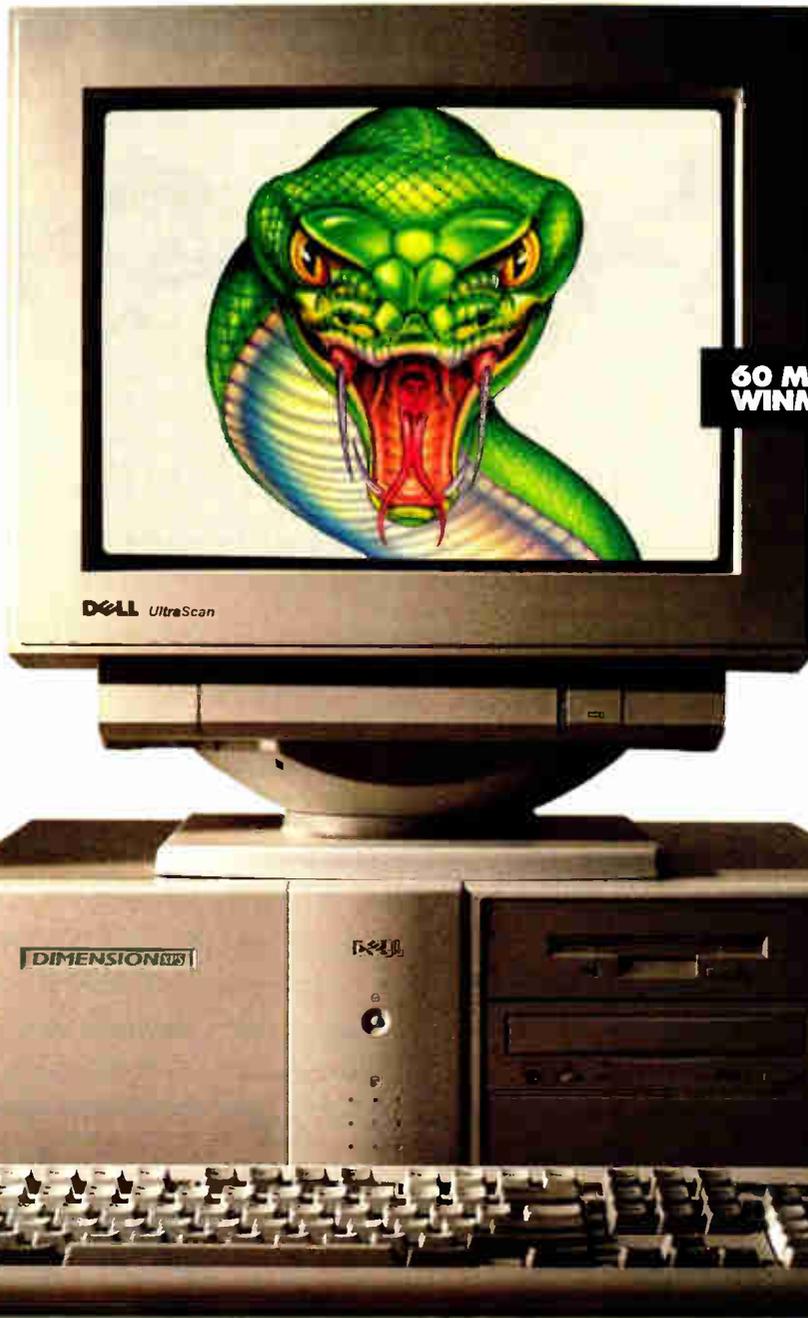
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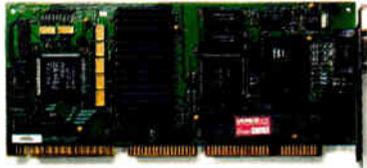
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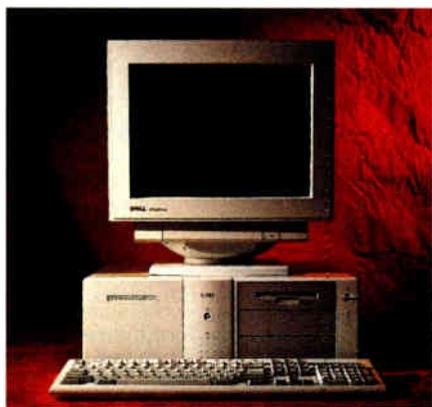
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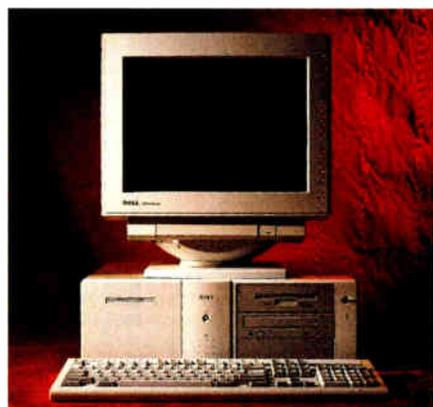
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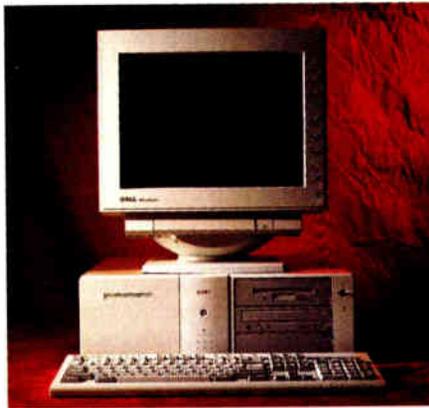
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SECURITY

PCs Catch Criminals Using Fingerprint Analysis

TAIPEI—When it comes to industrial espionage, spies can disguise their identity, alter ID cards, and crack passwords, but they cannot change their fingerprints. With that immutable fact in mind, two companies have developed products that use advanced image-processing techniques to capture, encode, and match fingerprints to identify criminal suspects and prevent unauthorized entry.

The idea behind the products of Hsinchu, Taiwan-based Startek Engineering (+886 35 785388) is to use a fingerprint identification system to control access into a computer, transaction-processing equipment, or a physical location like a laboratory. To achieve this, Startek's technology combines optics and accurate matching algorithms to compare a new fingerprint to ones stored in a computer.

Startek offers two products, each of which can store 1000 fingerprints. The FC100 is used for computer and transaction-processing security applications. It consists of a stand-alone FingerCheck fingerprint verifier, an AT-bus interface card, and a software application interface and library. The second product is the FC200, which is an embedded version of the FC100. The FC200 consists of FingerCheck and an RS-232 interface. Both systems are for access control applications and can process a fingerprint in 2 to 3 seconds.

In computer security applications, FingerCheck is connected to a 386 or 486 PC through the AT-bus card. To use the FC100, you place your finger three times on the reader window, a small,



Startek's fingerprint identification system connects to a PC through the AT-bus card. The red LED fingerprint reader is at the top left.

red LED screen that's located on top of FingerCheck. A CCD (charge-coupled device) camera inside the unit takes optical snapshots of your fingerprints at one-thirtieth of a second. Fingerprint images are digitized in an image-grabber processing module, resulting in 2-D images of your fingerprints on a computer screen.

Meanwhile, Startek's software automatically extracts 13 feature points of your fingerprint images. Each feature point is translated into binary images and stored in the software library. A single fingerprint is stored in a file of up to 256 bytes. The next time you attempt to gain access to the

PC, it will accept or reject your fingerprint.

The company's proprietary matching algorithms perform the accept/reject operation. By using an automatic planar-point-pattern device, the program compares the vectors of your binary images to those in the PC. Startek claims the false rejection rate is less than 1 percent. Startek's FC100 costs \$2700. Prices for the FC200 depend on configuration.

New Delhi, India-based CMC also uses fingerprint verification, but to solve a different problem. Startek's products are designed to control access to sensitive data and locations. CMC's FACTS (Fingerprint Analysis and Criminal Tracing System) uses the power of the computer to reduce the amount of time required for a person to compare fresh fingerprints to thousands of fingerprints in an existing database, a task that—when performed manually—is herculean. Agencies like the FBI use mainframe computers to store and match fingerprints, but Tim Fontenot, spokesman for CMC, says

FACTS is a scalable solution that can run on a 386 or 486. This makes it suitable for small cities or developing countries.

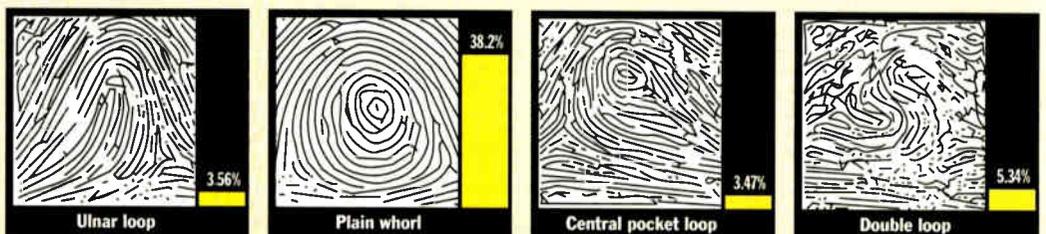
FACTS consists of several components that connect over a network. A control machine handles the matching and encoding functions. An input workstation converts a fingerprint received on paper or as a photograph to a digital image. Once FACTS has extracted the important features from a fresh fingerprint, the system compares it to those in the database and gives a short list of likely matches. At that point, a human expert can examine the list and identify the correct match. CMC, which has a subsidiary in the U.S. called Baton Rouge International ((504) 296-8440), says FACTS is being used by the National Crime Records Bureau in New Delhi.

Although Startek and CMC are solving different problems, both are combining the power of the PC with mathematical algorithms to catch criminals by their own hands.

—Mark LaPedus and Dave Andrews

Fingerprint Classifications

Startek's program automatically breaks down a fingerprint into seven different classifications (e.g., plain arch, radial loop, and plain whorl). The software locates 13 feature points based on a fingerprint classification system developed by E. R. Henry. The figures show fingerprint types and the percentage of people who have them.



DEVELOPERS:

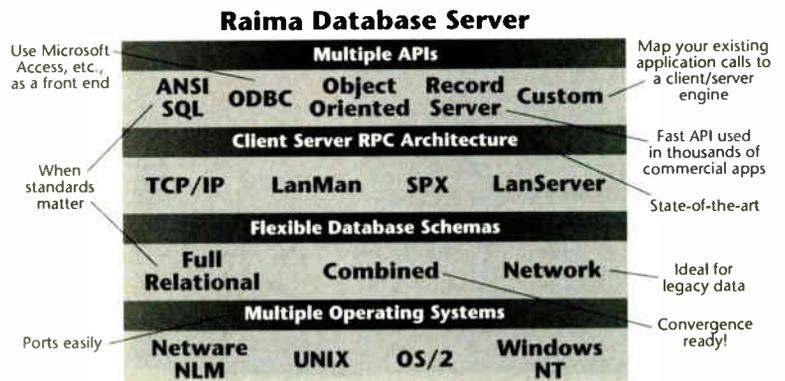
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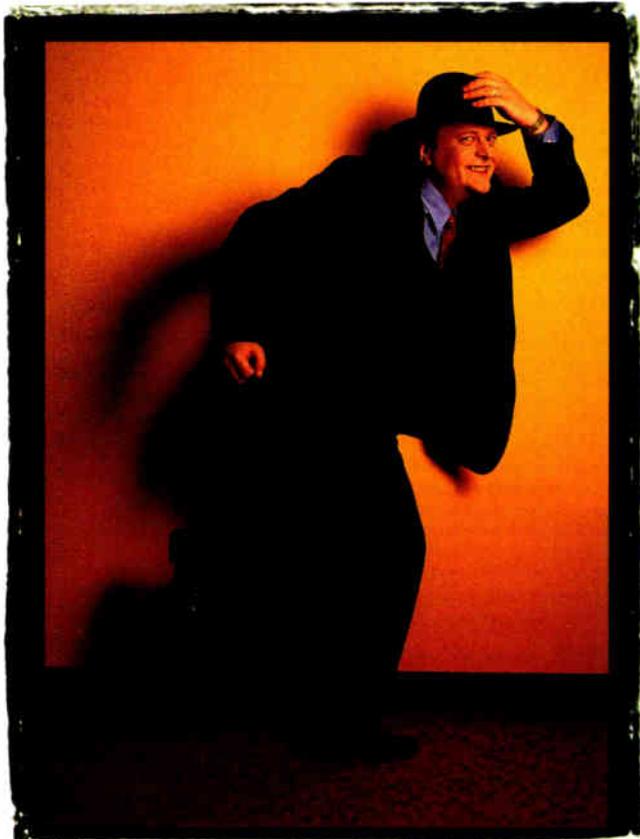
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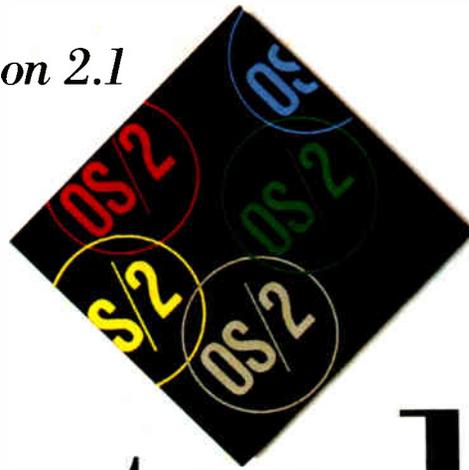


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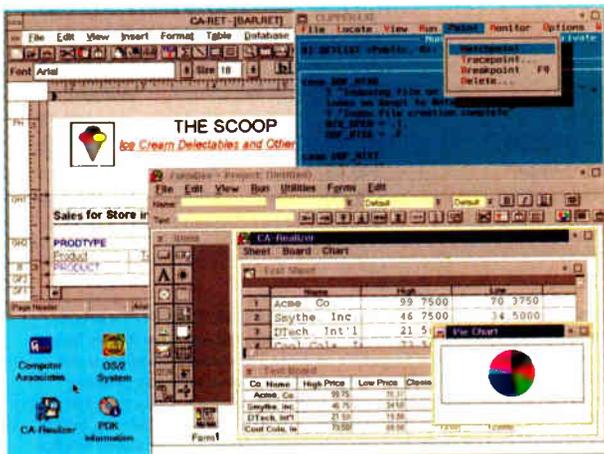
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PROCESSORS

I'll See Your Chip and Raise You One

Obsolence is the greatest fear of computer buyers, and that fear has been focused mainly on the heart of the system: the microprocessor. To alleviate these worries, chip makers such as Intel, Cyrix, and Weitek have devised processor upgrade options to help PC and workstation buyers protect their investments.

Intel's well-publicized program lets users upgrade systems through its OverDrive family of processors. Cyrix's (Richardson, TX) newest family of 486 processors is designed for those who want to upgrade 386DX PCs to 486 performance for only \$299. The company's Cx486DRx2 16-/32-, 20-/40-, and 25-/50-MHz clock-doubling processors that upgrade 386DX processors to 486 processors list from \$299 to \$399. Weitek (Sunnyvale, CA) should now be shipping its \$1500 Power uP processor, which the company claims improves performance of SparcStation 2 and IPX workstations by as much as 1.9 times.

Are users actually upgrading? Or do processor upgrades amount to a security blanket that's destined to sit in a closet? Chip makers insist the benefits are real and that people are taking advantage of the opportunity to inject an added dose of speed into their computers. Less biased observers say the benefits are more about peace of mind than megahertz.

"It's more of a marketing

ploy than a real need expressed by users," asserts Bill Ablondi, who is vice president of the research firm BIS Strategic Decisions (Norwell, MA). "It's become a checklist item now that both buyers and sellers feel they have to satisfy."

Ablondi estimates that fewer than 5 percent of PC owners have replaced their processor. One reason for the hesitancy, he explains, is that BIS surveys indicate that a majority of users still do not feel comfortable about opening up their PCs to add a circuit board—much less swap processors.

Cost is another factor. With the price of Intel 486-based PCs dropping below \$1000, it's sometimes difficult to justify spending \$500 or more on a clock-doubling OverDrive upgrade. New computers are also engineered to work optimally with a faster chip, notes Ablondi, often outperforming similar systems that have been "cobbled together."

Indeed, the need for a new processor is often a sign that it's time to upgrade the whole system, notes Mike Feibus, editor of *MicroSystems Report*, a newsletter published by research firm MicroDesign Resources (Sebastopol, CA). "If the processor is sputtering," he says, "then chances are, there's a half dozen other things in the system that are sputtering, too—memory, hard disk, video, and so on." Feibus esti-

mates that perhaps 15 percent of users with processor upgrade options might eventually exercise them.

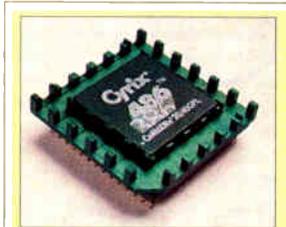
Jim Chapman, vice president of marketing at Cyrix, disagrees with these assertions. "Clearly, there's a camp that's going to buy new machines," he concedes. But he also says upgrades are an attractive option for corporations that want to extend the life cycle of their machines by 12 to 18 months. Chapman says one benefit of Cyrix's chip upgrades is that—unlike Intel's OverDrive—the Cyrix upgrades don't require a special socket. Chapman says the Cyrix upgrades will work on "99.5 percent of the [386DX] systems out there." Cyrix is currently testing a clock-doubling chip for 16-MHz 386SX chips and a 33-/66-MHz 386DX upgrade chip.

Intel, which has likened the OverDrive socket it supplies to PC makers to a "vacancy" sign inside the computer, won't divulge sales numbers for its

OverDrive chips but says its high-profile upgrade campaign is meeting expectations. The net percentage of people upgrading is small, concedes Mike Fister, general manager of Intel's End User Components division. But because the OverDrive processors are intended mainly as a "mid-life boost" for PCs that are depreciated over five or six years, he insists it's too early to judge their success. "If you bought an OverDrive chip a month after you bought a PC, then I'd say you probably bought the wrong system to begin with," says Fister.

The real key to the widespread acceptance of processor upgrades may be bringing down prices, agrees Fister. Math coprocessors that once sold for more than \$500 now sell for less than \$100, and the same thing could happen to CPU upgrades. If it does, expect to see a lot of "no vacancy" signs.

—Christopher O'Malley



When installing Cyrix's Cx486DRx2 upgrade, I found that the hardest part of the task is pulling the old processor out of the system's motherboard. Once that was accomplished, installation was fairly easy. Cyrix supplies a chip puller (which resembles a shoehorn) that makes the job easier.

HANDS ON

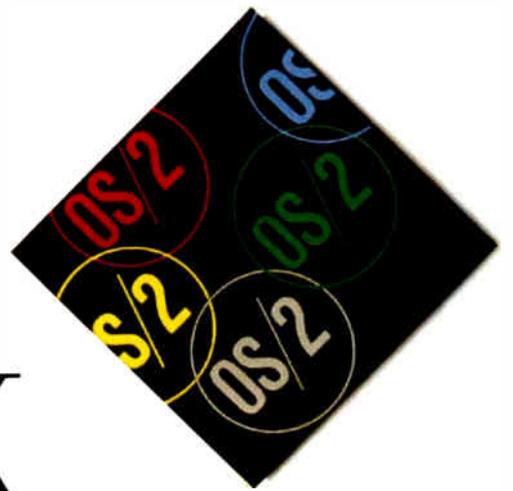
BYTE DOS BENCHMARKS: CPU TESTS (VERSION 2.4)

	CYRIX/CACHE	COMPAQ 386/20	486/33 MMZ
Sieve*	85.25	27.98	123.54
Sort*	10.60	3.18	12.09
Integer Math*	463,597.33	225,631.07	505,880.80
Move (byte)*	55.41	55.41	185.78
Move (word-odd)*	141.43	138.36	356.68
Move (word-even)*	145.35	145.32	370.14
Move (doubleword-odd)*	78.99	66.44	226.98
Move (doubleword-even)*	125.00	125.02	570.84
CPU Index (Desktop Class)	0.73	0.49	1.60

*measurements in ips = iterations per second

When installed in a Compaq 386/20, Cyrix's \$349 Cx486DRx2 ran BYTE's benchmarks about 1.5 times as fast as the original processor, but less than half as fast as a 486. When evaluating whether to upgrade, you need to consider more than just CPU performance. For example, if you have an 8-bit graphics card, you probably won't see any increase in screen performance after you upgrade. Tests were run using version 2.4 of the BYTE DOS benchmarks. For all tests and all indexes, higher numbers indicate better performance. Desktop Class indexes are calculated relative to a Compaq Deskpro 386/33L.

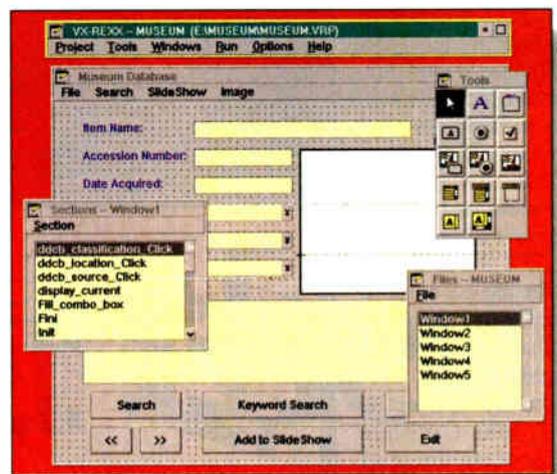
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DIGITAL SIGNATURES:
NOT SO FREE

WASHINGTON—The National Institute of Standards and Technology has avoided a potentially messy court battle over a public-encryption standard, but the solution has angered many who believe it lets one company profit from a standard that was promised to be free to the public. When NIST unveiled

EMERGING TECHNOLOGY

Optical-Computing Power Coming to Light

Researchers see optical computing as an emerging technology with a bright future. Recently, Stephen A. Kupiec, chief engineer at laboratory. Methods that scientists are considering to compute photonically include OPLA, SEED (self-electro-optic effect device), and bit-serial

News & Views

SYSTEMS

IBM's Ambra: Virtual Corporation... Logical Move

A number of company names (i.e., Merisel, SCI Systems, Acer, and Wearnes Technology) are mentioned in the same breath as Ambra, the new IBM subsidiary that will sell lower-than-low-end PCs. Ambra president David Middleton says that the new division hopes to capture at least 10 percent of what he says is a \$10 billion market of people who prefer to buy their PCs by phone.

However, the companies listed above will contribute as much to the manufacturing, distribution, and support of Ambra's PCs as IBM will. For example, SCI will build Ambra's motherboards, Acer is providing systems development and subsystems technologies, and Merisel is handling the order taking. With IBM playing a less dominant role than ever before, analysts say one question that users will inevitably ask is: Can Ambra maintain the quality they expect of IBM systems?

Rival Compaq boasts in-house manufacturing across its product line. Dell says it has brought all its manufacturing in-house, giving Compaq one less point of contrast, and Gateway 2000 has brought in all its desktop manufacturing as well. Necessity or good marketing? "There's no reason why you should have lousy quality whether you outsource or not," says David Wu, analyst for market research firm S. G. Warburg in New York City.

The key, he adds, is how well products are tested.

What remains to be seen is the effect Ambra will have on the competition, billed "a tough call" by Infocorp analyst Scott

Miller. Also open is how Ambra sales might dip into those of IBM's own Value-Point, particularly in a mail-order channel that generates 10 percent of that line's sales—a sizable portion considering the profit margins of low-end systems. "It almost seems like the company is duplicating effort," says Miller. "You have two direct-response organizations. How do you retool that?"

The biggest wait-and-see, however, is Ambra's business model, the virtual corporation, which shows a major company outsourcing perhaps more than the industry has ever before seen to beat lowball clone makers at their own game. "It certainly is a new way to do business," says Miller. "If a company like IBM can be successful at this, it raises the questions: 'Do I really need to be in the manufacturing business? Does it make more sense to spend my resources doing other things?'"

—Ed Perratore

Ambra Computer Corp.,
Raleigh, NC, (800) 252-6272.



AMBRA VS. DELL: A DESKTOP SAMPLING

SYSTEM	CPU	CONFIGURATION	PRICE
Ambra S450SL	486SLC-2/50	4 MB of RAM, 64-KB L2 cache	\$1069
Ambra D466BL	Blue Lightning 66	4 MB of RAM, 256-KB L2 cache	\$1559
Dell Dimension XPS 450V	486DX2/50	4 MB of RAM, 128-KB L2 cache	\$1778
Dell Dimension XPS 466V	486DX2/66	4 MB of RAM, 256-KB L2 cache	\$1978

How low is low? Ambra, the new direct-response IBM subsidiary, has announced two notebook computers and 14 PCs—including a dual 60-MHz Pentium tower PC with a CD-ROM drive and a 540-MB SCSI hard drive for \$6559. The chart shows the low end of the Ambra line and similar products that Dell announced the same day. Ambra configurations include a mouse, DOS, Windows, a 256-color graphics card, and a 240-MB hard drive. Dell's minimum systems include a 230-MB hard drive and a #9 GXE VL video card but no monitor. The Blue Lightning 66 is IBM Technology Products' (Somers, NY) processor subsystem. IBM expects to start sampling a clock-tripled 33-/100-MHz computer in this quarter.

EMBEDDED PROCESSORS

PowerPC Goes Underground

IBM Technology Products plans to begin volume shipments in mid-1994 of a line of embedded processors that are based on the PowerPC architecture and designed for applications like printer and I/O control, PDAs (Personal Digital Assistants), and consumer electronics devices. Designated the PowerPC 400 family, to differentiate it from the PowerPC 600 family under development by IBM and Motorola for general-purpose computing platforms, the processors in the 400 family will be made available in chip form, on board-level controllers, and as ASIC (application-specific IC) cores.

The last variation is particularly interesting because it lets manufacturers add custom control circuitry to the same chip containing a PowerPC processor, thereby eliminating the design problems and performance hit you take when you move signals off-chip. The ASIC core is also an important competitive advantage: AMD and Intel don't offer an ASIC core for their first-line embedded architectures, the 29K and 960, respectively.

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Catch



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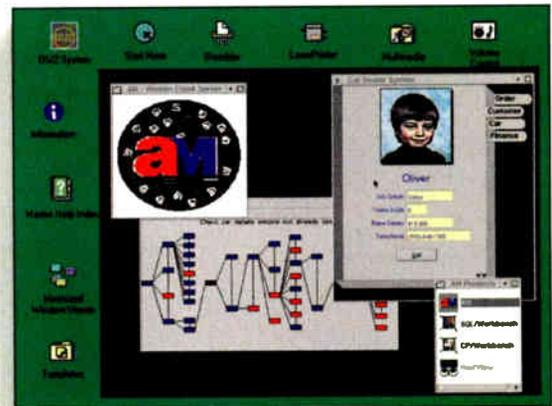
For the latest-breaking developments, we take you to corporate America, where *AM* and OS/2 offer a tried and tested mechanism for building 32-bit, multitasking, line-of-business client/server applications. *AM*'s visual programming environment streamlines the development and maintenance of mission-critical client/server applications by teams of programmers. And Static SQL support makes *AM* a real headliner.

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If *(wait)* **this** *(wait)* **is** *(wait)* **how**

(wait) **your** *(wait)* **computer** *(wait)*

does *(wait)* **Windows,** *(wait)*

have *(wait)* **we** *(wait)* **got** *(wait)* **a**

(wait) **PC** *(wait)* **for** *(wait)* **you.**

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But wait: it gets even better.

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DESKTOP PUBLISHING

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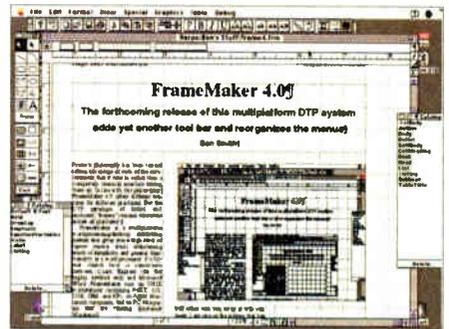
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PSION'S NEW POCKET COMPUTER IS TWICE AS NICE

PSION HAS TAKEN THE BEST features of its Series 3 pocket computer (e.g., a multitasking operating system, long battery life, and diminutive size) and improved upon them by doubling the screen, internal system RAM (now 512 KB), and the speed at which its processor runs (now 7.7 MHz).

Because Psion redesigned its applications to take advantage of the new system's improved graphics capabilities, it has also increased the internal application ROM to 1 MB. The Series 3a also lets you record reminders and other brief voice messages for later replay through its built-in microphone. The result is an improved version of a very capable computer that easily slips into your pocket. The Series 3a will sell for about \$499.

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- Creates automatic hypertext links (clicking on a page number in the table of contents brings you to that page)
- Supports RGB, HLS, CMYK, and Pantone color models
- Document comparison
- Customizes menus in three ways
- Equation editor good for math-intensive documents
- Rotates text and graphics in 0.001-degree increments
- Side heads now supported

MAC VERSION

- QuickAccess toolbar lets you easily access commands
- Support for QuickTime, Apple Events, and Publish/Subscribe
- Thumbnail preview of documents and images
- Ungroups imported PICT images for further editing

WINDOWS VERSION

- QuickAccess toolbar
- Can import CorelDraw and GEM graphics files
- More document-importing filters

UNIX VERSIONS

- Import and export text through the XClipboard utility
- HP VUE and OpenWindows support for drag-and-drop and double-click file launching

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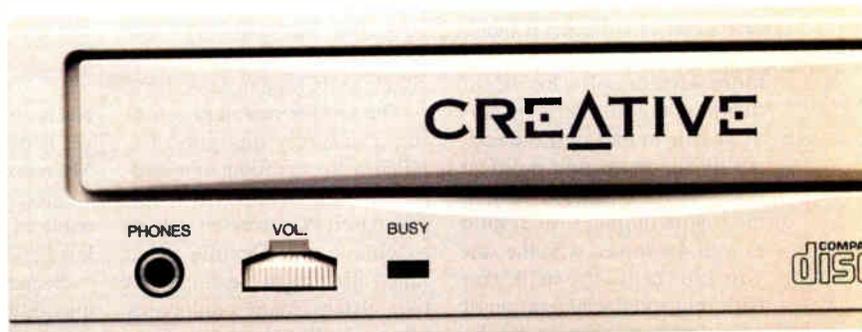
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World Radio History

SAEED VAHID

Moving Forward—Cautiously

At the climax of the Islamic revolution 14 years ago, the ruling government generally regarded computers as luxury equipment that offered little benefit to a country in which almost 40 percent of the population was employed in the agrarian sector. Before the revolution and the overthrow of the Shah of Iran, mainframe and minicomputers were mostly used by large organizations. But Iranians in all sectors of business now recognize the benefits of computerization.

When western countries applied economic sanctions to Iran after the U.S. embassy was seized, buyers of cast-off mainframes in Iran lacked support in the area of software, documentation, and after-sale service. Due in part to these economic sanctions and political upheaval, Iran lagged behind the microcomputer revolution as well. However, with the August 1988 cease-fire in the war with Iraq and the adaptation of a free-market economy by the new government, Iran is trying to keep pace with the world.

The U.S. government prohibits U.S. companies from exporting computers with a rating of more than 6 MTOPS (million theoretical operations per second) to Iran. Iranian buyers can nevertheless purchase such equipment from companies like Tatung that are headquartered in East Asia, as well as through European channels. Lower powered 386-based PCs are also available through resellers for U.S.-based companies. Although the majority of PCs in use come from East Asian countries, firms like Dell, ALR, NCR, and IBM now have resellers in Iran. Companies in

Iran have also been able to obtain Mac Quadras and R4000-based workstations.

Iran's own indigenous computer industry has suffered to some extent due to changing policies. For example, in the early 1980s, a group of Iranian engineers at a company called Pooya began to build a natively designed minicomputer, as well as write the system's own operating system. However, just as they finished the system, the state ban on importing PCs was lifted, and it was no longer economically justifiable to manufacture the expensive minicomputer. Pooya now offers Samsung's PCs and ICL's DRS-6000 RISC machines to its Iranian customers.

The last attempt at developing a natively designed PC failed with the rollout of a Z80-based PC to a market in which 286-based PCs were already in extensive use. Despite these failed attempts at creating a native system, many companies remain in the business of assembling components and making quality clone computers.

As in a number of countries, the internationalization of English-language software poses a unique set of challenges to software developers in Iran. Five Persian character sets exist in the market, each one introduced by a different company for use in its own software.

About 90 percent of the microcomputers in Iran run Microsoft's MS-DOS. A Tehran-based software company called Computer Software, working in collaboration with Microsoft, has begun a project to add Persian language capabilities to the popular operating system. A beta version of Persian DOS



has been released, but it has not yet been formally announced. Microsoft is also developing a version of Windows that is capable of handling the right-to-left Persian script.

Because none of the companies developing Persian software in Iran are strong enough to influence the other software companies, each of their proprietary Persian character sets will continue to be used in parallel. Perhaps Microsoft's Persian DOS will be a powerful enough force in the market to make the DOS character set the dominant one. But if software companies continue to introduce proprietary products and the government continues to implement confusing policies, the dominant characteristic of Iranian computing may be one of chaos. ■

Despite a slow initial start and the lack of a standard Persian character set, the Iranian computer market is growing steadily.

Saeed Vahid is a freelance technical writer based in Tehran. You can reach him on BIX c/o "editors" or on the Internet at isi@iream.bitnet.

C Set++



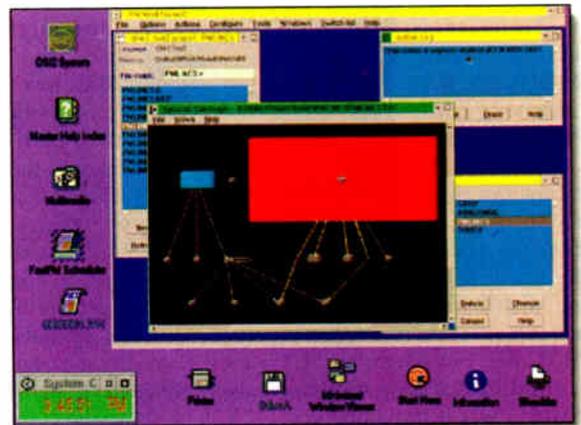
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C Set++

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frameworks for PM, container classes and classes for multitasking, streams and more.

There's a whole set of other helpful features, like an interactive source level debugger. The unique Execution Trace Analyzer traces the execution of a program, then graphically displays diagrams of the analysis. You also get Workframe/2™, a language-independent tool that lets you customize your own environment. It's adaptable and flexible—you can use any 16 and 32-bit DOS, Windows™ and OS/2 tools.

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World Radio History

SYSTEMS

IBM's Ambra: Virtual Corporation... Logical Move

A number of company names (i.e., Merisel, SCI Systems, Acer, and Wearnes Technology) are mentioned in the same breath as Ambra, the new IBM subsidiary that will sell lower-than-low-end PCs. Ambra president David Middleton says that the new division hopes to capture at least 10 percent of what he says is a \$10 billion market of people who prefer to buy their PCs by phone.

However, the companies listed above will contribute as much to the manufacturing, distribution, and support of Ambra's PCs as IBM will. For example, SCI will build Ambra's motherboards, Acer is providing systems development and subsystems technologies, and Merisel is handling the order taking. With IBM playing a less dominant role than ever before, analysts say one question that users will inevitably ask is: Can Ambra maintain the quality they expect of IBM systems?

Rival Compaq boasts in-house manufacturing across its product line. Dell says it has brought all its manufacturing in-house, giving Compaq one less point of contrast, and Gateway 2000 has brought in all its desktop manufacturing as well. Necessity or good marketing? "There's no reason why you should have lousy quality whether you outsource or not," says David Wu, analyst for market research firm S. G. Warburg in New York City.



The key, he adds, is how well products are tested.

What remains to be seen is the effect Ambra will have on the competition, billed "a tough call" by Infocorp analyst Scott

Miller. Also open is how Ambra sales might dip into those of IBM's own ValuePoint, particularly in a mail-order channel that generates 10 percent of that line's sales—a sizable portion considering the profit margins of low-end systems. "It almost seems like the company is duplicating effort," says Miller. "You have two direct-response organizations. How do you retool that?"

The biggest wait-and-see, however, is Ambra's business model, the virtual corporation, which shows a major company outsourcing perhaps more than the industry has ever before seen to beat lowball clone makers at their own game. "It certainly is a new way to do business," says Miller. "If a company like IBM can be successful at this, it raises the questions: 'Do I really need to be in the manufacturing business? Does it make more sense to spend my resources doing other things?'"

—Ed Perratore

*Ambra Computer Corp.,
Raleigh, NC, (800) 252-6272.*

AMBRA VS. DELL: A DESKTOP SAMPLING

SYSTEM	CPU	CONFIGURATION	PRICE
Ambra S450SL	486SLC-2/50	4 MB of RAM, 64-KB L2 cache	\$1069
Ambra D466BL	Blue Lightning 66	4 MB of RAM, 256-KB L2 cache	\$1559
Dell Dimension XPS 450V	486DX2/50	4 MB of RAM, 128-KB L2 cache	\$1778
Dell Dimension XPS 466V	486DX2/66	4 MB of RAM, 256-KB L2 cache	\$1978

How low is low? Ambra, the new direct-response IBM subsidiary, has announced two notebook computers and 14 PCs—including a dual 60-MHz Pentium tower PC with a CD-ROM drive and a 540-MB SCSI hard drive for \$6559. The chart shows the low end of the Ambra line and similar products that Dell announced the same day. Ambra configurations include a mouse, DOS, Windows, a 256-color graphics card, and a 240-MB hard drive. Dell's minimum systems include a 230-MB hard drive and a #9 GXE VL video card but no monitor. The Blue Lightning 66 is IBM Technology Products' (Somers, NY) processor subsystem. IBM expects to start sampling a clock-tripled 33-/100-MHz computer in this quarter.

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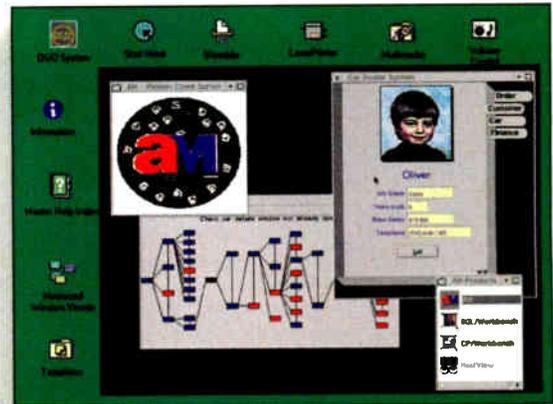
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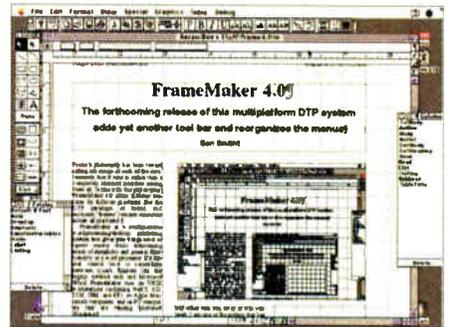
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Circle 172 on Inquiry Card.

World Radio History

SAEED VAHID

Moving Forward—Cautiously

At the climax of the Islamic revolution 14 years ago, the ruling government generally regarded computers as luxury equipment that offered little benefit to a country in which almost 40 percent of the population was employed in the agrarian sector. Before the revolution and the overthrow of the Shah of Iran, mainframe and minicomputers were mostly used by large organizations. But Iranians in all sectors of business now recognize the benefits of computerization.

When western countries applied economic sanctions to Iran after the U.S. embassy was seized, buyers of cast-off mainframes in Iran lacked support in the area of software, documentation, and after-sale service. Due in part to these economic sanctions and political upheaval, Iran lagged behind the microcomputer revolution as well. However, with the August 1988 cease-fire in the war with Iraq and the adaptation of a free-market economy by the new government, Iran is trying to keep pace with the world.

The U.S. government prohibits U.S. companies from exporting computers with a rating of more than 6 MTOPS (million theoretical operations per second) to Iran. Iranian buyers can nevertheless purchase such equipment from companies like Tatung that are headquartered in East Asia, as well as through European channels. Lower powered 386-based PCs are also available through resellers for U.S.-based companies. Although the majority of PCs in use come from East Asian countries, firms like Dell, ALR, NCR, and IBM now have resellers in Iran. Companies in

Iran have also been able to obtain Mac Quadras and R4000-based workstations.

Iran's own indigenous computer industry has suffered to some extent due to changing policies. For example, in the early 1980s, a group of Iranian engineers at a company called Pooya began to build a natively designed minicomputer, as well as write the system's own operating system. However, just as they finished the system, the state ban on importing PCs was lifted, and it was no longer economically justifiable to manufacture the expensive minicomputer. Pooya now offers Samsung's PCs and ICL's DRS-6000 RISC machines to its Iranian customers.

The last attempt at developing a natively designed PC failed with the rollout of a Z80-based PC to a market in which 286-based PCs were already in extensive use. Despite these failed attempts at creating a native system, many companies remain in the business of assembling components and making quality clone computers.

As in a number of countries, the internationalization of English-language software poses a unique set of challenges to software developers in Iran. Five Persian character sets exist in the market, each one introduced by a different company for use in its own software.

About 90 percent of the microcomputers in Iran run Microsoft's MS-DOS. A Tehran-based software company called Computer Software, working in collaboration with Microsoft, has begun a project to add Persian language capabilities to the popular operating system. A beta version of Persian DOS



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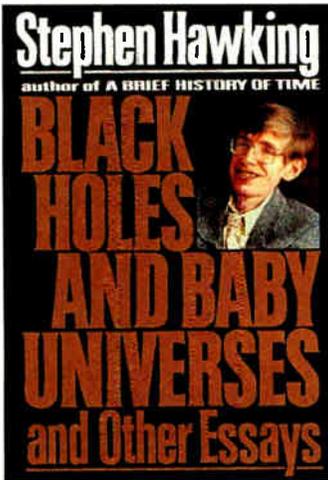
has been released, but it has not yet been formally announced. Microsoft is also developing a version of Windows that is capable of handling the right-to-left Persian script.

Because none of the companies developing Persian software in Iran are strong enough to influence the other software companies, each of their proprietary Persian character sets will continue to be used in parallel. Perhaps Microsoft's Persian DOS will be a powerful enough force in the market to make the DOS character set the dominant one. But if software companies continue to introduce proprietary products and the government continues to implement confusing policies, the dominant characteristic of Iranian computing may be one of chaos. ■

Despite a slow initial start and the lack of a standard Persian character set, the Iranian computer market is growing steadily.

Saeed Vahid is a freelance technical writer based in Tehran. You can reach him on BIX c/o "editors" or on the Internet at isi@irearn.binet.

Hawking Returns



HUGHES PACK

Stephen Hawking's *Black Holes and Baby Universes and Other Essays* is a collection spanning 16 years of fascinating scientific thought. Cleanly written, it lets you examine the progress of Hawking's work and study from 1976 to the present day. Hawking describes this book as writings ranging from "autobiographical sketches through the philosophy of science to attempts to explain the excitement I feel about science and the universe." No small subjects here.

The first portion of the book is devoted to personal glimpses into Hawking's life and attitudes in essays titled "Childhood," "Oxford and Cambridge," "My Experience with ALS,"

and "A Brief History of *A Brief History*." Readers who are not among the elite Hawking fans will enjoy learning more about this person many are calling "the most brilliant theoretical physicist since Einstein." After this insight into his personal history, Hawking delves into a discussion of a "theory of everything." He then proceeds to take potshots at philosophers of science, labeling many of them "failed physicists."

Physicists, astronomers, and cosmologists who don't live in a cave will not find any new physics in the more technical essays, but they may find a new way to understand physics. Hawking acknowledges in the preface that "there is inevitably a certain amount of repetition" among this collection of essays. Despite the repetition, the presentations are not identical, and each is phrased slightly differently. These differences can be extremely valuable to those who seek a more concrete grasp of highly abstract concepts. Each presentation can serve to patch a small hole in the wall of understanding, and as these holes are filled, one's knowledge ends up on a more solid foundation.

One recurring topic, the uncertainty principle, appears in "Is the End in Sight for Particle Physics?" to explain the lack of radiation from an accelerating electron in the ground state of an atom. "Is the End in Sight" is actually a reprint of Hawking's essay given when he was inaugurated as Lucasian Professor of Mathematics at Cambridge in 1980. The uncertainty principle reappears in "The Quantum Mechanics of Black Holes," when Hawking finally gives in to the realization that black holes can indeed emit particles.

In the essay "Black Holes and Baby Universes," the uncertainty principle is used again to deal with the emission of particles from black holes, but this time we get into a little-known science fact of faster-than-light travel. Does this mean *Star Trek* has it right? No, it simply means that many seemingly strange things aren't that strange after all, especially when brilliant minds work the laws of physics.

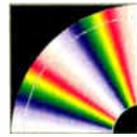
The reader must keep in mind that these are short essays, and most of the topics covered in the scientific essays are covered much more thoroughly in Hawking's previous book, *A Brief History of Time*. For those who have not read the earlier work, this winning collection of essays will very likely provide the stimulus to go on. ■

Hughes Pack is the Theodore R. Carpenter faculty fellow in science at Northfield Mount Hermon School in Northfield, Massachusetts. He is involved with the Hands-On Universe Project, which is attempting to bring astronomical image processing into the high school classroom via personal computers. You can reach him on BIX c/o "editors."

BLACK HOLES AND BABY UNIVERSES AND OTHER ESSAYS

Stephen Hawking,
Bantam Books
ISBN 0-553-09523-4

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MULTIMEDIA BEATLES

A HARD DAY'S NIGHT

The Voyager Co., 1351 Pacific Coast Hwy.,
Santa Monica, CA 90401, (310) 451-1383, \$39.95

The Voyager Co. has garnered a reputation for its innovative approaches in transferring books to electronic media. Its latest CD-ROM, the Beatles' *A Hard Day's Night*, breaks new ground by proving how effective this technology is with a movie. This CD-ROM contains the Fab Four's entire 1964 film of the same name—all 90 minutes of it—as a QuickTime movie. You can view, stop, or pause the black-and-white movie's action and sound in a 160- by 120-pixel screen from within a HyperCard stack. A button lets you expand the movie to a 320- by 240-pixel screen, but the image becomes grainy—enough so that my test subjects switched to the smaller window. A pop-up menu lets you jump to different spots within the movie, similar to the chapter feature on laserdisc players.

Also included in the HyperCard stack is an essay by Bruce Eder, as well as the movie's original script. The script's text can be displayed beside the QuickTime window, and it stays in sync with the movie's action with hardly a glitch. Bracketed text indicates lines or scenes that were never used, while text in parentheses indicates improvised dialogues. The script supplies a fascinating glimpse of the creative process involving the Beatles and Richard Lester, the movie's director.

Today, Lester's nearly 30-year-old visual montages and stop-frame trickery seem remarkably prescient of MTV. *A Hard Day's Night*, the CD-ROM movie, shows how far CD-ROM has come and where it will go.

—Tom Thompson

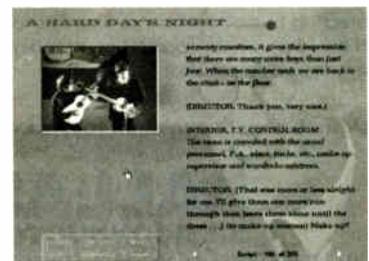


IMAGE FROM A HARD DAY'S NIGHT CD-ROM

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WINDOWS DISSECTED

WINDOWS INTERNALS by Matt Pietrek Addison-Wesley, ISBN 0-201-62217-3, \$29.95

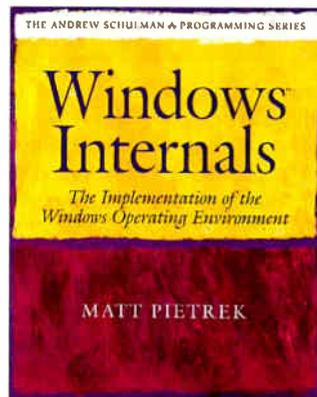
When I run Windows from a DOS prompt, I type WIN, and in a few seconds, the Windows user interface appears. I had a pretty good idea of what happens in between, but I was never quite sure. *Windows Internals* solved that mystery for me. From the moment I opened this book, I was transformed from a mere programmer to a Windows systems designer. It explains every aspect of Windows, including start-up and shutdown, memory management, program loading, the windowing system, the GDI (Graphical Device Interface), the scheduler, messaging, and dynamic linking. Each component is examined in great detail with the aid of C p-code.

Reading the first chapter was a real education for me, as it explains how the system goes from a simple DOS-based configuration to a complex multitasker while still relying on DOS. Each sentence is like tracing into a line of code, and this chapter provides a step-by-step process of explaining exactly how Windows works.

I was pleased to see that, unlike similar books, *Windows Internals* does not contain a discussion of basic programming fundamentals such as protect mode and selectors. It assumes that you are already familiar with them. Beginning programmers or readers not familiar with Windows programming should probably start with something more basic before reading this book.

The text is balanced with just the right amount of humor, and the book is surprisingly easy to read for such a highly technical subject. It includes listings for some handy little programs, but don't look for fancy diagrams or pictures—this is hard-core development material. Every experienced Windows programmer should read *Windows Internals* and keep it on the shelf for future reference.

—Steven J. Matrianni



WARM AND FUZZY LOGIC

FUZZY THINKING: THE NEW SCIENCE OF FUZZY LOGIC by Bart Kosko Hyperion, ISBN 1-56282-839-8, \$24.95

Fuzzy logic, more than any recent technical topic, is in dire need of a marketing overhaul to make it more understandable to a wider audience. Bart Kosko's *Fuzzy Thinking: The New Science of Fuzzy Logic* is not the required solution. Although I found the book stimulating, provocative, informative, and thought-provoking, it does a much better job of explaining the philosophy of fuzzy logic to the believer than to the skeptic.

Although Kosko's scientific arguments and explanations are

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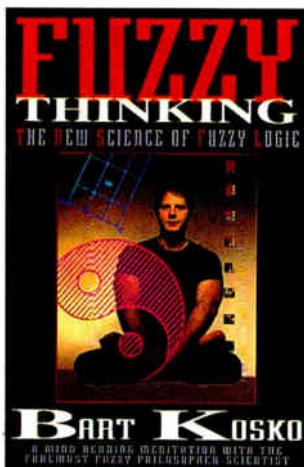
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stellar, he discounts his credibility by glibly assuming that everyone raised under a Western philosophy is fundamentally unable to deal with "the Tao of fuzzy," while those raised in a predominantly Eastern culture will take to it naturally. An insult to both cultures. Kosko is at his best when he tells how certain mathematical principles can be applied to make smart decisions in smart products, such as a washing machine that knows for each load how much soap to use and how hot the water needs to be.

Kosko believes that the slow acceptance of fuzzy-logic design techniques in the U.S. as compared to the rapidly increasing practical usage of the technology in Japan is directly related to deep-seated cultural differences. Western culture and science have long been based on truth. Statements are true or false. An item is or it isn't. Computer bits are on or off. Rarely (even in the depths of political debate) is there a middle ground, a degree of truth, a concept of *almost*. Eastern philosophy is more accepting of shades of gray—degrees of truth, existence, and reality.

In recent years, the bivalent Western world view has started to shift. We now describe the world in terms of fractals and chaos theory—neither of which have well-defined borders. Our view of the world has become more accepting of imprecision. Fuzzy logic is simply another method of coping with this increasingly complex world view. *Fuzzy Thinking* ranges from philosophy through hard science to metaphysical futures. The book is not an introduction to fuzzy logic, the science. Rather, it is an introduction to fuzzy logic, the mind-set.

I thoroughly enjoyed *Fuzzy Thinking* and the ideas it has generated. Linking fuzzy logic with Eastern philosophy, however, will do little to convince the advocates of "hard" facts that it is a solution who's time has come.

—Raymond GA Côté

POWERBOOK BY THE BOOK

THE POWERBOOK COMPANION, 2d ed., by Richard Wolfson and Sharon Zardetto Aker Addison-Wesley, ISBN 0-201-62621-7, \$24.95

For those MacFolk who never leave home without their PowerBooks, *The PowerBook Companion* should be packed along with the computer. It provides a technical overview of the PowerBook line (remarkably, it was up to date on the PowerBook 165c and 180c), with numerous tips on paring down the essential operating system (to conserve disk space) and extending battery life. If your PowerBook mysteriously conks out, the step-by-step troubleshooting chapter can be a lifesaver.

Based on my own travel experiences, the advice for connecting to a variety of telephones with or without RJ-11 jacks is right on. Highly recommended. ■

—Tom Thompson

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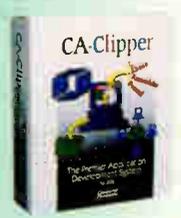
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Keeping Time on Your PC

MICHAEL A. LOMBARDI

If you've ever relied on your computer's clock for timekeeping, you know that it's not particularly accurate. Most people aren't concerned if their computer's clock is off by a few seconds (or even minutes, or hours) so long as they can tell when a file was last revised. However, many applications, such as manufacturing process control, synchronous communications, and financial recordkeeping, require timekeeping that's accurate to the nearest second or better.

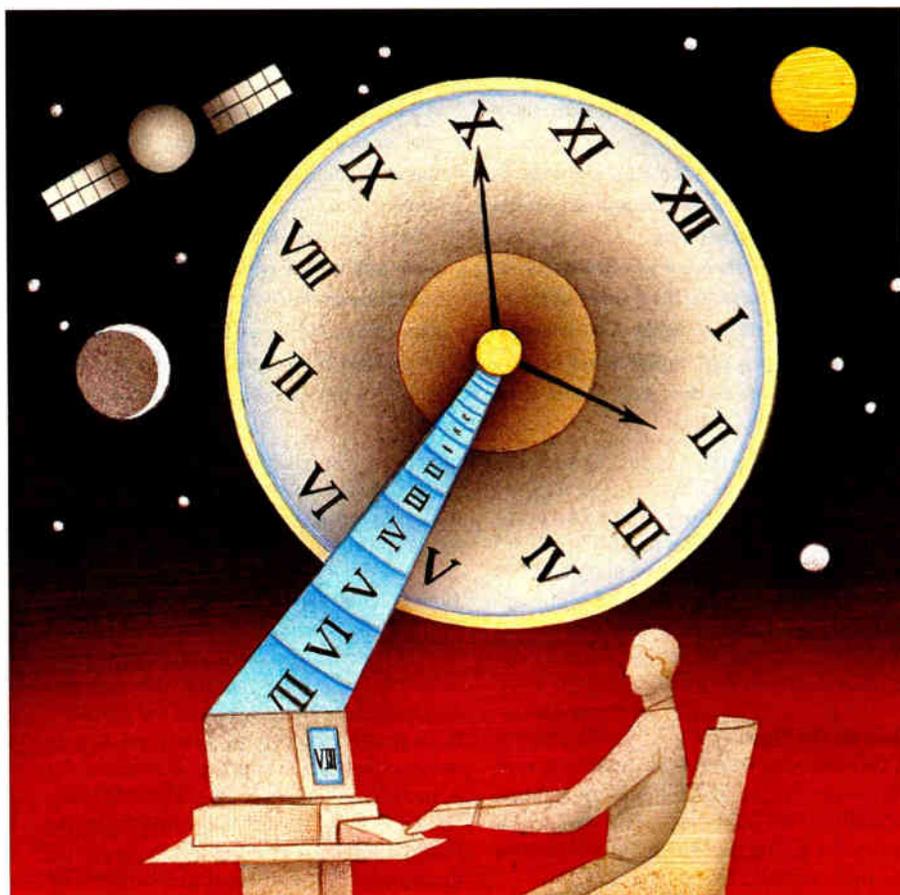
How can you make your computer keep accurate time? The answer lies in setting your clock to a reliable time source and then frequently polling that source for time updates and resetting your clock as often as necessary.

Accurate time information is easy to get through your modem or a network time service. You can also "keep time all the time" using a radio clock or a precision real-time clock board to capture accurate time information broadcast by government agencies. Whatever method you choose, you no longer have to be satisfied with your PC's marginal timekeeping abilities.

Accurate Time by Modem

Since 1988, the National Institute of Standards and Technology, or NIST, a branch of the U.S. Department of Commerce, has operated ACTS (Automated Computer Time Service) out of Boulder, Colorado. Anyone can access ACTS through a modem and simple telecommunications software (see the text box "How to Set Your PC Clock by Modem"). When you connect to ACTS via modem, it sends out a highly accurate and reliable time code that you can use to set your computer clock to the correct time according to NIST's clock.

ACTS is referenced to an atomic clock located at NIST that functions as the U.S. national standard for civilian time and frequency. ACTS provides far more accuracy than your typical PC



JAMES ENDICOTT © 1993

Your PC's clock was never meant to be an accurate timepiece. But that doesn't mean you can't turn it into one.

clock can handle (see the text box "The Clocks Inside Your PC"). It's capable of setting your computer clock to within 1 millisecond of NIST time. The software clock in your PC, however, ticks about once every 55 ms. Thus, you can be assured only that your clock has been set to within 55 ms of the correct time. Even then, your clock won't stay set properly for long. For example, a PC clock that gains 5 seconds per day advances 1 ms every 17 seconds.

You can also set your computer clock to NIST time through the Internet at the following address: time_a.timefreq.bldrdoc.gov (absolute Internet address 132.163.135.130). You can access the server and obtain the software and documentation needed to use the Internet time service. This service is less accurate than the modem service, since it is difficult to estimate network delays. However, it's well suited for keeping your clock set to the nearest second.

continued

The Clocks Inside Your PC

Every DOS-based computer has a built-in software clock. Generally, it's driven by a Motorola 146818 real-time clock chip, Intel 8253/8254 timer-counter chips, or equivalent devices. Your BIOS tells the chip to generate an interrupt every 54.936 milliseconds, or about 18.206 times per second. Another BIOS routine counts the interrupt requests and generates a time-of-day clock that can be read or set by other software. DOS uses the software clock to date- and time-stamp files.

The software clock is a poor timekeeper. Its accuracy is limited by the stability of the interrupt requests. Any change in the interrupt-request rate by, say, an ill-behaved application causes the clock to gain or lose time.

ACTS isn't the only source of accurate time accessible by modem. The USNO (U.S. Naval Observatory) operates a computer time service similar to ACTS. USNO time is available via modem at (202) 653-0351 (1200 bps only). Several commercial software packages enable you to call the USNO service, including TimeChecker from Zephyr Services (Pittsburgh, PA).

Time All the Time

A shortcoming of modem services is that you have to make a telephone call (often a toll call) to set your clock. But by using a radio clock, you can get accurate time all the time, without the expense.

Radio clocks are designed to receive and decode time signals broadcast over radio by many national governments. Your applications can use the radio clock to constantly set your computer's clock, or they can get all timing information directly from the radio clock, ignoring your computer's clock entirely.

Radio clocks cost anywhere from as little as under \$500 to as much as \$5000 or more. Some are stand-alone devices with a digital display, while others are plug-in expansion cards. Stand-alone units connect to your PC, Macintosh, or other computer through RS-232, RS-422, or IEEE-488 interfaces.

All radio clocks provide enough accuracy for PC timekeeping, and most provide greater accuracy than ACTS. However, you need to make sure that the radio signal of the clock you choose can be received in your area. Also, nearly all radio

clocks require an outdoor antenna to operate properly, so you'll need to make sure that you can mount the right type of antenna for your radio signal.

Further, the clock's time can drift by a minute or more each day you leave your computer on. Another problem is that your software clock cannot display all possible time-of-day values. Its resolution is limited to the interval between interrupts. Only times that are even multiples of 54.936 ms can be displayed. For example, your clock cannot display 00:00:01.00; the closest it can get to this is 00:00:00.98 or 00:00:01.04.

Since the 286, PC-type computers have come with battery-backed hardware clocks that are considerably more accurate than software clocks. But these, too, have problems. For example, they cannot display fractions of a second, so they cannot be read or set with any

degree of accuracy better than a second.

A hardware clock's accuracy is determined by the quality of its time-base oscillator, which typically is a 32.768-kHz crystal. These crystals are economical, costing less than \$1 in single quantities. However, they offer only marginal timekeeping performance, and they are sensitive to temperature changes, voltage fluctuations, and vibrations.

Even under the best conditions, these oscillators are not likely to be stable to better than 1 part per million—about 0.1 second per day. In actual operation, most hardware clocks seem to gain or lose time at a rate of about 1 to 15 seconds per day, with 5 or 6 seconds per day being typical.

each minute, a voice announces the current time. WWV and WWVH also broadcast a binary-coded decimal time code on a 100-Hz subcarrier that can be read and decoded only by a radio clock. The time code provides the current hour, minute, second, month, day, year, and other information. The time is accurate to within 1 to 50 ms, depending on your distance from the transmitter and signal-propagation conditions.

Time Through Airwaves

Radio clocks designed specifically to receive WWV/WWVH signals, such as those from Odetics (Anaheim, CA), are an economical source for obtaining accurate time. However, they have limitations. One potential shortcoming with using a WWV/WWVH radio clock is that you may need a large outdoor antenna to get good reception.

Another limitation is that, since these stations use shortwave radio signals, reception can be difficult during some parts of the day. As a general rule of thumb, frequencies above 10 MHz work best during daylight hours, while lower frequencies work best at night. Some radio clocks, such as the one from Chrono-Log (Havertown, PA), get around this problem by taking advantage of the fact that WWV and WWVH broadcast on several frequencies. They scan these frequencies and tune in on the one currently providing the best reception.

Radio clocks are designed to receive and decode time signals broadcast over radio by many national governments. Your applications can use the radio clock to constantly set your computer's clock, or they can get all timing information directly from the radio clock, ignoring your computer's clock entirely.

Under the right conditions, WWV and WWVH can be heard just about anywhere in the world, including the Southern Hemisphere. However, 5, 10, and 15 MHz are allocated for time and frequency stations by international agreement. Consequently, at least 15 other stations broadcast on these frequencies, often blocking out WWV's signals. For example, near India you'd hear the Indian Republic's broadcast, not WWV, on 5 MHz.

When you tune in to a WWV/WWVH broadcast, you hear audio tones that sound like a clock ticking. At the beginning of

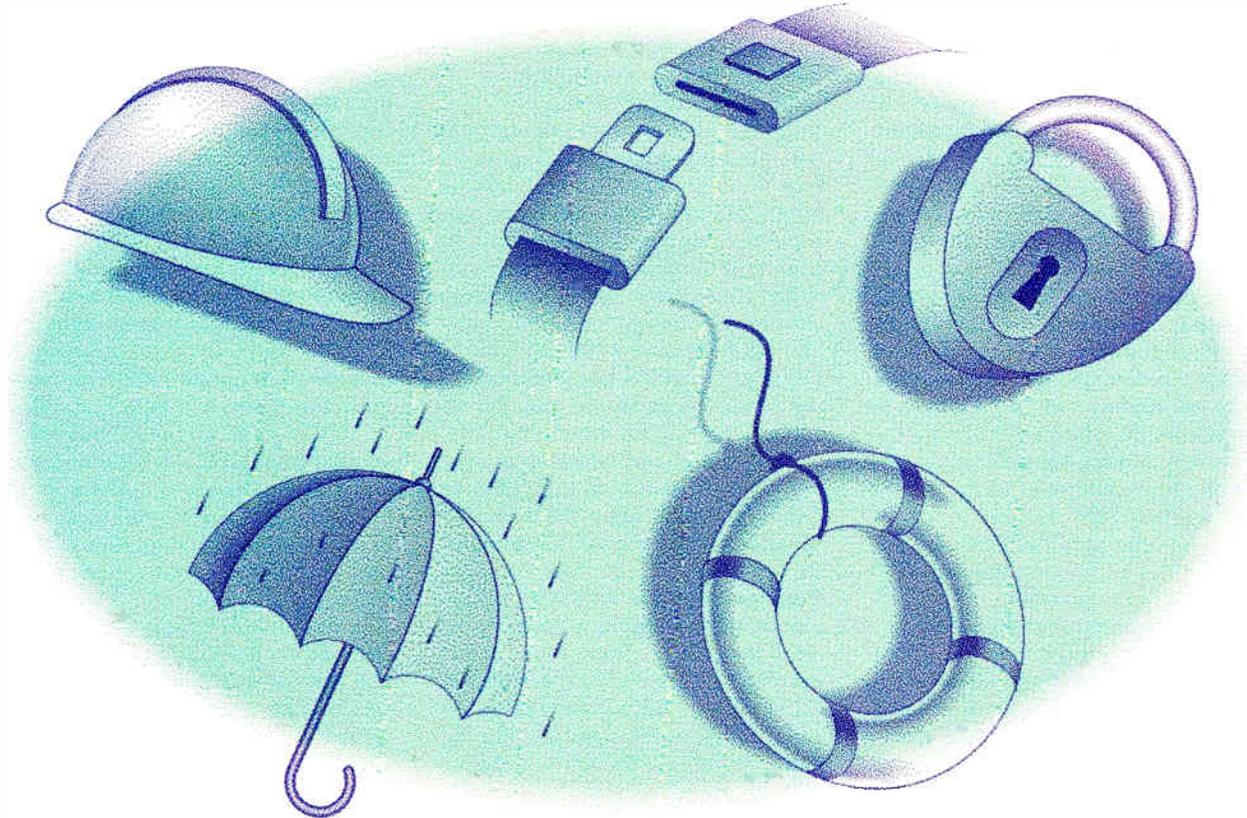
When you tune in to a WWV/WWVH broadcast, you hear audio tones that sound like a clock ticking. At the beginning of

When you tune in to a WWV/WWVH broadcast, you hear audio tones that sound like a clock ticking. At the beginning of

Other Time Sources

Some radio clocks, such as those from Spectracom (East Rochester, NY) and

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Circle 121 on Inquiry Card.

How to Set Your PC Clock by Modem

You can dial in to ACTS (Automated Computer Time Service) at (303) 494-4774. Set your communications software for 300 or 1200 bps, with 8 data bits, 1 stop bit, and no parity. The 1200-bps time code is transmitted every second (see "The 1200-bps ACTS Time Code"). It contains more data than the 300-bps time code, which is transmitted every 2 seconds.

After you connect with ACTS, it sends you a simple ASCII time code. The last character in the time code is an asterisk (*), which is called the OTM (on-time marker). The time values sent by the time code refer to the arrival time of the OTM. In other words, if the time code says it is 12:45:45, this means it is 12:45:45 when the OTM arrives at your computer.

ACTS assumes telecommunications delays between the time the OTM leaves Colorado and when it arrives at your computer. Consequently, it sends the OTM out 45 milliseconds early. This 45-ms figure represents the sum of the following conditions: 8 ms for transmitting the OTM at 1200 bps, 7 ms to allow for the OTM to travel to the average caller in the U.S., and 30

ms for modem-processing delays.

The 45-ms OTM advancement typically removes most telecommunications delays. Say you are calling ACTS from Chicago, and the actual delay is 50 ms. The OTM then arrives at your computer only 5 ms late, with about 90 percent of the delay already removed.

But if you are making an overseas call or if your call goes through a satellite, the delay can be 300 ms or more. Fortunately, ACTS lets you measure the actual line delay, so you can remove as much of the delay as possible.

To measure your actual delay, your software must return the OTM to ACTS after receiving it. Each time the OTM is echoed back, ACTS measures the actual delay. After four consecutive measurements, ACTS begins advancing the OTM by an amount of time equal to the delay. Thus, if your actual delay is 50.4 ms, ACTS sends out the OTM 50.4 ms early instead of 45 ms early. Once ACTS begins using the measured delay, the OTM changes from an asterisk to a pound sign (#). Now the OTM arrives at your computer within 1 ms of the correct time.

In rare instances, ACTS can't mea-

sure the actual delay. For example, if the modem connection goes by satellite (i.e., a long delay) in one direction and by land (i.e., a short delay) in the other direction, the standard 45-ms advancement is used, even if your software returns the OTM.

A number of commercial and shareware software packages are available for calling ACTS. Among them are TimeSet from Life Sciences Software (Stanwood, WA) and Time-Sync from SolaCamp Software (Lutherville, MD).

ACTS uses UTC (Coordinated Universal Time). UTC is a 24-hour clock based on the local time in Greenwich, England. It differs from your local time by an integral number of hours only; the minutes and seconds remain the same.

A call to ACTS takes just seconds (see editor's note). Since the time-setting process is so quick, ACTS limits your on-line time to 56 seconds, or 28 seconds if all incoming lines are in use.

Editor's note: NIST-developed MS-DOS and QBasic programs for accessing ACTS are available electronically. See page 5 for details.

The 1200-bps ACTS Time Code

After you connect with ACTS, your screen will display the following information, which is explained below:

||||| YR-MO-DA HH:MM:SS TT L UT1 msADV UTC(NIST) <OTM>

||||| is the MJD (modified Julian date). The MJD is the last five digits of the Julian date, which is simply a count of the number of days since January 1, 4713 B.C. To get the actual Julian date, add 2.4 million to the MJD.

YR-MO-DA is the date. It shows the last two digits of the current year, month, and day.

HH:MM:SS is the time in hours, minutes, and seconds. The time is always sent as UTC. An offset needs to be applied to UTC to obtain local time in the U.S. For example, mountain time in the U.S. is seven hours behind UTC during ST (standard time), and six hours behind UTC during DST (daylight saving time).

TT is a two-digit code (00 to 99) that indicates whether the U.S. is on ST or DST. It also indicates when ST or DST is approaching. This code is set to 00 when ST is in effect, or to 50 when DST is in effect. About 48 days prior to a time change, the code starts counting the days until the change. When ST is in effect, the code counts down from 99 to 51 in the 48 days prior to the time change. When DST is in effect, the code counts down from 49 to 01 in the 48 days prior to the time change.

L is a one-digit code that indicates whether a leap second will be added or subtracted at midnight on the last day of the current month. If the code is 0, no leap second will occur this month. If the code is 1, a positive leap second will be added at the end of the month. This means that the last minute of the month will contain 61 seconds instead of 60. If the code is 2, a second will be deleted on the last day of the month. Leap seconds occur at a rate of about one per year. They are used to correct for irregularity in the earth's rotation.

UT1 is a correction factor for converting UTC to an older form of universal time that is still used in navigation. It is always a number ranging from -0.8 second to +0.8 second. This number is added to UTC to obtain UT1.

msADV is a five-digit code that displays the number of milliseconds that NIST advances the time code. It is originally set to 45 ms. If you return the OTM four consecutive times, it will change to reflect the actual line delay.

The label UTC(NIST) is contained in every time code. It indicates that you are receiving UTC from NIST (National Institute of Standards and Technology).

The on-time marker (OTM) is a single character sent at the end of each time code. The OTM is first an asterisk (*). It changes to a pound sign (#) if ACTS has successfully measured the line delay.

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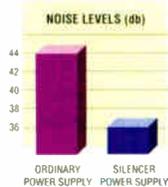
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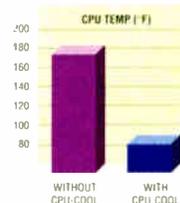
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Circle 123 on Inquiry Card (RESELLERS: 124).

Franklin Instrument (Warminster, PA), receive signals from WWVB, a NIST radio station transmitting from Colorado. WWVB is a low-frequency station, broadcasting on 60 kHz. No voice or other aural announcements are made on WWVB. WWVB broadcasts a time code capable of 0.1-ms accuracy.

The coverage area of WWVB is smaller than that of WWV and WWVH. However, you can receive its signals in nearly all of the contiguous 48 American states with only a small antenna and equipment that's easy to set up and use.

You can also get NIST time from GOES (Geostationary Operational Environmental Satellites), which is operated by the National Oceanic and Atmospheric Administration. GOES broadcasts from two different satellites on a frequency of about 468 MHz. Only a small antenna is necessary to receive the signal in most parts of North and South America. The signal includes a time code accurate to about 0.1 ms. Arbiter Systems (Paso Robles, CA) makes a radio clock that is capable of receiving GOES signals.

The most accurate radio clocks available can tune into signals relayed by the U.S. Department of Defense's GPS (Global Positioning System) satellites. GPS provides worldwide coverage. With the aid of only a small outdoor antenna, a GPS radio clock can receive time accurate to within less than 1 microsecond, which is about 1000 times the accuracy you can get from ACTS.

The price of GPS radio clocks has fallen dramatically over the past few years, to about \$1000 from highs of well over \$10,000, and their use is becoming widespread as a timing source for both computer and telecommunications networks. Many new GPS products have been released recently, ranging from hand-held navigation receivers to receivers that plug into a PC or AT expansion bus. In fact, a recent survey in the January issue of *GPS World* lists more than 50 manufacturers of GPS receivers, including Odetics and TrueTime (Santa Rosa, CA).

More Stable Clocks

To keep the most accurate time on a PC, you can replace its clock with a precision real-time clock board. These boards, such as those from Bancomm and Guide Technology (both in San Jose, CA), include high-quality time-base oscillators. They also let you use an external oscillator to get superior results. This means that if you have access to a frequency standard, such as a quartz, rubidium, or cesium oscillator, you can use it as your time base by connecting it to your real-time clock board.

performance of a precision real-time clock is unequalled. If you work in a laboratory or industrial setting where a frequency standard is already available, this may be the ideal method for getting accurate time.

Smarter Clocks

NIST recently invented its Smart Clock technology, the basic premise of which is simple: If a clock knows the rate at which it gains or loses time, it can correct itself. Clocks usually drift at about the same rate from day to day. A microprocessor-controlled Smart Clock, however, automatically corrects your clock's drift based on the clock's past performance. For example, if you call ACTS at the same time each day, you might discover that your PC's clock is always fast by 4 seconds. Using this information, your Smart Clock, working much like a memory-resident program does, would gradually move the time back 4 seconds per day (i.e., $\frac{1}{6}$ second every hour).

Software that uses concepts similar to those of Smart Clock is starting to appear on the market. For example, RightTime from Air System Technologies (Dallas, TX) is a memory-resident program that automatically adjusts your PC's clock, keeping it on time to within a half-second per week.

Whether you use RightTime's algorithms, your modem, or a precision real-time radio clock board augmented with an external oscillator, it's easy to change your PC clock into a reliable timekeeper. But you have to adjust your clock and measure its performance against a trustworthy

time source. That's the benefit provided by ACTS and other time services. ■

Editor's note: NIST wants you to know that the mention of products in this article does not constitute a NIST endorsement.

Michael A. Lombardi is a computer specialist for the Time and Frequency Division of the U.S. Department of Commerce's National Institute of Standards and Technology in Boulder, Colorado. You can contact him on BIX clo "editors."

APPLICATIONS FOR PRECISION TIMEKEEPING

	ENTERPRISE	ASSIGNMENT	TASK EXAMPLE
	Aviation	Air traffic control	Air traffic can be routed through air corridors at precise intervals
	Finance	Record keeping	Provides a legal audit trail of the dates and times when transactions are completed
	Laboratories	Data acquisition	Temperatures can be monitored over a defined time slice
	Navigation	Position location	Locations can be determined by observing a star's position at precise times
	Power utilities	Power flow	Synchronized power-flow networks send electricity where and when it is needed the most
	Radio/TV	Communications	Satellite linkups for network news feeds can be coordinated
	Surveying	Measurement	Provides the accurate time required to measure distances and locations
	Transportation	Vehicle control	Synchronizes mass-transit vehicle dispatch, location, and schedule control

Precision clock boards greatly increase the stability of your PC clock, but you still need to set and check on the time using ACTS or another service. But if you use a good oscillator as a time base and your system is undisturbed, these boards will keep the correct time for many years. You may never need to set your PC clock again.

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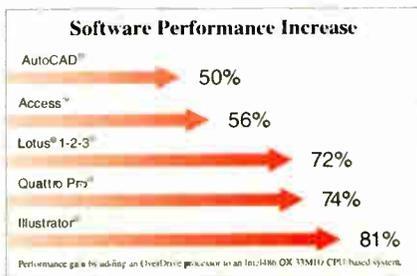
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World Radio History

PDA's ARRIVE But Aren't Quite Here Yet

Technically impressive, Apple's Newton MessagePad and the Tandy/Casio Zoomer are the first true Personal Digital Assistants. Their potential is tantalizing, but the reality leaves something to be desired. Prices are high, handwriting recognition is marginal, and communications are incomplete. Yet with technology advances, PDAs may yet fulfill their original vision.

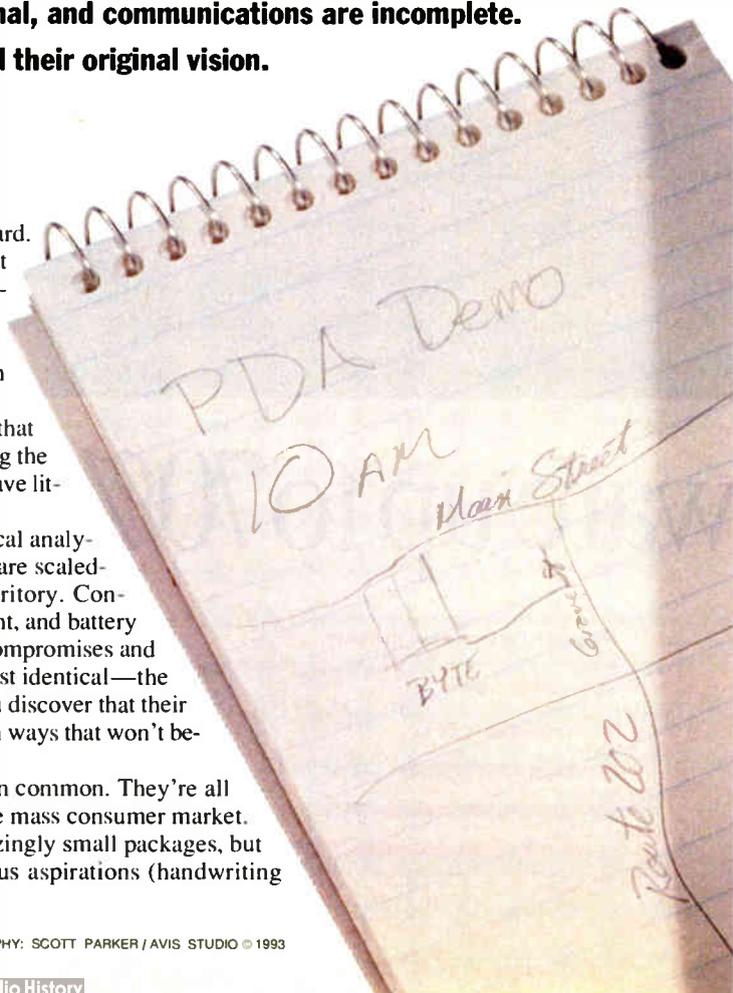
TOM R. HALFHILL

The first personal computers all looked the same: a box with a video screen and a keyboard. Beneath the surface, however, were significant differences in terms of microprocessors, operating systems, and system architectures. Likewise, the first pen-based PDAs (Personal Digital Assistants) all look very much the same, too: a tiny box with an LCD screen and a stylus.

But appearances, once again, are deceiving. Some devices that claim to be PDAs aren't PDAs at all without absurdly stretching the definition. They're aimed at widely different markets, and they have little in common but portability.

Their differences become even more apparent after a technical analysis of their underlying architectures. Some PDA-type devices are scaled-down desktop computers, while others explore bold new territory. Constraints of cost, compatibility, memory, CPU power, size, weight, and battery life have forced their designers to make very different sets of compromises and trade-offs. Even if you isolate the two devices that appear almost identical—the Apple Newton MessagePad and the Tandy/Casio Zoomer—you discover that their supporting architectures are sharply divergent, though perhaps in ways that won't become obvious to casual users until future iterations.

At the same time, the early PDAs also have several things in common. They're all rather pricey compared to other electronic gadgets aimed at the mass consumer market. They all squeeze large amounts of computing power into amazingly small packages, but in some cases it's not enough power to satisfy their ambitious aspirations (handwriting



recognition in particular). They all come with a suite of useful applications, such as notepads, address books, and appointment calendars, but no "killer application," such as VisiCalc or WordStar, that dramatically reveals new possibilities.

Are PDAs ready for prime time? Are they worth the price? Can they justify their existence by doing anything important? Or will they be doomed to early failure, banished to their design labs until the technology catches up with our expectations?

This partially depends on what you expect from a PDA and how much you're willing to pay. Most people will probably be disappointed with the early PDAs or will guard their wallets until prices drop. But a remarkable number of companies are gambling on hopes that thousands of people will think PDAs are the best thing since sliced silicon.

PDAs are seeking a niche, but they're not just niche products. They're ultimately aimed at the millions of people who will probably never buy a personal computer, and they're destined to have a major impact on personal comput-

ing at large. PDAs already are accelerating the trend toward wireless communications and will encourage the on-line distribution of software. More important, one of these tiny devices adopts a new approach to system software that foreshadows the object-oriented operating systems that will be coming to desktops later in the decade.

What's a PDA?

Not surprisingly, there is no industrywide consensus on what constitutes a PDA. Because Apple chairman John Sculley coined the term in January 1992 and guided the Newton architecture's development, it's tempting to let Apple define the grounds of this debate. However, that wouldn't be fair to Apple's competitors, and it may not take into account the expectations of users.

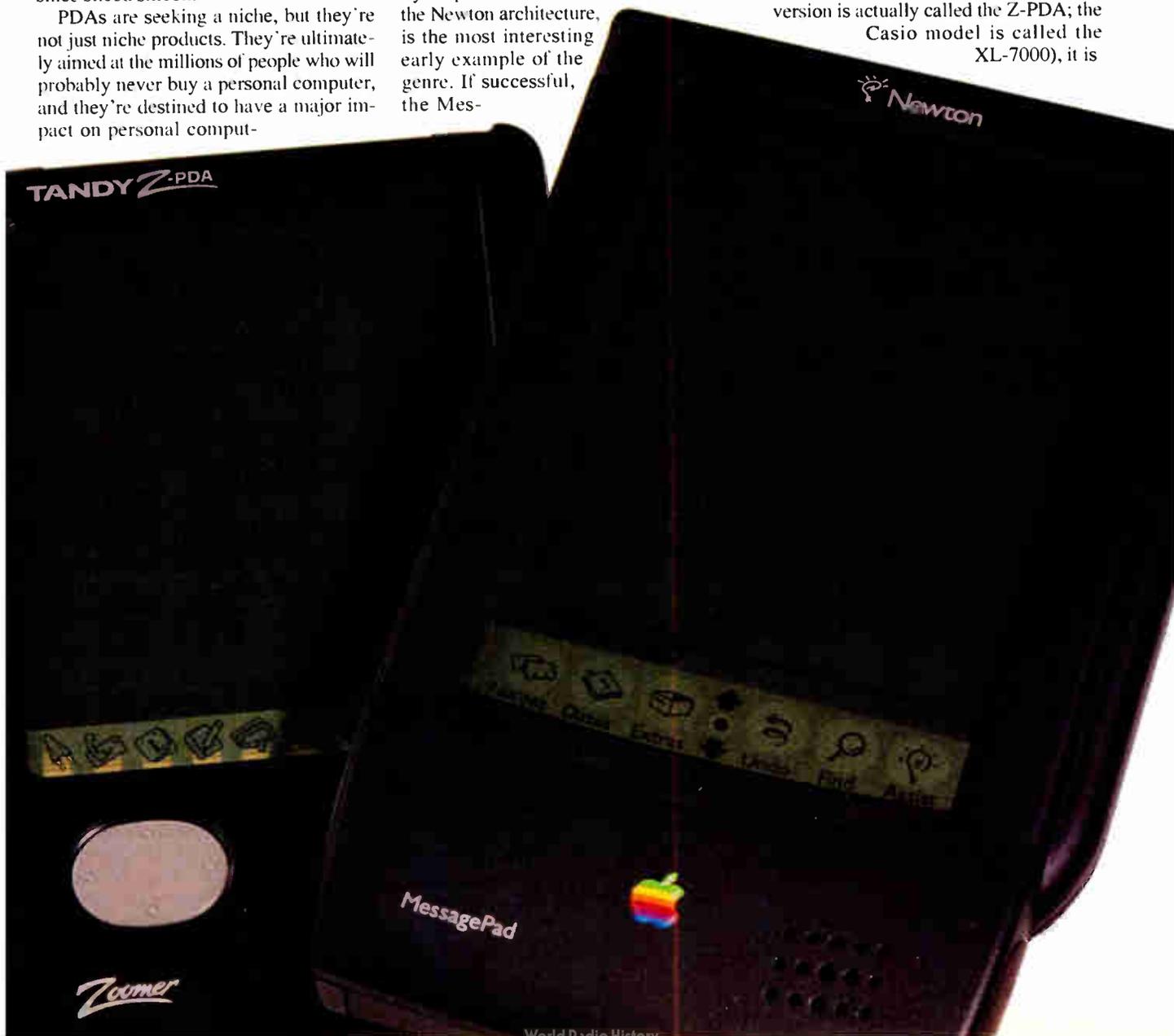
Apple's MessagePad, the first in a family of products based on the Newton architecture, is the most interesting early example of the genre. If successful, the Mes-

sagePad will be widely imitated because, unlike the proprietary Macintosh, the Newton architecture is openly licensed to all comers. The list includes Cirrus Logic, Matsushita, Motorola, Sharp, and Siemens. Sharp, which manufactures the MessagePad for Apple, is also selling a variant called the ExpertPad.

However, Sharp is hedging its bets with a tablet-size device called the PT 9000 that isn't based on Newton technology (see the text box "Sharp's Non-Newtonian PDA"). Instead, the PT 9000 uses the GEOS operating system from GeoWorks (Berkeley, CA).

Another important GEOS-based system is the result of a partnership between Tandy (Fort Worth, TX) and Japan-based Casio, with significant input from GeoWorks and Palm Computing (Los Altos, CA). Nicknamed the Zoomer (the Tandy version is actually called the Z-PDA; the

Casio model is called the XL-7000), it is



perhaps the MessagePad's closest competitor in terms of appearance, user interface, and intended audience (see "Ease of Use Is Relative" on page 89).

Eo, Inc. (Mountain View, CA) makes the Eo 440 and 880 Personal Communicators, a pair of clipboard-size pen computers based on AT&T's Hobbit chip and Go Corp.'s PenPoint operating system. The Eo 440 and 880 perform many of the same functions as the MessagePad and the Zoomer, and in some ways they do a better job of it. For instance, their larger screens are more suited for creating documents, they can receive faxes as well as send them, and they can be equipped with cellular phones. Nevertheless, the Eo devices are not PDAs. Unlike the Zoomer and the MessagePad, they make no pretense about being consumer products.

Other contenders in this category include the Hewlett-Packard 100LX, a DOS-based palmtop computer; pocket-size personal organizers, such as the Sharp Wizard OZ-9600 and the Casio Boss; and content-oriented reference tools, such as Franklin's Digital Books. For various reasons, however, they fall short of what we expect from a true PDA (see the table "What Makes a PDA?" on page 72).

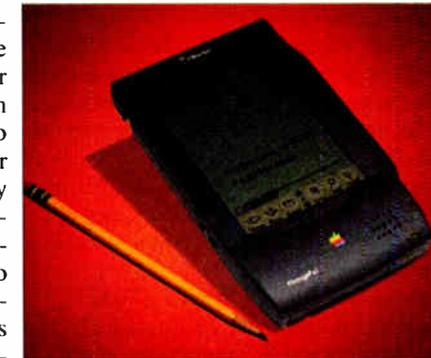
Sculley risked inflating those expectations over the past two years by making Newton the most visible work-in-progress in Apple's 17-year history. But users' expectations have also been influenced by Gene Roddenberry, the late creator of *Star Trek*.

Roddenberry first introduced PDAs to the public in 1966. When *Star Trek* was still in its conceptual stages, he decreed that no paper or pencils were to appear anywhere on the sets of the starship *Enterprise*. Instead, crew members jotted notes on electronic tablets that eerily resemble an Eo 880, and they used a handheld device called a tricorder to gather, process, and display information. On *Star Trek: The Next Generation*, the sequel to the original series, crew members communicate remotely by speaking into active-badge-like devices worn on their tunics.

This futuristic vision of multifunction hand-held computers, wireless communi-

cations, and an effortless user interface is the inspiration for today's PDAs, even if some designers do not acknowledge or are not consciously aware of the pop-culture source. Unfortunately, they have to meet twenty-fourth-century expectations with twentieth-century technology.

Still, the vision yields a practical definition of a PDA. At a minimum, a PDA should have significant computing power and be capable of performing a number of different functions, which rules out high-end calculators and dedicated



Apple's MessagePad is promised to be the first in a family of products based on the Newton architecture. Newton licensees are planning to introduce everything from smart telephones and fax machines to advanced cable TV converters.

language translators. It should be easily held in one hand, usable almost anywhere while you are standing or sitting, and capable of running on battery power for extended periods of time, which rules out laptop and notebook computers. It should offer flexible communications, at least within the bounds of today's rapidly evolving but still-limited infrastructure, which rules

out most personal organizers. And, most challenging of all, it must be so affordable and easy to use that it will attract the millions of people who have thus far steadfastly resisted desktop PCs.

"We're not talking about a downsized personal computer," says Michael Tchao, manager of product planning and strategy for Apple's Newton Group. "We're not talking about Lotus 1-2-3 in the palm of your hand. We're not talking about pocket PageMaker. We're not talking

about a little-bitty Microsoft Word with little-bitty keys and little-bitty menus. We're talking about a new class of device and a new category of users."

However, no device currently available meets all these criteria, especially at an affordable price. Like color TVs, VCRs, CD players, and other consumer electronics gadgets, PDAs won't become genuine mass-market

items until prices drop below \$300, and ideally even lower.

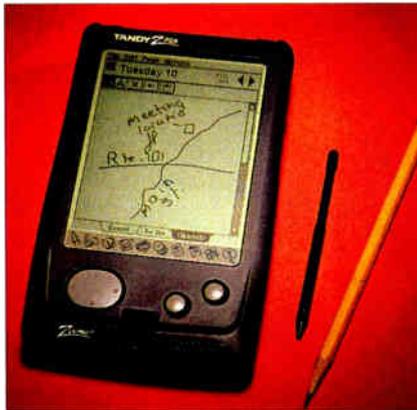
The Mighty Pen

Not everyone will agree with this definition, however, particularly those whose PDA-like products it excludes. For example, the Eo 440 and 880 are capable machines, but at \$2000 to \$3300, they're clearly not intended for mass consumption. The HP 100LX and Sharp Wizard are often considered PDAs, but they have QWERTY keyboards. Although there's disagreement on this point, those who target the mass market convincingly argue that keyboards are simply too intimidating for the computer-illiterate.

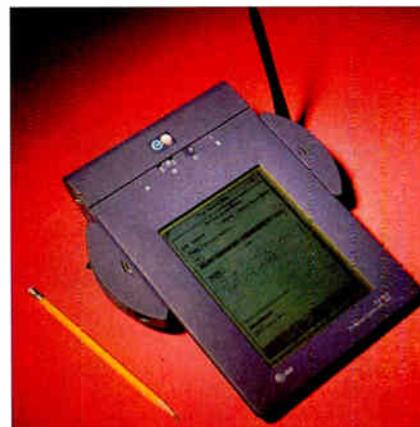
"If you're designing a device for broad consumer acceptance, you've got to have a pen interface," says Joe Ratner, Zoomer project manager for Radio Shack. "From the very beginning, we decided the Zoomer had to have a pen interface. It couldn't have a keyboard."

Ratner explains that it's impossible to fit a touch-typeable QWERTY keyboard on a pocket-size device, and crowded keyboards that have dozens of multifunction keys are even more intimidating to consumers than a full-size desktop keyboard. His counterparts at Apple, who interviewed more than 1200 consumers while designing the MessagePad, came to the same conclusion.

Gerry Purdy, vice president and chief analyst for mobile



Tandy and Casio collaborated on the Zoomer, a PDA that strongly resembles the Apple MessagePad but is built on a completely different hardware and software architecture.



The Eo 440 Personal Communicator is too big and too expensive to be a true PDA. However, it handles wireless communications in a complete and compelling manner.

Sharp's Non-Newtonian PDA

ED PERRATORE

When it comes to hand-held computing, Sharp seems determined to cover all the bases. The company is largely responsible for building the personal organizer market with its Wizard series, and it is the first Newton licensee to announce a MessagePad-type product, the PT-7000 ExpertPad. Sometime in October, Sharp will announce another type of small computer with PDA-like functionality aimed at current PC users, the PT 9000.

This system is a cross between a sub-notebook and a true PDA in size, operating system (GeoWorks' GEOS), and applications. Sharp believes that many prospective buyers will have difficulty with the PDA concept—that of a semicomputer consumer product—so they might be inclined to go with a more familiar form factor.

The PT 9000 measures about 9 by 7 by 1½ inches and weighs roughly 2 pounds with six AA batteries installed; its size approximates that of the Dauphin DTR-1 sub-notebook PC. It has a 7½-inch, super-twist nematic, black-and-white, 640-by-400-pixel (eight gray shades), non-backlit screen. The PT 9000 screen is both pen- and touch-capable. In other words, you can use, say, your finger rather than a stylus, although for some menu choices anything larger than a stylus point would frequently make incorrect selections.

Around the outside edge are one PCMCIA Type 2 slot and one Type 3 slot (on opposite ends of the unit), serial and parallel ports, an external keyboard connector, an external floppy drive connector, and an AC adapter port. Sharp will sell an external floppy drive, an AC adapter, and a sub-notebook-size external keyboard.

Inside is a Vadem VG230, a 16-MHz 8086-class (16-bit) processor that incorporates functions such as a memory controller through VLSI technolo-

gy. Standard are 1 MB of RAM, which is upgradable by way of plug-in cards to 3 MB, and 6 MB of ROM for the operating system and applications. The power button takes you to suspend mode only.

Sharp claims the six AA batteries give you a cumulative 22 hours of typical use—that is, turning the unit on and off at regular intervals. Sharp will also sell rechargeable lithium-ion batteries, which are currently used in some video camera equipment and manufactured by a company called ATI (not the video-card maker). Sony is also making this type of



The Sharp PT 9000

provides several ease-of-use features, such as the column of assignable icons on the right that allow you to turn immediately to a particular application or file.

battery under license from ATI; Panasonic will begin selling it next year. In the PT 9000, two lithium-ion batteries fit where the six AAs would go and provide you with a claimed 24 hours of typical use.

Bundled GEOS software includes the usual GeoWorks group: a word processor, a spreadsheet, communications software, and a database manager. Also in ROM, but not a part of GEOS, is a personal information manager from Palm Computing that's very similar to what Palm wrote for the Zoomer. Other mini-applications include an address

book, a scheduler, a note taker, a to-do list, a calendar, a calculator, and a world clock. Relevant mini-applications let you invoke a sketch pad with a mini-toolbar of editing functions. Traveling Software's LapLink and America Online access software are included as well.

A column of buttons runs down the side of the screen—three of the buttons are assigned, five are customizable. You can use these five for shortcuts to commonly used applications, and you can even assign an icon to a file.

Early Impressions

The beta unit of the PT 9000 I looked at appears significantly faster than the 8-bit Tandy/Casio Zoomer. Handwriting recognition, like the Zoomer's, is disappointing, but you have the choice of keeping text you've scribbled as ink or having the software translate it. In fact, you can toggle between a bit map and a botched recognition job. The software recognizes block letters only.

One nice feature is the ability to delete previous strokes of the stylus—the vertical line of a *T*, for example—to keep you from having to write something all over again. Thanks to the GEOS operating system, the PT 9000 offers multitasking and multi-threaded execution.

For now, Sharp will say only that the PT 9000 will be priced below \$1000. Like true PDAs, however, it's a risky venture at any price—the first keys to mass-market acceptance are more wax than gold. But by sticking closer to existing notebook technology than to new architectures from the MessagePad and other PDAs, Sharp's hybrid offering may help sell the overall concept of hand-held computing for the entire industry.

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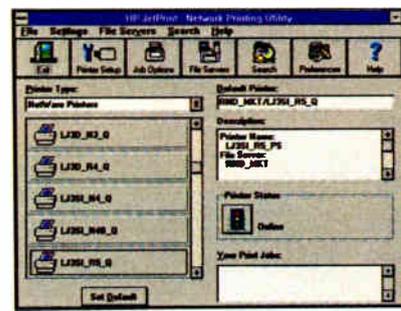
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WHAT MAKES A PDA?

	Portability	Battery life	Low price	Mass market	Ease of use	Wireless communications	Applications	Pen
Apple Newton MessagePad	●	○	●	●	●	●	●	●
Tandy/Casio Zoomer	●	●	●	●	●	●	●	●
Eo Personal Communicator 440/880	○	○	○	○	●	●	●	●
Sharp PT 9000	○	●	●	●	●	●	●	●
Organizers (Sharp Wizard, Casio Boss)	●	●	●	○	○	○	○	○
DOS-based hand-helds (HP 100LX, Fujitsu Poqet PC)	●	●	○	○	○	○	○	○

●=well suited ○=adequate ○=not well suited

PDAs are defined as highly portable, easy-to-use computing and communications devices aimed at the mass market. To be highly portable, the unit must be easily held in one hand and able to be carried in a pocket. Long battery life is also an important portability factor; you don't want to worry about being near a power outlet all the time. Ease of use assumes no keyboard; most people don't type well. For now, a pen interface is the preferred means of input, although someday voice input might supplement it. To appeal to the mass market, PDAs must be low in cost, preferably \$300 or less, and they must come with a good suite of general-purpose applications. Finally, PDAs must deliver seamless two-way wireless communications for fax and data access.

computing at Dataquest (San Jose, CA), predicts that QWERTY-based devices such as the 100LX and Wizard are "going the way of the slide rule." PDAs will eventually replace them.

The point is that PDAs aren't substitutes for PCs; they're different devices aimed at a different market. "I'm not expecting to replace my desktop computer or my laptop with a PDA, but I'm definitely going to have a PDA," says Jeff Hawkins, founder of Palm Computing, who first conceived the Zoomer while working at Grid Systems. "For heavy-duty text writing, pen input won't replace a keyboard."

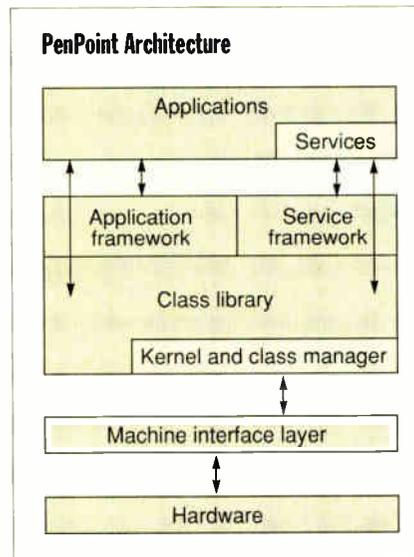
PDA designers think their devices are more likely to be used by *consumers* of information than by *creators* of information. Therefore, user input will tend to be brief and frequently limited to selections from menus. Those who need to enter lots of data will use conventional computers, although some PDAs, such as the Sharp PT 9000, will offer keyboards as an option.

"But a pen interface doesn't necessarily mean the same thing as handwriting recognition," Ratter points out. "For some applications, you don't need recognition. Digital ink is good enough."

Digital ink—storing the image of the user's handwriting instead of translating it into ASCII text—is one of the trade-offs juggled by designers of today's PDAs (see the text box "Ink vs. ASCII").

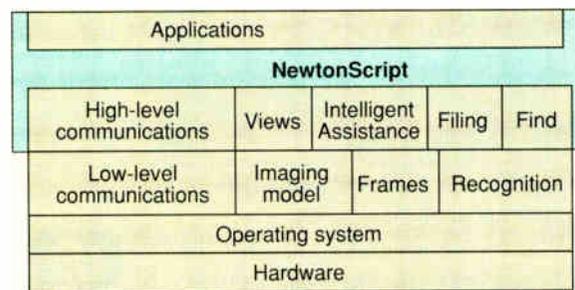
PDAs tend to look alike, so one way of telling them apart is to peel back the surface. Their underlying architectures deter-

mine not only what they can do now, but also what they'll be capable of doing in the future as the technology advances.



PenPoint, like Newton Intelligence, is object-oriented, but it maintains ties to a file-based structure.

Newton Architecture



Newton Intelligence is object-oriented from the ground up. Most programmers will access MessagePad resources and write applications using NewtonScript.

Operating Systems of the Future

Some operating systems running on PDA-type devices are descended from those of desktops: DOS, GEOS, Windows for Pen Computing. Others are dedicated to proprietary hardware and don't attempt to duplicate the functionality of a full-fledged operating system: These include those of the Sharp Wizard and Casio Boss. Some operating systems, such as Magic Cap from General Magic and WinPad from Microsoft, look promising but haven't yet appeared in actual products.

Only two operating systems currently available were designed from the ground up to support PDAs: Go's PenPoint and Apple's Newton Intelligence. Both are heavily object-oriented and depart from the traditional model used by today's operating systems for desktop computers.

Newton Intelligence borrows a few of its components from the Mac: Portions of QuickDraw (the Mac imaging engine) handle the MessagePad's display, and an AppleTalk protocol stack supports name lookup, zones, data streams, and printing, although there's currently no support for AppleTalk Remote Access. Newton Intelligence is multitasking and extensible, and Apple plans to distribute software updates and extensions via on-line services.

The Newton operating system consists of four major components: the Recognition Architecture, the Communications Architecture, the Information Architecture, and the Intelligent Assistance. Most of it is written in C and C++, with a small portion of the low-level kernel written in assembly language. The

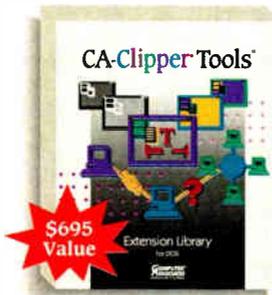
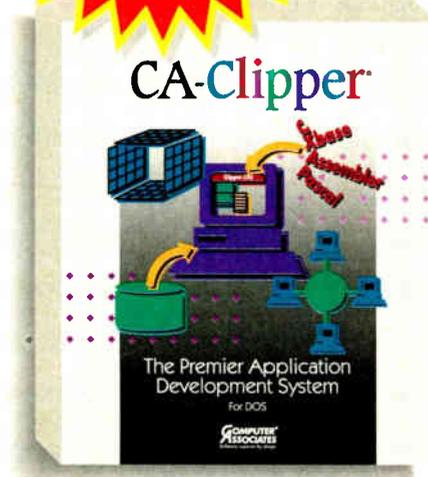
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Customizable Reactive Error Handling	YES	NO	NO
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Reads and Writes dBASE IV (.MDX) Files	YES	NO	YES
Reads and Writes Paradox (.DB/FOX) Files	YES	NO	NO

Comparison based on FoxPro Version 2.5 for DOS and dBASE IV Version 1.5.



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user-interface layer is coded in C, C++, and NewtonScript, a new language that combines features of C and Pascal. NewtonScript is the development tool for all Newton applications software, including the programs that are burned into the Mes-

sagePad's ROMs. Drivers and other low-level functions that access the MessagePad's hardware directly are best written in assembly language.

The Recognition Architecture has a recognizer engine that translates your printing,

cursive writing, or any combination of the two. The recognizer was designed by ParaGraph International, a U.S./Russian joint venture based in Moscow and Sunnyvale, California (see "Pen Computing Catches On" on page 105). It's trainable, automat-

Ink vs. ASCII

It'll be a long time before handwriting recognizers are as good as pharmacists at interpreting anybody's sloppy scrawl. Therefore, the designers of today's PDAs must compromise the ideal of always recognizing everything a user writes. One alternative is to minimize freehand pen input by offering selections in menus. Another is to capture an image of the user's handwriting without attempting the difficult translation into ASCII text.

The latter approach is known as *digital ink*. Some PDA designers contend that digital ink is not a compromise or a workaround. For certain applications, they say, ink is an entirely appropriate data type. Often-cited examples include brief reminder notes and entries in appointment calendars. In neither case, they argue, is a user likely to need full-text searching or sorting, the main advantages of ASCII text.

"There's an underlying assumption that 'before I can do useful work, it's gotta be in ASCII,'" notes Gregory Stikeleather, president of Aha Software (Mountain View, CA), which makes an ink-oriented word processor called InkWriter. "That isn't always the case."

Still, it's hard to believe that universal recognition wouldn't be implemented if it were reliable, adaptable, and didn't tax a PDA's resources. For one thing, byte-coded text requires less storage space than digital ink—an important consideration for hand-held devices with small RAM-based file systems. And there's always the chance that a user might indeed want to search a series of reminder notes for a key phrase or look for a particular name in a large appointment book.

For the immediate future, though, digital ink will be an integral feature of PDAs, and designers are taking different approaches to it. These differences are typified by Apple's Mes-

sagePad and Tandy/Casio's Zoomer.

Both of these PDAs let you tap an icon to switch the handwriting recognizers off. This lets you write freely in digital ink, which the computer captures and stores as a graphical image. This image is not a simple bit map of pixels, however. Both PDAs save your writing as vectorized strokes, similar to the difference between bit-map fonts and outline fonts. When compressed, the strokes require less storage space than bit-map images and also preserve information that could be useful later (see the text box "Jot Defines Electronic Ink" on page 110).

The Zoomer makes the best use of this information. It supports *deferred recognition*, the ability to translate ink into text anytime after it's captured. You merely select the ink, turn on the recognizer, and confirm that you want to translate the writing into text.

This is where saving penstrokes becomes important. It's much easier for a recognizer to interpret stroke data instead of a plain bit map, because the strokes preserve the way in which a character is written, not just its image. If nothing more than a bit map were saved, the recognizer would be reduced to optical character recognition, which is not very reliable for handwriting.

The MessagePad doesn't support deferred recognition, although nothing in the Newton Recognition Architecture precludes it from being added in the future. Apple gives two reasons for this decision: Real-time recognition saves storage space, and usability testing has showed that people tend to write much sloppier when the recognizer is off, making it more difficult to recognize.

As a result, the MessagePad's approach to digital ink is somewhat less flexible than the Zoomer's. In truth, however, the Zoomer probably needs digital ink more than the MessagePad.

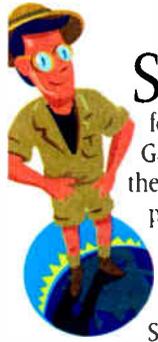
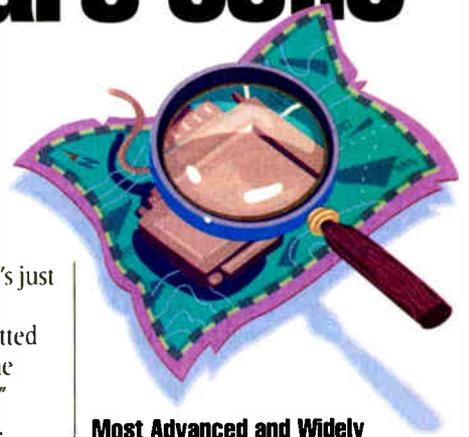
The Zoomer's recognition is noticeably slower (a consequence of the Zoomer's 8088-compatible CPU versus the MessagePad's ARM610 RISC chip); it's less adaptive (it recognizes only printing, not cursive writing, and it isn't trainable); and it is somewhat less accurate (based on results of preliminary tests).

A key difference between the two recognizers is that the Zoomer interprets words character by character, while the MessagePad lets you choose between a dictionary-based system, character-by-character recognition, or a combination of the two. Normally, the MessagePad tries to find each word you write in its 10,000-word dictionary. If it can't find a match, and if the character-by-character option is off, the MessagePad makes a guess—often a very wild guess. For example, the MessagePad stumbled badly on the proper name *Halfhill*, even though both parts of the compound word were in its dictionary. Five attempts yielded these five guesses: *florists*, *teachers*, *forecasts*, *four their*, and *Clarence*.

One solution to the problem is to add the word to the dictionary by spelling it on a pop-up QWERTY keyboard. Once I added *Halfhill*, the MessagePad got it right every time. The other alternative is to activate the character-by-character option, which works fairly well but slows down the recognizer and reduces overall accuracy.

The Zoomer's answer is to always offer the option of digital ink—unlike the MessagePad, which offers it only in certain applications. "If I were writing poetry, a dictionary-based recognizer would be great," comments Jeff Hawkins, founder and chairman of Palm Computing. "But when you start writing names and other words that aren't in the dictionary, you start running into problems."

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Finally, Don leaned back and asked the assumptive question, "What about protection — are you using Sentinel?"

Nervously, Simon sipped his coffee. His hands shaking as his eyes darted the room. "No. I didn't think I needed to."

Don's chair slid out from under him and he crashed to the floor. Amazed in disbelief, Don cried, "You What?!" Grabbing his tattered scrapbook, Don pulled out photos of his travels. "Ever been to Seoul? Prague? Anywhere? Ten bucks will buy you anything, even bootlegged copies of software."



Don's Road to Success

Thumbing through the scrapbook, Don shared his experiences. "Back in the '80s, I was in your shoes — beaten, battered and bruised." Simon listened. "Then, after a heart breaking trip around the world, I called the Software Publishers Association (SPA)."

"I could hardly believe it. They told me developers lose billions of dollars each year. Why? Illegally copied software. In some countries there are nine pirated copies for each legal copy sold."



Simon was disgusted, "It's just not fair."

"That's why I committed myself to solving the piracy problem," explained Don.

Simon's eyes lit up. "The dongle!" he shouted. Don corrected him, "Not just any dongle — the dongle that paved the road to success for over 10,000 developers worldwide — Sentinel."

Successful Developers Use Sentinel

Don pulled a stack of letters out of his gunny sack. "All of these people tell the same story." Don read about a successful developer from California who swears she wouldn't be in business without Sentinel. Another company says protection costs less than litigation, plus they don't have to spend time and money supporting illegal users.

Others confessed they wouldn't market products internationally without protection.

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Circle 133 on Inquiry Card (RESELLERS: 134).

World Radio History



ically adapting to your handwriting style over time.

Similarly, a graphics interpreter detects specific objects and penstrokes as you sketch on the display. For example, it automatically transforms a round scribble into a perfectly formed circle; four perpendicular lines become a precise rectangle. Both the handwriting recognizer and the graphics interpreter detect several pre-defined gestures for manipulating words and shapes. You can move objects, resize them, and cut and paste them on a system clipboard.

Newton's Communications Architecture supports a wide variety of I/O devices via the MessagePad's RS-422 serial port, PCMCIA slot, and 19.2-Kbps infrared transceiver. The serial port connects to printers, fax modems, and desktop PCs. The Type 2 PCMCIA slot accepts wireless communication cards and other add-ons. The infrared link lets you beam data to another MessagePad or a Sharp Wizard OZ-9600. This architecture is extensible, so new communications options can be added in the future.

A Central Data Bank

What sets Newton Intelligence apart from the typical desktop operating system is the Information Architecture. It's datacentric, not filecentric, a radical departure from DOS, System 7, Unix, and other common operating systems. PenPoint has a very similar structure, although it doesn't go quite as far as Newton in abandoning the old file-oriented model. Both Newton and PenPoint give us a likely preview of the object-oriented operating systems from Microsoft (Cairo) and Taligent (Pink) that are coming to desktops.

Instead of storing data in discrete files organized in a hierarchical file system, Newton Intelligence lumps everything together in an object-oriented central repository that's accessible to all applications. Technically, this is known as a *persistent object store*, and it promotes data-sharing among applications without the complex plumbing that's now being retrofitted to operating systems for desktops.

Because conventional operating systems segregate information in files, applications can't share live data until the operating system is equipped with a mechanism such as Microsoft's DDE or OLE, or Apple's Publish/Sub-

scribe or Amber/OpenDoc. Although these mechanisms work, they add yet another thick layer of code that wasn't anticipated in the original architecture of the operating system. They also force developers who want to take advantage of the new features to modify their code to expose internal objects to other applications. If the code isn't already object-oriented, extensive rewriting may be necessary. Both Microsoft and Apple are in the process of pulling their respective developer communities in these new directions.

Newton's Information Architecture takes a different approach to data storage and sharing. When data enters the MessagePad, the Information Architecture automatically tags (i.e., names), compresses, and saves the data in an object called a *frame*. A frame is a structure composed of tagged locations called *slots*. Slots can contain user data, program code, and even other frames. As objects, high-level meanings can be attached to frames: for example, *address* can represent "1 Phoenix Mill Lane."

A collection of related data frames is known as a *soup*, and soups reside in physical locations called *stores*. For instance, a soup of contact names might exist in a store located on a PCMCIA RAM card. Soups automatically maintain indexes to their frames.

This unified model means that all information stored in the MessagePad automatically becomes part of an object data-

base that Newton applications can search, modify, and display in countless ways. It eliminates the overhead of data translation and the redundant copies that often result from translation. Furthermore, because all information is processed as Unicode, the MessagePad readily adapts to foreign languages.

It's in the Soup

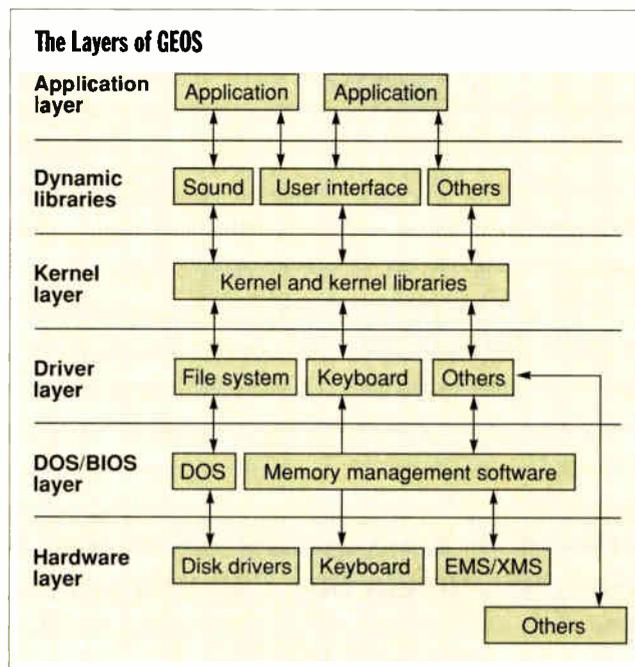
All of this dovetails with the final component of Newton Intelligence, the Intelligent Assistance. This component takes advantage of the data soup to make plausible connections between the information and your actions. For example, if you ask the MessagePad to "fax to Lisa," the Intelligent Assistance automatically assumes the sketch you just drew on the screen is what you want to send. Next, it locates all people named Lisa in the object database. If there's more than one, the MessagePad prompts you to make a choice. Then it retrieves Lisa's fax number and generates a fax document. The next time you connect your modem to a phone line, the MessagePad sends the fax. The Intelligent Assistance is also extensible.

Although all these capabilities can (and will) be bolted onto existing operating systems, Newton Intelligence was designed around this datacentric model in the first place, making it considerably more compact and efficient. For example, it easily fits within the MessagePad's 4 MB of ROM, leaving ample room for several other system components and all the built-in applications software.

Different Approaches to Objects

PenPoint is built on a similar object-oriented structure, but it doesn't appear to go as far as Newton toward discarding the traditional file-oriented model. PenPoint applications can store data as objects, much like Newton does, but they also have the option of saving documents in conventional file formats such as WKS or RTF. A systemwide import/export architecture translates those files as necessary when they are called by a PenPoint application. Newton applications, on the other hand, might provide backward compatibility with conventional file formats by encapsulating a file within a slot or a frame in the object store.

All these structural details will probably remain transparent to users—unless something goes



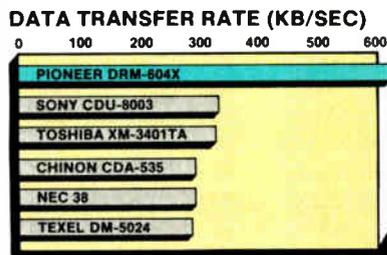
The GEOS operating system is based on the familiar DOS architecture, but it does make use of some high-level objects for the sake of reducing code requirements for programmers.

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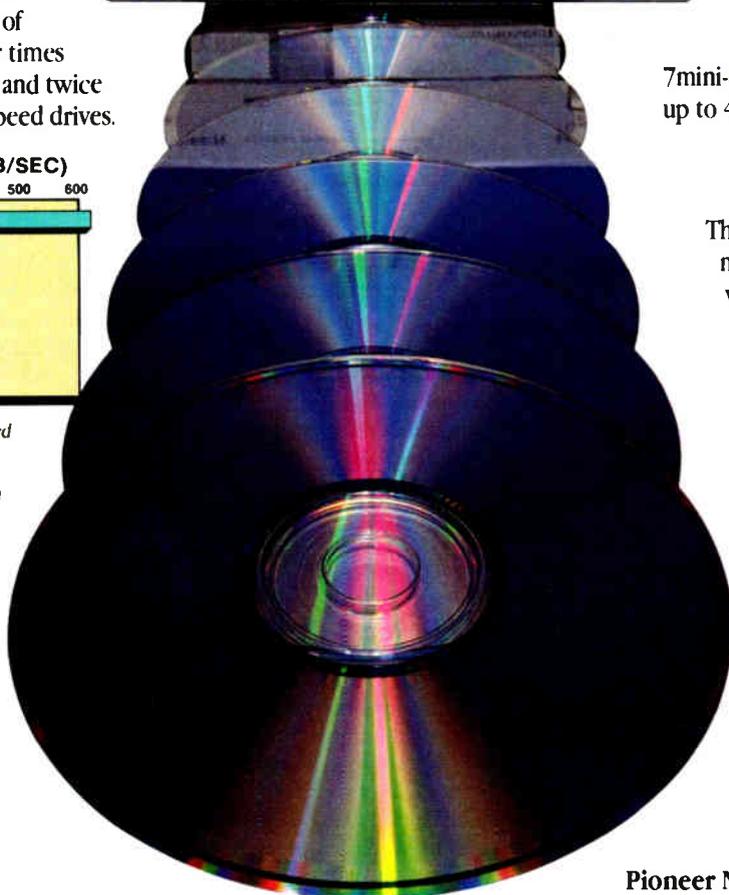
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horribly wrong. That's when the subtle differences between Newton and PenPoint might become more obvious. Newton critics say that its centralized object database could backfire by compromising data integrity and that PenPoint has better safeguards in this respect.

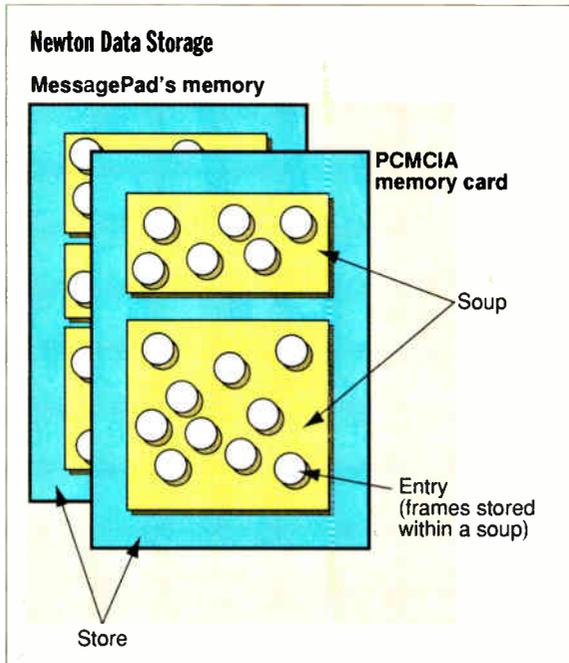
Data integrity is paramount in a RAM-based system, because a crash could corrupt all of a user's accumulated data, not just a single file associated with a single application. PenPoint was designed with extensive memory protection, so applications are effectively "walled off" from each other. The walls keep one application from interfering with another application's data or from crashing the whole system. To keep those thick walls from impeding IAC (Interapplication Communication), PenPoint has a system-level messaging mechanism that allows PenPoint applications and their objects to interact with each other.

Memory protection is receiving close attention in the design of multitasking operating systems, and it's a key feature of Microsoft Windows NT and IBM's OS/2 2.1. But Apple says the kind of memory protection found in PenPoint adds too much overhead to data-sharing between applications and that Newton's Storage Manager protects the integrity of the central repository in better ways.

Newton applications never access the object database directly, explains Larry Kenyon, principal engineer of Newton Intelligence. Instead, all reads and writes are handled as transactions and funneled through the Storage Manager's I/O system, where a sentry verifies the data before updating the object store. "Applications can't even touch the data," says Kenyon. "The sentry is always in place to keep that from happening."

Even if a system crashes or is switched off during a transaction, no data will be corrupted, he claims. Of course, no operating system can prevent loss of data if the hardware is physically damaged or if the MessagePad's main batteries and lithium cell go completely dead. Prudent users still need to back up their data.

The NewtonScript development language provides additional safeguards, says Apple's Michael Tchao. Unlike C, it automatically handles memory management and garbage collection. Applications programmers no longer have to allocate memory, and all references are to objects, not to handles or pointers. Tchao says 80 percent of crashes are caused by memory



A store is the physical location of data storage, either main memory or a PCMCIA RAM card. A soup is a collection of related data. Entries are tagged frames of information in a soup. Soups automatically maintain indexes to their entries and can update or remove them on demand.

management problems and that NewtonScript makes the programmer's nightmare of memory leaks and dangling pointers a thing of the past.

NewtonScript objects also have latent typing, and all operations are type-checked before they're performed. This nails argument errors before they have a chance to trash the stack and cause problems dozens of instructions later.

Even if NewtonScript makes life easier for programmers and contributes to data integrity, will developers embrace the new language? Critics say that because NewtonScript is nonstandard and bucks the industry trend toward C and C++, porting code won't be as easy.

But Tchao predicts that programmers will adapt quickly to NewtonScript's hybrid C/Pascal syntax. Based on early experience, he claims development will be faster on the Newton than on other platforms, mainly because there's less code to write. Developers won't have to recompile their applications to run on Newton devices built around other microprocessors, because NewtonScript code is executed by a run-time interpreter. Apple has already received inquiries from about 1500 "serious" developers, says Tchao, and about 50 applications written in NewtonScript will be introduced by Christmas. By the end of 1994, Apple predicts that about 300 applications will be available.

"Anytime you invent a new language, the language zealots—and there are a lot

of language zealots out there—run screaming from the room," says Tchao. "But we haven't found that to be the case with NewtonScript."

A New User Interface

Another consequence of Newton's datacentric architecture is that it discards the old data-processing model of booting an operating system, running and quitting application programs, loading and saving documents, and maneuvering through hierarchical file systems that mirror the layout of mass-storage devices. Although this model has served us well for decades, it assumes a certain familiarity with a computer system's underlying structure—the difference between an executable file and a data file, for instance, and the hierarchy of directories, subdirectories, and files. If PDAs are to successfully penetrate the mass market, these assumptions have to be abandoned.

The MessagePad has no start-up sequence, and you never explicitly load or run a program on it as you do on a desktop PC. Instead, you simply flick on the power switch, and you automatically return to the same application and document that was active during your last session. You move smoothly from one application to another by tapping its icon. To the casual user, it appears that all applications are always running, although actually the operating system is transparently swapping chunks of code in and out of the computer's RAM (640 KB on a standard MessagePad).

When you move to a different application, you find yourself at the exact spot in the last document that you created with that application. To switch documents, you simply tap on an icon. You never have to explicitly load or save a document; any changes you make are automatically updated in the central database.

Nor must you deal with a file system that exposes the detailed structure of the system's mass storage. You can call up a scrolling list of notes that you've created, but you can't view a "disk directory" that mixes data files with executable and auxiliary files. Newton saves documents chronologically, and you can organize them into folders if you want to do so, but the nuts-and-bolts framework of the storage system always remains hidden. This is a greatly abstracted extension of the Mac's file system, which shows only one icon for an executable file, even though it actually consists of separate files for the

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World Radio History

PDA CPUs: New Form Demands New Functions

DICK POUNTAIN

The new battery-operated, hand-held PDAs demand a new class of CPU, and semiconductor manufacturers are all rushing to pick up a piece of this potentially huge market. It seems like vendors announce new PDA-class chips every week, all offering different and non-Intel-compatible architectures. To understand how this has come about, consider the features a PDA processor chip should have.

Low cost. PDAs are aimed at the consumer market. In a unit that costs only a few hundred dollars, the CPU cannot cost more than \$25 to \$30. Thus, PDA designers can forget about using 486DXs and Pentiums, which cost hundreds of dollars each.

Smallness. Printed-circuit-board space is at a premium in any hand-held device.

Very low power requirements. Battery life for a PDA needs to be an order of magnitude better than that of a laptop PC, allowing weeks or months between battery changes. Another important threshold that PDA designers are aiming for is operation on just two AA-size batteries.

Power. Although PDAs are pocketable, don't confuse them with pocket calculators; the kinds of applications promised by, for example, Apple's MessagePad require as much processing power as a high-end desktop PC. Handwriting recognition in particular consumes lots of real-time computing power.

High integration. The chip should contain a lot of peripheral functionality, such

as RAM, ROM, and various controllers, that would otherwise require external chips.

Ability to run compact code. This reduces the amount of ROM and RAM needed to store the software.

These requirements are not wholly independent: for example, smallness and low cost go together, as a chip's price in volume production is related to its die size (i.e., the amount of silicon it contains). On the other hand, smallness and

announced. The two first-generation PDA processors are the U.K.-designed ARM610 (Advanced RISC machine), which is used in Apple's Newton MessagePad, and the AT&T 92010 Hobbit, which is used in Eo's Personal Communicators. Both are 32-bit RISC designs, but the Hobbit is unusual in its use of an on-chip hardware stack, which is optimized for executing C function calls, instead of the large register file typical of a RISC CPU.

Both chips contain a cache and a memory management unit to support virtual-memory operating systems, but otherwise they show only modest integration. The Hobbit, for example, is part of a five-chip family that together make a PDA.

The second-generation PDA chips, which come from Japan, are Hitachi's SH7000 series and NEC's V800 series. While the ARM610 and the Hobbit are general-purpose RISC CPUs, these newcomers resemble microcontrollers on steroids. Both are based on 32-bit RISC cores with greatly simplified architectures.

Hitachi's SH7034 chip is a highly integrated device, with 4 KB of on-chip RAM and 64 KB of PROM, a DRAM controller, a four-channel DMA engine, twin serial ports, an eight-channel A/D converter, and a whole slew of timers and pulse generators. The SH7032 has no PROM, but it has a total of 8 KB of RAM. Both SH CPUs feature a 16- by 16-bit integer multiply-and-accumulate instruction that executes in one to three cycles, enabling fast digital signal processor-style signal and image processing. You could build a simple PDA around the SH by adding only display and PCMCIA controllers.

NEC's V810 is not as integrated, but it includes a single-precision FPU; a 16-bit-bus version, called the V805, is probably the smallest and lowest-powered

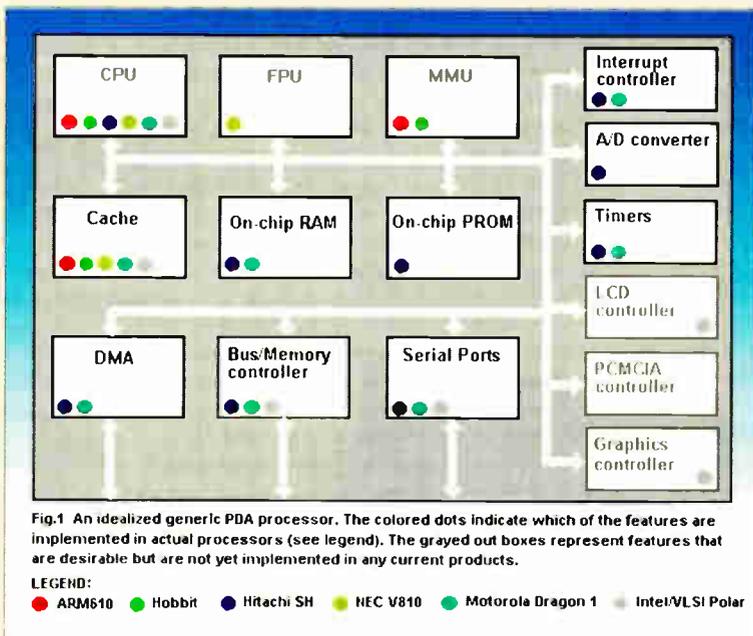


Fig. 1 An idealized generic PDA processor. The colored dots indicate which of the features are implemented in actual processors (see legend). The grayed out boxes represent features that are desirable but are not yet implemented in any current products.

LEGEND:
 ● ARM610 ● Hobbit ● Hitachi SH ● NEC V810 ● Motorola Dragon 1 ● Intel/VLSI Polar

high integration fall on opposite ends of the spectrum and call for trade-offs. "Small and powerful" nowadays means RISC, and almost all the PDA chip designers start with a compact RISC processor core (typically one with 30,000 to 40,000 transistors) and then add peripheral units to taste. Because PDAs represent a completely new software market in which PC or Mac compatibility is arguably not necessary, CPU makers are free to use leading-edge technology.

The Players

Although very few PDAs have actually been shipped so far, a second generation of processors is already being

CPU chip currently available. The forthcoming V820 will have DMA, with serial ports and timers located on-chip, like the Hitachi SH series. Nintendo is rumored to be designing the V810 into a forthcoming CD-ROM games machine.

CISC chips are not entirely excluded from the PDA scene: Motorola designed its 68349 Dragon 1 in collaboration with General Magic for use in PDAs based around General Magic's Magic Cap operating system. The Dragon is 68000 compatible and has integrated data RAM and DMA and serial ports. However, Motorola also plans a fast RISC PDA chip based on the PowerPC.

CMOS a Must

All these chips are implemented in fully static CMOS so that you can slow or stop the clock and then restart it without losing the processor state. The Hitachi SH and Motorola Dragon chips include special sleep instructions that stop the CPU but continue to time the peripherals; the SH also has a standby mode that stops everything and reduces power consumption to a few microwatts. The Hobbit, ARM610, and V810 can be put into a similar state by external clock logic. All the chips come in low-power 3.3-V versions, but only NEC's V810 can currently operate reliably on the 2.7 V you get from two tired AA batteries.

Hitachi and NEC have made code density an issue for PDA processors, a reflection of their experience with embedded processors, where much of the software is held in on-chip ROM. The Hitachi SH employs a 16-bit instruction format, so its programs are only 60 percent to 70 percent the size they'd be on RISC chips with 32-bit instructions. The downside of these short instructions is some awkwardness, particularly with address arithmetic.

The NEC V810's instructions are mostly 16-bit with just a handful of 32-bit, while the Hobbit uses a variable-length encoding scheme that also yields good code density. The ARM610 uses all 32-bit instructions but shortens its code by condensing condition tests and operations into a single op code (e.g., ADDEQ, add if Z flag set).

Benchmark figures are even more contentious than usual in the PDA arena, as there's little agreement about the conditions under which power consumption, speed, or MIPS per watt should be measured. Rather than step into this hornet's nest, I'll just quote ballpark figures. Power consumption for the CPUs mentioned here all lie in the range bounded by the NEC V810's 100 milliwatts and the Dragon's 300 mW (all at 3.3 V), an order of magnitude less than the 3 to 5 W consumed by a typical desktop 486. NEC claims the V805 consumes only 28 mW at 2.2 V and 10 MHz. Apart from the Dragon, all the chips can process at 15 to 20 MIPS, placing them squarely in the 486 league.

Most observers agree that the NEC V805 offers the best MIPS-per-watt rating right now, but expect the lead to change continually as the CPUs are fabricated in better processes and with different degrees of integration. When comparing power consumption between a highly integrated CPU such as the Hitachi SH and one with fewer functions such as the NEC V805, you should add in the likely consumption of all the extra support chips that the latter chip requires. However, this is rarely feasible in practice.

An Integrated Future?

Adding more functions increases a chip's die size and hence its price, but so long as all those functions are useful there should

be a net savings, thanks to the reduced external chip count. A highly integrated chip like the Hitachi SH will be cost-effective so long as you design a PDA precisely around the functions that it provides.

Another possible strategy, however, is to go with custom integration. Both ARM and NEC are offering their tiny RISC cores as macro cells for embedding into customized application-specific ICs, which could contain a set of peripheral functions precisely matched to a particular PDA's design. For example, by migrating to a 0.6-micron CMOS process, ARM should be able to fit most of the MessagePad's functionality (i.e., graphics, LCD, and PCMCIA controllers) onto a future CPU chip.

Intel and VLSI Logic recently revealed two PDA chip sets they're developing as a joint venture, based on Intel's 386SL and 486SL power-managed CISC processor cores. Code-named Polar (386) and Draco (486), both are twin-chip sets with one chip containing the CPU core, cache, memory and bus controllers, and a Windows-compatible graphics accelerator subunit, while the other holds keyboard, mouse, serial I/O, pen, and floppy and hard disk controllers and an HP-SIR infrared link.

Power management circuitry will be able to switch off individual peripherals according to demand, although no power or speed figures were available at press time. VLSI's high-bandwidth 25-pin ML bus is used to connect the chips together, which keeps the total pin count for the set to a reasonable 276. When the Polar and Draco chip sets become available this fall, you'll be able to design a PDA by just adding a PCMCIA controller chip.

In the end, it's likely to be consumer acceptance of PDA software that will determine the winners and losers among these CPUs, rather than their relative technical excellence. Those that achieve sales volume will survive. As PDAs come with most of their software built-in, the aftermarket for software may be small, making portability less of an issue than it is in the PC market. You might even see three or four different CPUs become established.

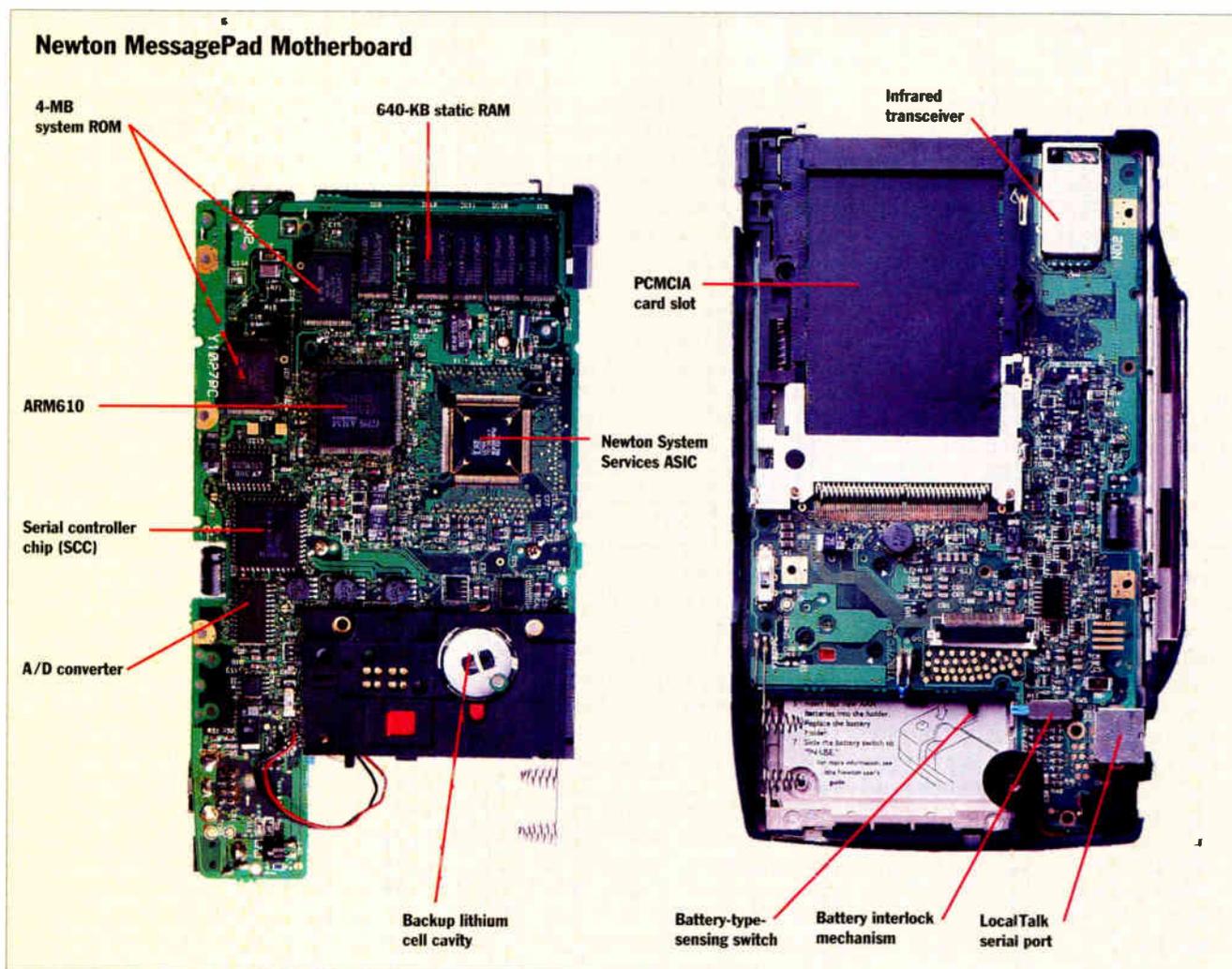
PDA PROCESSORS COMPARED

	ARM610	AT&T Hobbit	Hitachi SH series	NEC V810	Motorola Dragon	Intel Pentium
Die area (square mm)	71	92	92	53	100	294
Transistors	359,000	419,000	593,000	240,000	550,000	3.1 million
Cache	4K	3K	8K*	1K	1K	16K

* On-chip RAM.

Compared to the Pentium, PDA CPUs seem puny in size, yet many deliver considerable punch. Small size and high performance are necessary for these small, battery-powered devices.

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resource and data forks.

PDA designers consider such details extremely important. Apple says it went so far as to hire a cultural anthropologist to observe people and notice how they use such things as Post-it Notes and other traditional tools. "You have to go beyond ease of use and provide assistance to the user," says Shifteh Karimi, user studies manager for Apple's Newton Group.

Again, PDAs are giving us a peek at the future. Desktop computers are moving toward the same datacentric philosophy, although retrofitted solutions such as OLE 2.0 and Amber/OpenDoc are not as elegant. Desktop PCs could also benefit from Newton's abstract file system, as mass-storage devices with gigabyte capacities strain users' ability to find individual files in deeply nested stacks of folders and sub-folders.

The Zoomer's Architecture

Apple is by no means alone in recognizing the value of a new user interface for a product aimed at the masses. The Zoomer takes

a strikingly similar approach, even though it's built atop an entirely different architecture.

While Apple spent millions of dollars infusing the MessagePad with the latest technology—an advanced operating system, an optimized development language, an ARM610 (Advanced RISC machine) RISC chip—Tandy tried to reduce costs by building the Zoomer with tried-and-true parts. Casio designed an Intel-compatible CPU that's equivalent to a 7.5-MHz 8088. GeoWorks adapted its desktop GEOS environment to reside in ROM. Palm Computing wrote almost all the applications software in assembly language and created an extremely compact handwriting recognizer that fits in 48 KB. Intuit contributed Pocket Quicken, a mobile version of its best-selling money management program.

But despite their different evolutionary paths, the MessagePad and the Zoomer could appear very much alike to casual users. Not only do they look like twins, but they'll also hit the street at about the

same price (\$700), and both conceal their internal complexities with remarkably similar user-interface layers.

Both the MessagePad and the Zoomer are instant-on/instant-off devices that automatically drop you at the same spot in the same document from your previous session. Both allow you to move transparently between applications by tapping on a row of "hard icons," affixed to the bottom of the screen, or "soft icons," displayed on the LCD. Both shield you from their underlying file systems, although the Zoomer lets advanced users run a File Manager that exposes the realities of DOS. Both have similar communications capabilities and a suite of applications in 4 MB of ROM.

Structurally, however, they're worlds apart. GEOS has high-level objects that save a lot of coding for applications programmers, but it has nothing like Newton's object-oriented database.

Applications share data the traditional way: by exchanging (and, if necessary, translating) discrete files or by sending

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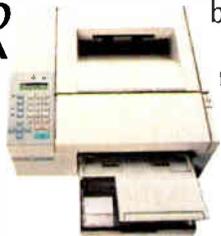
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The Wireless Factor

BOB RYAN

Before they can be more than just expensive electronic organizers, PDAs must let you communicate with other people and computers no matter where you are. Your PDA should let you send and receive E-mail messages, faxes, and even files and data from your desktop computer, network server, or other repository without having to be connected to a telephone jack. In fact, the lack of two-way wireless data communications ability is one of the biggest disappointments in the Apple Newton MessagePad and Tandy/Casio Zoomer.

At present, the most widespread, general-purpose two-way wireless communications network is the analog cellular phone network. You access this network with a PDA or a personal computer the same way that you access the wired analog phone system: by using a modem that translates between the digital world of your computer system and the analog signals used by the telephone system. Of course, using a cellular modem is not as simple as using a wired one. Modems today depend on carriers and other signals generated by central telephone switches. Using a standard modem with a cellular phone requires a special adapter that can supply these signals to the modem.

In addition, most modems today are not designed to work in a mobile environment. The slight interruption in your connection that occurs when you move from one cell to another is unimportant in terms of a voice connection, but it can wreak havoc with a modem connection. Also, wireless connections are subject to a greater amount of interference than wired ones, meaning that cellular modems require far more robust error detection than wired ones.

One company that's addressing these problems is Microcom, which has developed the MNP 10 protocol for cellular connections. MNP 10 supports smooth handoffs, has a lot of error checking, and can negotiate bit rates in real time as a cellular connection de-

teriorates or improves. Unfortunately, none of the currently available PDA devices use MNP 10.

Upgrading Cellular

Coming soon is CDPD (cellular digital-packet data), originally developed by IBM and backed by a former group of companies, including AT&T, Bell Cellular, AT&T, McCaw Cellular Communications, Motorola, and New Mobile Communications. CDPD is a specification that lets you send data over an enhanced cellular network. CDPD uses a full voice channel, but can move your connection from one channel to another to avoid congesting voice communications. At 19 Kbps, it offers a lot of bandwidth.

The drawback to CDPD is that it requires that you have a CDPD modem and that your cellular supplier upgrades its base stations to CDPD. Thus far, only Ameritech, Bell Atlantic Mobile, and McCaw have announced plans to deploy CDPD throughout their networks. McCaw plans to have CDPD up and running in its 105 markets in the U.S. by mid-1994. On the end-user side, IBM and Eo are developing CDPD capability for their machines, while Motorola is developing a CDPD modem on a PCMCIA Type 2 card.

Competing directly with CDPD and analog cellular are the Ardis and RAM Mobile Data digital RF data networks. Unlike CDPD, Ardis and RAM are digital technologies from the ground up. They offer inherently better data transmission facilities than analog services. Ardis, jointly owned by Motorola and IBM, supplies dedicated radio communications networks to large corporate customers. RAM Mobile Data, with base stations in major metropolitan areas in the U.S., sells its services to anyone. It provides a wireless bridge to public data networks and services. Besides using digital technology, Ardis and RAM have one other advantage over CDPD: They're available today.

The User Experience

Whether you use digital RF or analog cellular, the connection you make over

current wireless networks looks just like the wirebound connection you make with any terminal-based telecommunications program. Given that telecommunications remains the most arcane, unfriendly application in personal computing, this is a major problem for PDA vendors and service providers. If PDAs require their computer-ignorant target audience to learn the equivalent of even one of the easier-to-use packages, such as Procomm Plus, to communicate, then Apple, Eo, Tandy, and all the rest may as well fold their tents now. "Without ease of use," says Gerry Purdy, chief analyst for mobile computing at Dataquest, "[wireless providers] will always be selling to early adopters."

Luckily, both Newton Intelligence Group's PenPoint and Eo's PenPoint are built with communications in mind, as is Magic Communications' Magic, a software communications platform for PDAs under development by General Magic. In addition, General Magic has developed Telescript, a portable programming language designed to make it easy to develop communications applications. General Magic has revealed little technical information about Telescript, but both Apple and Eo have licensed it for use in future versions of their PDAs. In addition, IBM is developing a network server that incorporates Telescript. General Magic hopes to make Telescript a lingua franca that spans and binds together applications, operating systems, and networks that support personal communications.

Today, the software and networks are in place to create wireless mobile data communications. Although the software and services that are needed to make such communications easy is not yet here, this imbalance is not very important now, as most early PDA adopters will likely be PC users. In the future, however, the success of PDAs will hinge on the success of technologies like Telescript.

Bob Ryan is a BYTE technical editor. You can reach him on BIX as "b.ryan" or on the Internet at b.ryan@bix.com.

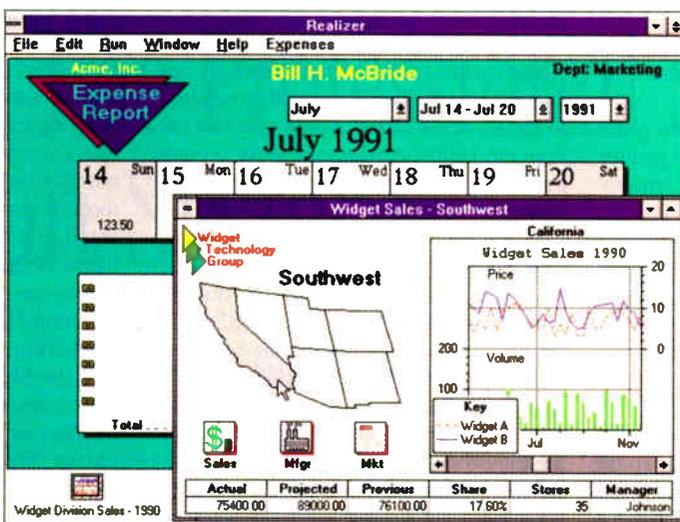
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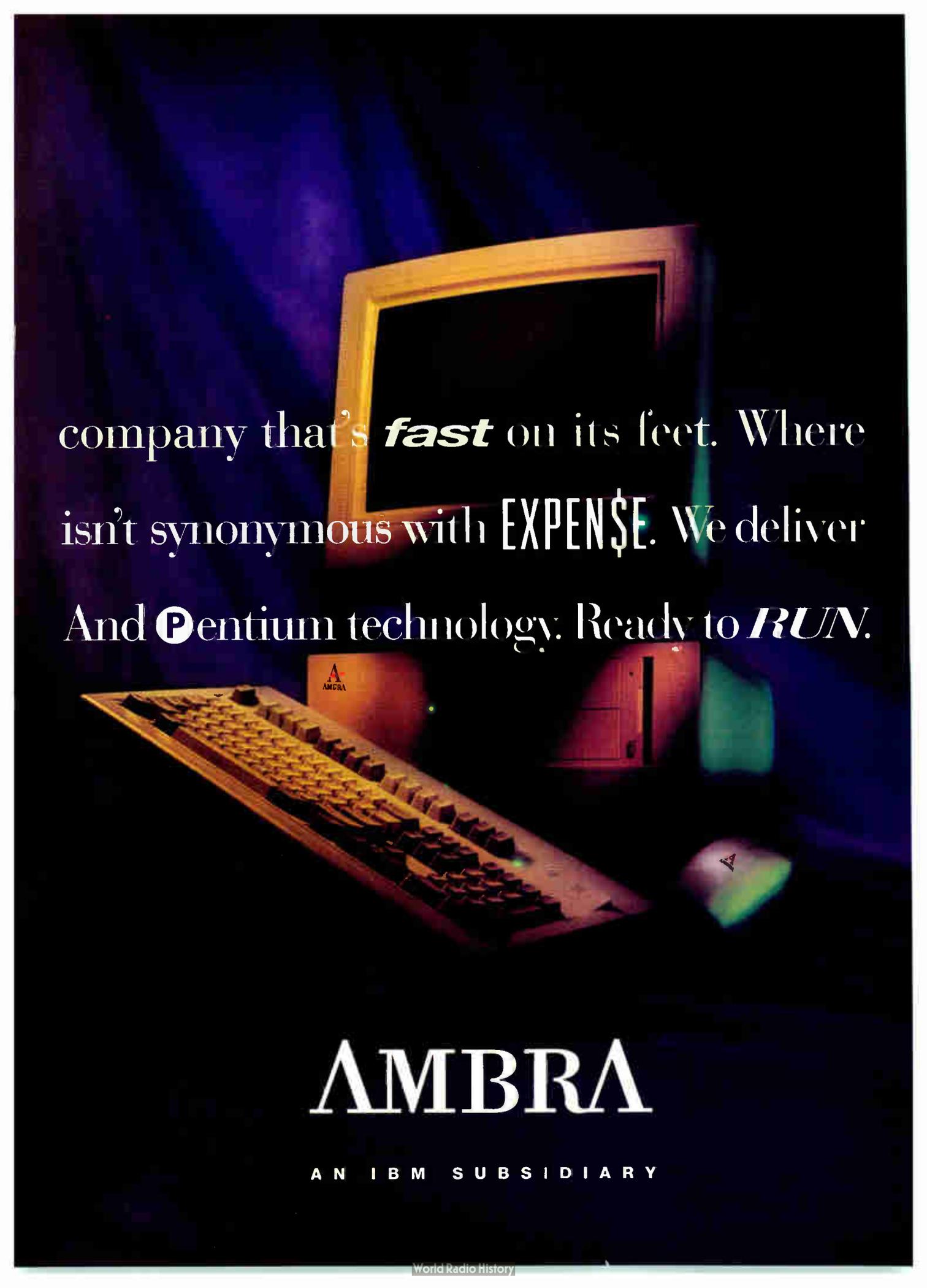
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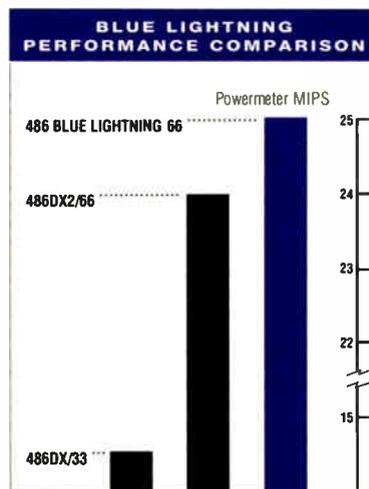
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Cache	256KB	128KB	—
Floppy	One	One	One
Hard disk	340MB	340MB	340MB
Onboard SCSI	✓	—	—
Local bus	✓ VESA	✓ VESA	✓
Video	Win accel w/1MB	Win accel w/1MB	Win accel w/512KB
Color monitor	15" FST*	15" FST	15" FST
Pentium-ready	✓	✓	✓
DOS 6.0, Windows 3.1, mouse	✓	✓ MS Works for Windows	✓
Network-ready	Ethernet (10BaseT)	—	—
Tech support	24 hours, 7 days/week	Mon-Fri, 6 am to midnight Sat, 9am-4 pm	24 hours, 7 days/week
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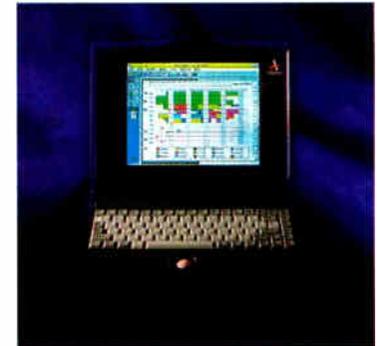
	AMBRA	DELL
Processor	Intel Pentium 60 MHz 64-bit proc complex	Intel Pentium 60 MHz 64-bit proc complex
Bus type	EISA	EISA
System case	Desktop	Tower
RAM	8MB	8MB
Cache	256KB	256KB
Floppy	One	Two
Hard disk	540MB SCSI	500MB IDE
Onboard SCSI	✓ Dual 32-bit	—
Local bus	✓ VESA	✓
Video	ATI™ Ultra Pro w/2MB DRAM	Win accel w/512KB
Color monitor	15" FST*	15" FST
DOS 6.0, Windows 3.1, mouse	✓	✓
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Price	\$4,259	\$7,566

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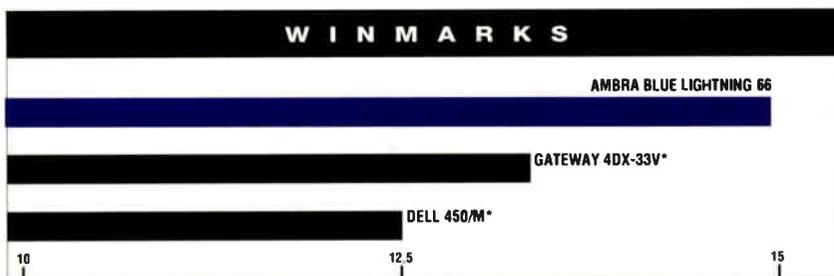
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Ease of Use Is Relative

**TOM THOMPSON,
TOM R. HALFHILL, AND
MICHAEL NADEAU**

No matter what hardware is inside or how the operating system works, PDAs (Personal Digital Assistants) must provide valuable applications and be easy to use if they are to succeed. In general, the Apple Newton MessagePad and the Tandy/Casio Zoomer have accomplished both, but perhaps not well enough for their ultimate target audience, the computer-illiterate consumer.

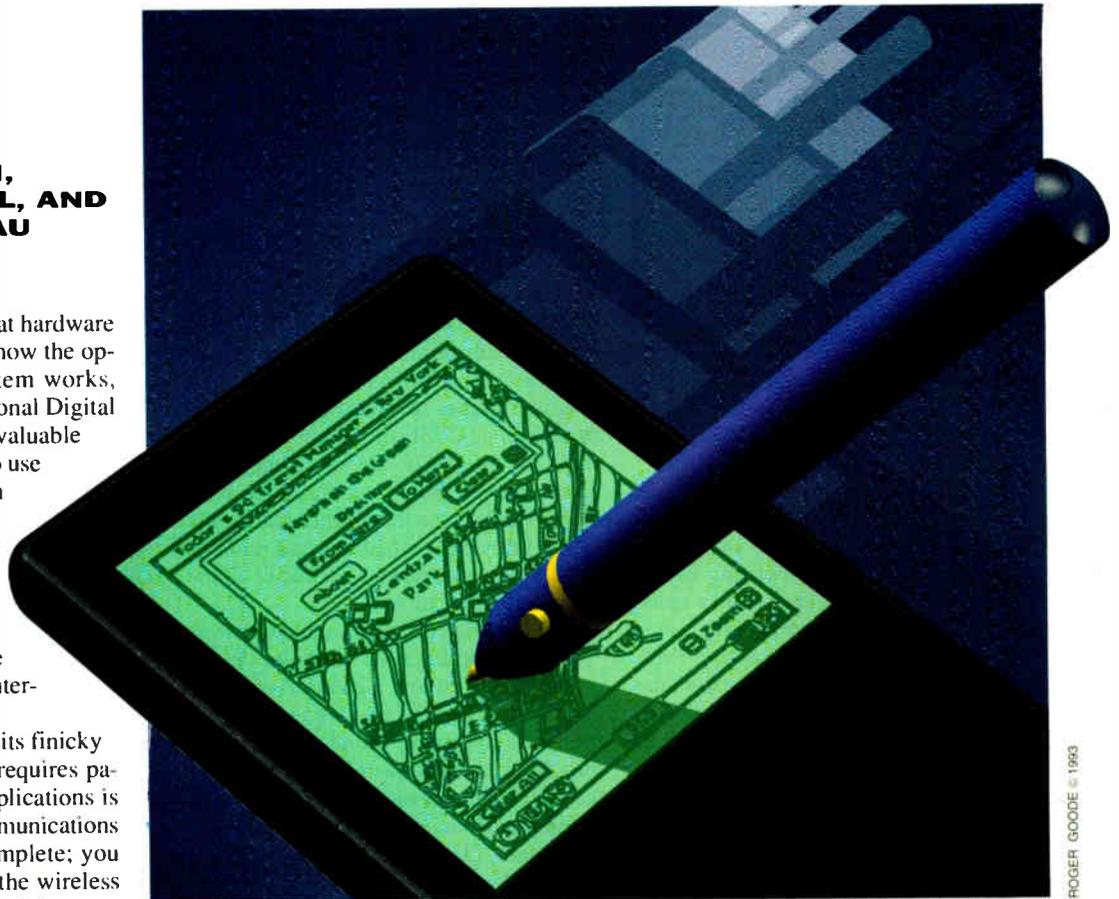
The pen interface, with its finicky handwriting recognition, requires patience. The number of applications is limited for now. And communications capabilities are still incomplete; you can only send faxes, and the wireless infrastructure that will provide many of the promised information services is still being built.

The Eo Personal Communicator is not a true PDA, but it provides an example of how well a portable, wireless communications device can be built using the technology and services available today.

MessagePad Stretches to Fit

Using the MessagePad is like breaking in a new pair of shoes. You might experience a few pinches at first, but eventually they stretch to fit you.

The MessagePad fits snugly in the hand, measuring 7¼ by 4½ inches and three-quarters of an inch thick. The unit weighs nine-tenths of a pound. It's equipped with 4 MB of ROM that contains the Newton Intelligence and the following applications: Notepad, Date, and Name. The 640 KB of static RAM holds the Newton Intelligence's working data, and about 200 KB is free for your use. It's powered by a 20-MHz ARM610 (Advanced RISC machine) RISC processor.



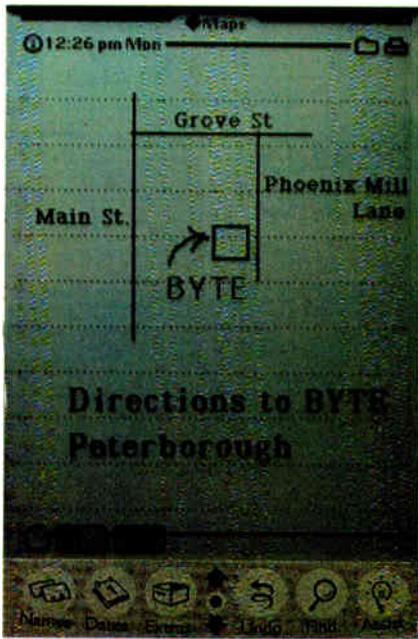
ROGER GOODE © 1993

Hands-on evaluations of the Apple Newton MessagePad, Tandy/Casio Zoomer, and the Eo 440 Personal Communicator

The text interpreter works well. It recognized the first three words of the message "handwriting recognition fairly hit-and-miss," but it came up with gibberish for the last phrase. The reason for this error was the two hyphens. Ac-

ording to a draft copy of the MessagePad Handbook, punctuation must be placed close to the words to be recognized properly. Because the recognizer uses dictionaries and name lists (i.e., your own additions to the dictionary) for the recognition process, the results of its handwriting interpretation are frighteningly accurate or a hodgepodge of obscure words and numbers. Nevertheless, the recognizer is very adept at handling certain writing idiosyncrasies. For instance, we found that dotting all the *i*'s after writing a word didn't bother the recognizer a bit.

A Handwriting Practice section gives you practice words to write so that Newton Intelligence can adapt to your writing style. It takes about 150 words to train the text interpreter. When you use



The MessagePad features a row of "hard icons" at the bottom of the screen that provide access to frequently used functions.

a MessagePad for the first time, it pays off to spend a half-hour or more in this section giving the recognizer time to study your penmanship. In the Handwriting Styles section, a slider lets you specify how much of your writing is cursive, printed, or a mixture of the two. A Recognition Preferences section lets you fine-tune both the handwriting recognizer and graphics interpreter for certain situations (e.g., in text, to recognize numbers and punctuation; in graphics, whether to connect shapes in a drawing).

Once the MessagePad was trained to recognize an individual's handwriting, its text recognition was more impressive than that of the Zoomer or Eo 440. Still, be prepared to use Undo and practice the gestures you must use to make corrections.

Another nice feature of the MessagePad is that you can select an object (e.g., a chunk of text or a drawing), "park" it by dragging it to the screen's edge, flip to another Newton application, and drag the object into that application. It's a nice visual metaphor for a clipboard that should be easy for the noncomputer user to grasp. Also, programs can control what type of information gets placed in an object. For example, when you enter your phone number in the Personal area, the window you write in accepts only digits. This goes a long way toward reducing user errors.

To test printing capability, we first scribbled a note in Notepad and then plugged the MessagePad into a LocalTalk node on BYTE's AppleTalk network. From

the Outbox, a printer-selection window showed the various network zones and PostScript printers. We tapped on a printer name, tapped on the Close box, and then tapped on a Print button. A minute later, a duplicate of the note appeared on a page coming out of a LaserWriter Pro 630.

An attempt at faxing the note didn't fare so well, however. Lacking a MessagePad fax modem, we plugged a Global Village TelePort/Gold fax modem into the MessagePad's serial port. According to the status window that appeared, the MessagePad was attempting to connect to the modem, but it never succeeded. So much for using third-party modems at the moment, but remember, we were looking at beta hardware and software.

For third-party hardware, we received a 2-MB PCMCIA RAM card from Epson. We put it into the card slot and switched the MessagePad on. Although this card was originally designed for PC notebooks, the MessagePad recognized it and asked us to erase it. After several seconds, we had an additional 2 MB of memory—a good show for Apple PIE (Personal Integrated Electronics), Epson, and hardware standards. The Newton Intelligence allows you to file individual schedules and notes to the RAM card or make a backup of all the MessagePad's data to it.

From the Notepad application, we wrote "See Rob Monday at 10"; after we tapped on the Assist button, Newton Assistance opened the Date Scheduling application, found the upcoming Monday's date, and then dropped a note saying "See Rob" into the 10:00 a.m. slot on the appropriate day.

Judging from just the built-in Notepad, Name, and Date applications, the MessagePad doesn't seem much of a win. After all, you can use a low-tech schedule book and business cards to arrange meetings and stay in touch. However, a MessagePad equipped with a fax modem and a Messaging Card changes the situation: You can fire off a diagram or a note to a contact's fax or E-mail address from nearly anywhere. The Messaging Card—actually a wireless pager that receives text messages—in turn lets your contacts get back to you immediately. For those folks who are on the road constantly but must still make quick business decisions, the MessagePad might be a solution.

Third-party Newton applications may make a case for owning a MessagePad. Fodor's 1994 Travel Manager program from GeoSystems lets you call up maps of the eight largest cities in the U.S., locate hotels, and obtain their phone numbers (see the screen on page 92). Selecting a hotel in, say, Boston gets you a map of the

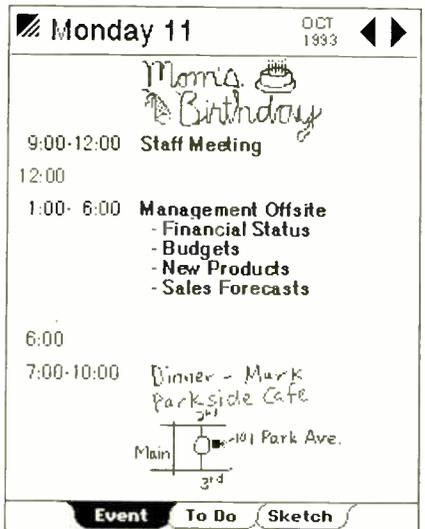
city with a diamond icon pointing out where that hotel is located. Tapping on the diamond zooms you in on a map of the city block, complete with street names.

You can then summon a From/To window, where you can drop in the hotel's name and the name of a restaurant you've already located. You then get either street-by-street directions or a line on the map tracing the route from the hotel to the restaurant. The ability to navigate through a new city using the MessagePad shows its value as a general-purpose device, given the proper software.

For vertical markets, the MessagePad's light weight, combined with the ability of Newton Intelligence to restrict the types of data entry it will allow, makes it suitable for forms handling. For example, an insurance company's accident form might allow text entries in some sections and only numbers in other sections and provide an area where a field agent can sketch an accident scene using only ink.

The synergy of Newton's Intelligent Assistance together with the object database is what makes the MessagePad a winner. The ability of Newton Intelligence and applications to locate information within the system and then act on it in rational ways is a major improvement over desktop operating systems. Once a contact's relevant information (i.e., address, phone number, fax number, and E-mail address) is captured in a MessagePad loaded with communications options, you can call that person, fax him or her, schedule appointments, or send the person E-mail with a few stylus strokes.

Newton Intelligence eliminates the many redundant operations (i.e., launching



The Zoomer emphasizes ink capture over handwriting recognition, which suffers from a slow, 8-bit processor.

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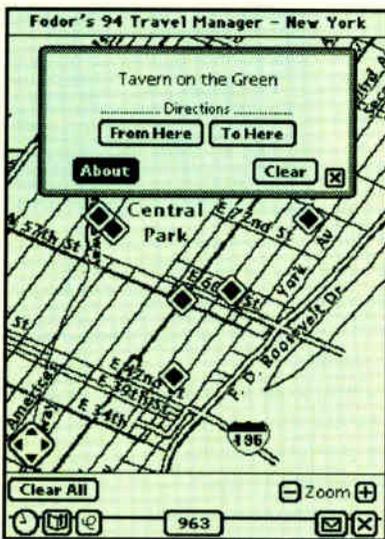
APPLICATIONS ON THE WAY

Although the MessagePad, Zoomer, and Eo Personal Communicator come bundled with several applications, you will most likely see more by the end of the year. Below is a representative sampling of what to expect.

Apple Newton MessagePad

(all application titles come from Apple's Starcore division)

- Fodor's 1994 Travel Manager: Top U.S. Cities: Contains detailed interactive maps highlighting destinations and routes in eight U.S. cities.



GeoSystems' MessagePad application, Fodor's 1994 Travel Manager, in use. The diamond at the lower left is your current location. The other diamonds indicate the locations of restaurants, selected by search criteria such as distance, cost, ethnic cuisine, and other parameters.

- Fortune 500 Guide to American Business: An expanded electronic version of the Fortune 500 and Service 500, with information on all aspects of America's largest companies.

- Money Magazine Financial Assistant: Includes calculation templates for evaluating a number of the most common financial decisions.

- Money Magazine Business Forms: Makes it easier to fill out the most commonly used financial forms, including expense reports, project plans, and loan calculations.

Eo Personal Communicator

- Gnosis, from Deskin Research Group, is a document retrieval and information management package.

- Pencil, from First Software, is a C development tool for PenPoint.

- Letter Express, from PenMagic Software, is a database of canned letters for use in business correspondence.

- SimCity, from Ink Development, is a PenPoint version of the popular simulation game.

- Pen Op, from Peripheral Vision, is a signature recognition and verification package.

the MessagePad are different animals. The Zoomer has a 7.5-MHz 8088-compatible CPU made by Casio and runs a pen-based version of GEOS, a desktop operating system from GeoWorks. The Zoomer has a character-by-character handwriting recognizer that reads only block printing, not cursive writing, and it is not trainable. It has a little more RAM than the MessagePad (1 MB instead of 640 KB) and sets aside more of that RAM for storing user data (384 KB, versus about 200 KB for the MessagePad).

The Zoomer also has more built-in software—particularly content-oriented software. Standard applications (all written by Palm Computing) include a date book, an address book, a notebook, a to-do-list manager, a calculator, a dictionary with 60,000 definitions, a 100,000-word spelling checker, a 660,000-word thesaurus, translation dictionaries (1000 words in 26 languages), world clocks, a form calculator (including measurement and currency conversions), and an almanac listing U.S. holidays, area codes, information on cities around the world, and even the complete text of the U.S. Constitution and the Declaration of Independence.

Intuit contributed Pocket Quicken, a mobile version of its best-selling personal finance program, and America Online provided a terminal program that lets users send E-mail, access on-line information, and download software.

Of course, to get on-line you'll need a modem. A PCMCIA fax modem for the Zoomer is in the works, but you can connect just about any external modem via the RS-232 port. An optional adapter cable converts the subminiature 10-pin D-type connector into a standard DB-9 connector. With appropriate software, this will also allow the Zoomer to exchange files with desktop computers.

The Zoomer is powered by three AA batteries, and alkalines are rated for about 100 hours of use. Two CR2032 lithium cells preserve your RAM-based data if the main batteries go dead or need changing.

Flipping back a protective plastic cover reveals the Zoomer's 320- by 256-pixel passive-matrix LCD screen, which measures 80 by 100 millimeters. Contrast is rather low, but the screen is readable in normal light. There's no backlighting, so you can't use the Zoomer in the dark.

The screen, of course, doubles as your input device. Writing on the Zoomer is easy—almost too easy. Because the plastic stylus glides across the slick surface with less resistance than that of a pencil on paper, it feels a little strange at first. But you'll adjust quickly. If you lose the

an application, locating a file, opening the file, and then searching for the desired data within the file) that you have to do on a desktop computer to accomplish the same thing, and it's a model that desktop computers should adopt. The MessagePad's implementation of this intelligent assistant is by no means perfect, but it's a huge step in the right direction.

Zoomer: Hands-On

Tandy's version is called the Z-PDA, and Casio's model is known as the XL-7000, but the two are virtually identical PDAs known collectively as the Zoomer. Software, peripherals, and accessories bearing the Zoomer name are compatible with ei-

ther device, and a pair of Zoomers can exchange information via their 9600-bps wireless infrared transceivers.

The Zoomer bears a strong resemblance to Apple's MessagePad, and indeed they have several features in common: a touch-sensitive LCD screen with a passive stylus; 4 MB of ROM, containing all the system software and built-in applications; a simplified pen-oriented user interface; a Type 2 PCMCIA slot for add-in cards; and an infrared transceiver for sharing data with compatible devices. The Zoomer measures 6½ by 4¼ inches and is 1 inch thick. It weighs 1 pound. On the street, both PDAs sell for around \$700.

Internally, however, the Zoomer and

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- **TS:** Search files for specific text when you forget the file name.
- **CDD:** Change the drive and directory in one command.
- **TOUCH:** Resets the DOS date/time on all files described to the current date and time (works great before DATECOPY for flexible backups).
- **MOVE:** Move subdirectory and contents to another directory.
- **DELDIR:** Delete an entire subdirectory and its contents in one command.
- **NUKE:** Delete and overwrite any file for security (cannot be un-deleted).
- **GETINI:** Reports any .INI files that match input variable.
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stylus, any implement that isn't too sharp will work just as well. (The programmers at Palm seem to favor wooden chopsticks.)

How good is the Zoomer's handwriting recognition? That's the gritty question everyone asks about pen-based devices, even though many PDAs (including the Zoomer) are designed to minimize free-hand translation. On the Zoomer, for example, you can navigate through most functions merely by tapping icons with the stylus, and you can switch off the recognizer to save your writing as digital ink.

But eventually you will want to write something and see it translated, because that's the only way to create information on the machine, unless you pop up the on-screen QWERTY keyboard. Some Zoomer proponents are enthusiastic about tapping letters on the keyboard; they say it's easy to learn and is often faster than relying on the recognizer.

Their first point may be true, but it raises the question of why you'd want to use a QWERTY keyboard on a pen-based PDA when the market is already crowded with similar devices that have real QWERTY keyboards. And the second point, unfortunately, also appears to be true: Handwriting recognition on the beta version of the Zoomer we tested was slow and not as reliable as we'd hoped.

It usually takes several seconds for the recognizer to convert a word into text. After you write a few words, the delay begins to add up, and you have to wait until it's finished converting, because there's no room on the screen to write anything more. Then you have to go back and correct the words it misinterprets.

The Zoomer's recognizer isn't trainable, but you are. Don't be surprised if you start bending to the Zoomer's demands. For example, one of us normally prints an uppercase *M* by drawing two vertical strokes joined with a *V*. The Zoomer got it wrong every time; it prefers to see an *M* drawn with a single zig-zag line. He soon began pleasing the Zoomer by changing his style, which has been burned into his ROM since the first grade.

Although the Zoomer's architecture can accommodate a different recognition engine, such as the ParaGraph recognizer on the MessagePad, that's not likely to happen until the hardware gets more powerful. The Zoomer's PalmPrint recognizer needs only about 48 KB of memory, and it's one of the few engines that runs on a CPU as slow as the Zoomer's 8088-class chip. A faster Zoomer would not only eliminate the annoying translation delays, but it would also enable Palm—or another company—to build a better recognizer.

Aside from the handwriting-recognition problems, we found the Zoomer a joy to use. The user interface is simple and straightforward. The date book and address book are logically organized, and we especially liked the ability to attach a hand-sketched map of directions to an address entry. The content-oriented material adds a lot to the Zoomer, although we wonder if there aren't better uses for the ROM than throwing in such things as birthstones, zodiac signs, and historical documents. We would vote for a generic terminal program that isn't dedicated to America Online, or even a chess game.

The Zoomer lends itself to games, of course. Its front panel has a directional pad and a pair of control buttons, just like a Nintendo Game Boy. The Zoomer will probably ship with a couple of simple games to get you started.

Considering their radically different hardware and software architectures, it's remarkable how closely the Zoomer compares with the higher-tech Newton. Their hidden differences will undoubtedly become more apparent as they evolve. And further evolution is mandatory before either platform is likely to reach its goal of bringing personal computing to the masses.

Eo: The Road Less Traveled

The smallest Eo, the 3-pound 440, dwarfs true PDAs. It's roughly the size of a subnotebook PC, measuring 10 $\frac{1}{8}$ by 7 $\frac{1}{16}$ inches and nine-tenths of an inch thick. Eo calls its systems Personal Communicators, which emphasizes their greatest strength. Portability and battery life (about an hour) were sacrificed to optimize the system for wireless communications.

For on-the-road communications, Eo's Personal Communicators are armed to the teeth. Both have a 14.4-Kbps cellular modem with 9.6-Kbps fax capability, along with Go Mail and Go Fax software. Sun-Select's PenTops provides connectivity to your desktop and to LANs. Eo Sound allows you to voice-annotate a document. The unit's larger screen aids in creating and viewing faxed forms and documents. A detachable phone headset provides voice connections. To top it off, you get a free subscription to AT&T Mail. Of course, you'd *better* get extras like this: Prices for the Eo 440 start at \$2800 with a hard drive and modem.

Go Corp.'s PenPoint operating system provides the pen-centric interface. If you've used PenPoint on, say, a 386 system, be prepared for a surprise when you run it on the Eo 440—performance is dramatically better. That's because of the Eo 440's 20-MHz AT&T Hobbit CPU. With 13 MIPS

to work with, PenPoint runs at a snappy pace. If you need even more speed, the Eo 880's 30-MHz Hobbit processor cranks out 20 MIPS, but the cost is a bigger unit that weighs 4 pounds.

Using the Eo's communications features is easy, but not completely foolproof. Even though we received a crash course in sending a fax via the Eo's cellular modem, we had trouble repeating the process later—without reading the documentation.

To fax a note from the Eo 440, you go to the Document menu item and select Send. Send gives you the option of choosing Go Fax or Go Mail (for selecting AT&T Mail). Selecting Go Fax brings up a cover sheet form on which you can write a note. After you fill in the name and number of the person you're sending the fax to—data you can either select with a few pen taps from a database or write in—Go Fax places the note in the Outbox.

From here, it becomes unclear what you need to do, as no prompt appears on the screen. To finish sending the fax, you go to the Outbox and tap on the Enabled box. A Dialing Location box then appears so that you can confirm or change information such as where you're dialing from, whether you wish to use a calling card, and so on. From this point, things are pretty automatic. Go Mail follows a similar process, but it has options such as selecting a file format for sending your fax.

This is not an onerous procedure for the Eo's target business user. But Apple and other PDA vendors cannot expect customers who have never used a cellular phone or a modem to embrace this kind of a ritual. Immediate gratification is key; PDA users should only have to make a couple of selections to make the connection they desire.

The PenPoint interface is easy to use, but a little less so than that of the MessagePad or the Zoomer. PenPoint has more menu and file layers. With its book-like table of contents, however, PenPoint could be easily adapted to provide a familiar interface metaphor for novice users. Our hands-on experience with these first PDAs shows that their ease of use is relative to the expectations of the user. Savvy computer users would say that the MessagePad, Zoomer, and Eo 440 are highly intuitive. Yet all have too many quirks and rough edges to make it in the mass consumer market. ■

Tom Thompson is a BYTE senior technical editor at large. Tom R. Halfhill is a BYTE senior news editor. Michael Nadeau is a BYTE senior editor. You can reach them on BIX as "tom_thompson," "thalfhill," and "miken," respectively.

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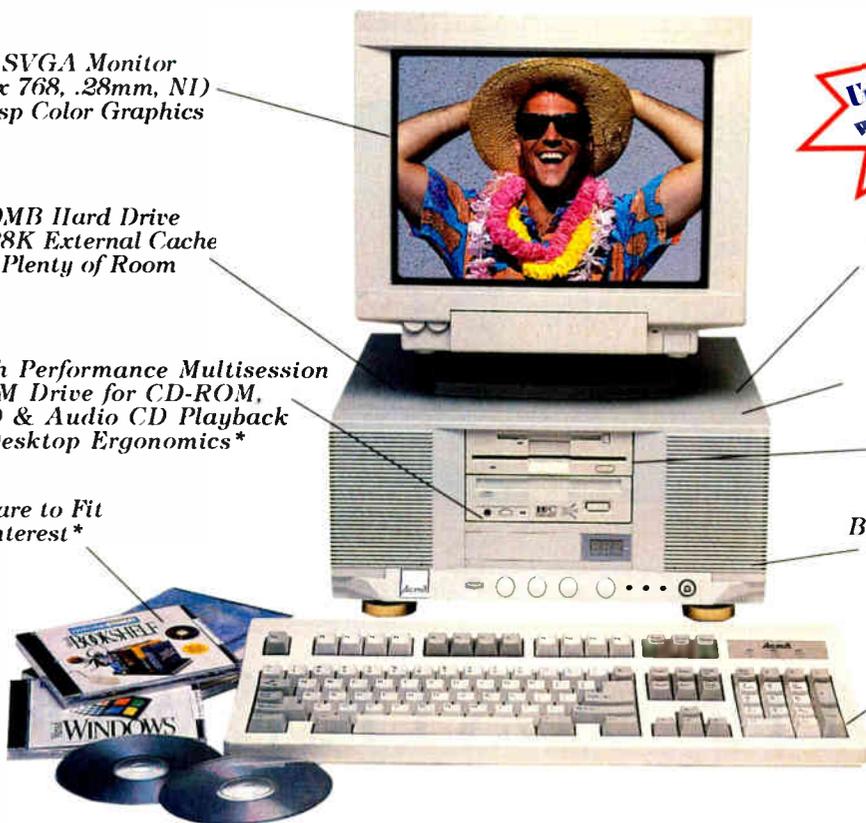
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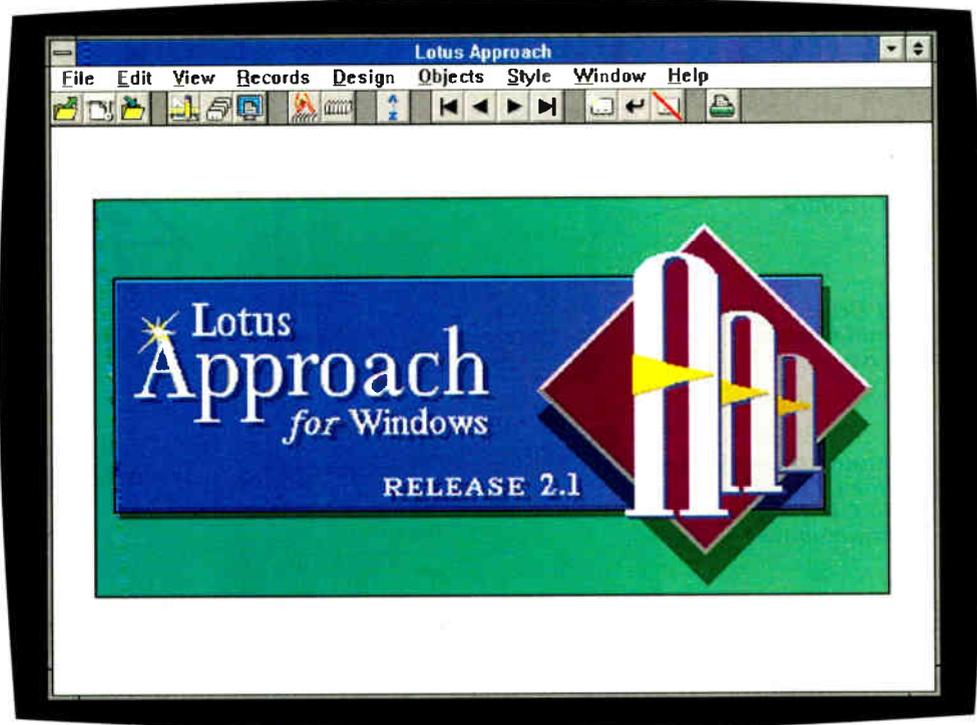


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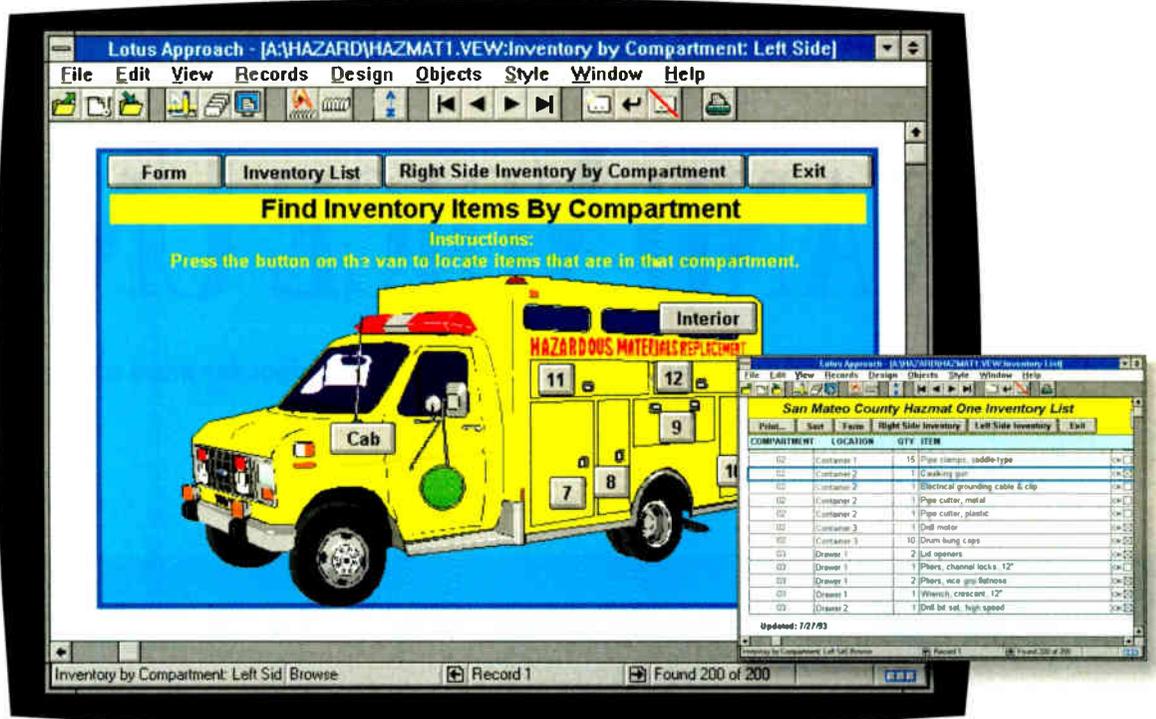
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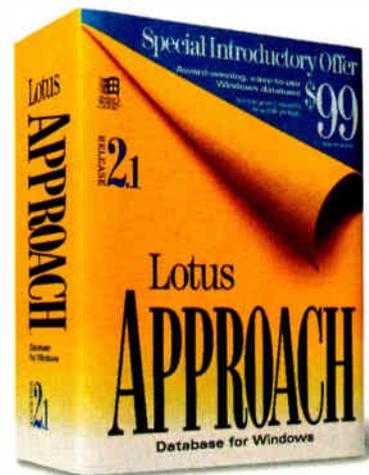
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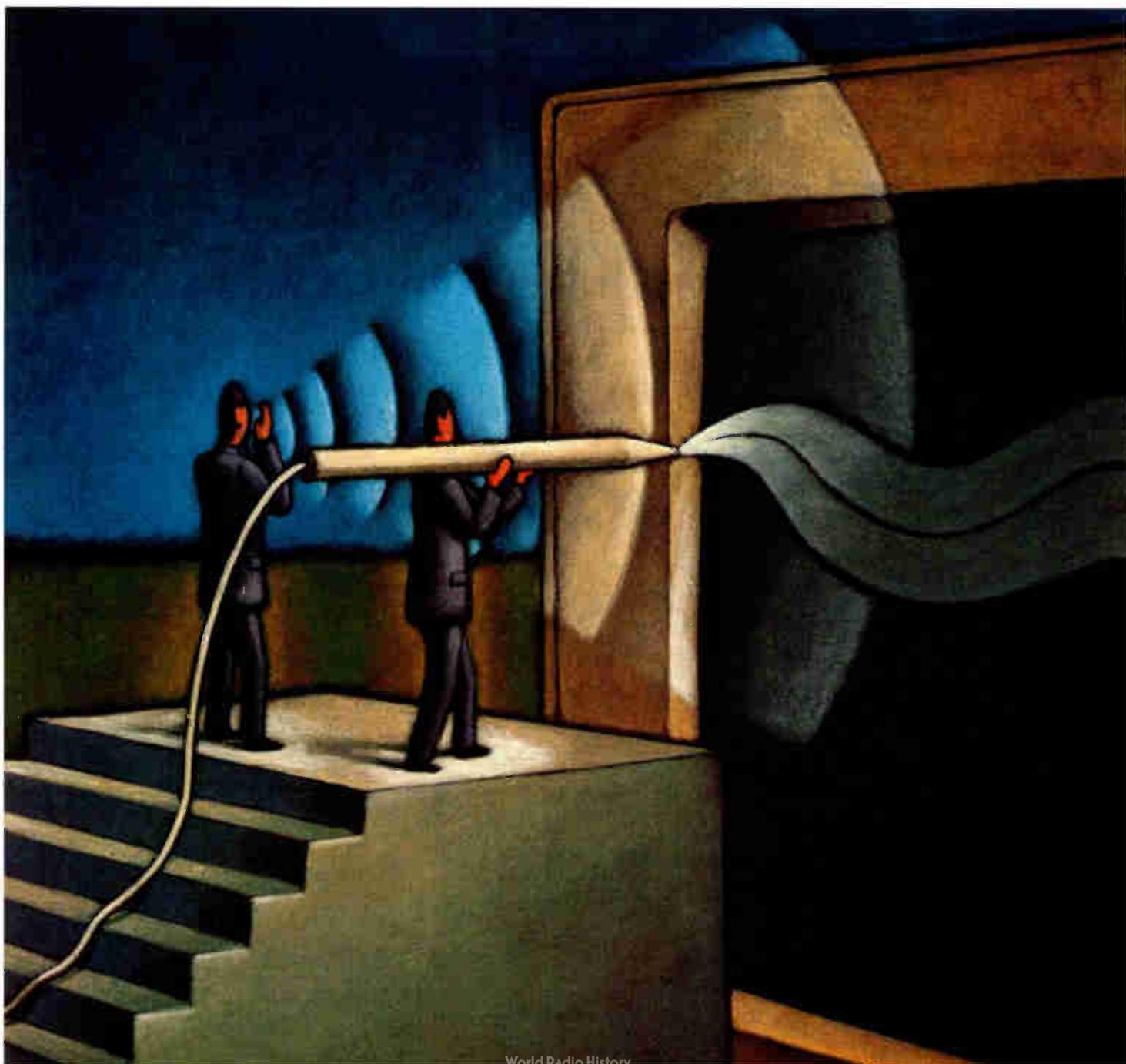
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The 1990s will be remembered as the decade in which large numbers of users began to communicate with computers through speech and writing. Held back in the past by immature technology and a lack of portable and desktop processing power, speech and handwriting recognition will break down the barriers that keyboards, mice, and GUIs present to natural communication with your computer.

"These input methods will be used in tandem, just like you use your fingers and your voice together," says Larry Dooling, president of Verbex Voice Systems (Edison, NJ), a manufacturer of desktop and portable speech systems (see the text box "Matching the Input Mode to the Task" on page 100). You can expect to see computers that combine some form of pen and voice input within a year, say several system manufacturers.

Raj Reddy, dean of the School of Computer Science at Carnegie Mellon University (Pittsburgh, PA) and a man with 30 years of speech research experience, predicts that about half the small, personal computers sold will use pen and voice input within five years. During that time, companies and research groups will be developing a wide range of joint pen and voice applications.

The underlying technologies of computing via pen and voice are more complementary than they might seem. Both perform what are basically pattern-recognition and matching tasks. Techniques such as Hidden Markov Modeling, neural networks, and template matching are used in both (see "Talk to Your Computer" on page 113).

Annotating Documents

One of the most obvious and easiest-to-implement applications of pen and voice input involves annotating documents on-

line. For example, suppose you are reading someone's draft on your screen. If your computer and software could take input from both a pen and a microphone, you could write editing marks, sketch a drawing, and record your comments. Later, when the author looks over your suggestions, he or she can listen to you and see your markups.

Implementing such a capability is relatively low-tech: The computer simply captures and stores in digital form the raw "ink" and speech signal, associating each with a place in the document. Yet the benefits are substantial, since both you and the author can save time by using speech to communicate something like "this paragraph needs more details on the historical ramifications of philosophy" and using a drawn-in arrow to indicate two words or paragraphs that need switching. You may even want to sketch in a freehand graph to suggest adding another figure. Software packages that integrate such annotation capability are already coming on the market, such as Microsoft Word 5.0. Some of the latest videoconferencing systems offer "white boarding" features that provide similar functions.

Information Entry and Control

Consider a typical spreadsheet application. It is easy to imagine entering data either by speaking or by writing in the cells. For instance, to enter a long-digit string, you could voice it to avoid repeatedly shifting your eyes between the paper and the screen. To enter a name that is unknown to the speech recognizer, you could write it to avoid spelling aloud, since spoken letters easily confuse the speech recognizer because so many sound similar.

However, because it is as hard to point with voice as with a keyboard, speech input would have to be supplemented in some way to indicate where the spoken

input should go. A good solution is to point with a pen to a particular cell while speaking its contents. Yet rather than letting the applications developer decide in advance where pen or voice input is better, the choice should be left to the user to be made on a case-by-case basis. Sometimes it will be easier to write or point to some input and other times easier to say; the choice might well change from one instance to another, even for the same user. In addition, you could use the pen not only for touching the tablet and pointing to the place of input but also for activating the microphone, thereby decreasing the risk of extraneous speech confusing the speech recognizer.

Pen/Voice Typewriter

An important, longer-range goal in speech research is to use voice to generate text documents without having to type. Building a widely acceptable voice dictation system will require efficient and flexible editing and control mechanisms. Pen input will provide the editing and control capability that is needed.

General dictation is a daunting speech-recognition task. Misrecognitions will be frequent in early speech-to-text systems not just because of algorithmic and modeling limitations but also due to other difficulties. For example, speech-to-text systems must deal with a wide range of homophones—words that sound the same but have different meanings. And spontaneous speech is unpredictable; it is often full of false starts, repetitions, and hesitation noises.

Using a pen to correct misrecognitions as they occur could make an otherwise tedious system acceptable. For instance, as you speak and notice a wrong word come up, you could simply cross it out; a short list of the computer's best alternative guesses appears and you circle one.

continued

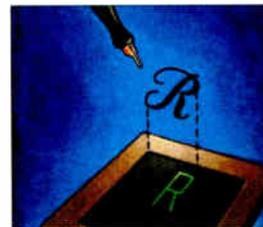
Pen and Voice Unite

Soon, speaking and writing will be an effective way for you to interact with your computer.....**98**



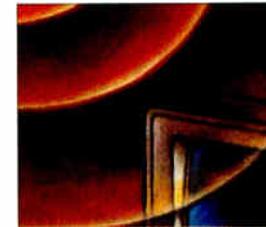
Pen Computing Catches On

Thanks to a number of advances, pen-assisted computing is becoming a reality for many users.....**105**



Talk to Your Computer

Voice technology adds new dimensions and provides greater flexibility to the user interface.....**113**



Matching the Input Mode to the Task

ALEX RUDNICKY

While you perform a wide variety of tasks on a computer, the ways you can do them fall into a small number of classes. Different input modes support these activities to a greater or lesser degree. A well-designed interface will supply those input modes that best support the expected activities.

Most complex applications incorporate several distinct activities; for example, window-based applications combine both keyboard and pointer input. Word processing includes both text

entry and editing and thus benefits from the availability of at least two input modes.

Newer input modes such as speech or stylus allow for a better fit between mode and activity. In addition, multiple input modes permit the use of parallel inputs using, for example, voice for mode switching in a graphics application while using a stylus to make changes on an image.

Spoken language is the best choice for queries, since natural language allows efficient specification of arbitrary constraints ("show all employees younger than 25 who have been employed less than a year"). As an input mode, speech is more efficient and eas-

ier to use than a keyboard.

Commands are more constrained than queries ("open file foo.bar"); they may need to follow a specific syntax and often can be made quite terse through the use of context. Choosing the best mode for item selection depends on the number of items from which to select. For small sets, such as yes/no choices or short menus, a pointing device might be best since a simple mechanical action (e.g., pressing a key or clicking a mouse) completes the transaction.

For larger sets, as might be found in a large vocabulary dictation task, speech may be best, since speaking a word is a simple one-step operation. Stylus devices appear to be best in situations that require a combination of positional and symbolic input, such as the markup of text or the entry of short notes or figures. Stylus entry is inefficient for the entry of extended text.

Pointing provides direct access to a location in space, which otherwise would have to be selected by coordinate specification (spoken or typed) or step-wise positioning (e.g., by arrow keys).

Alex Rudnický studies speech input and multimedia interaction at Carnegie-Mellon University (Pittsburg, PA). You can reach him on BIX c/o "editors" or on the Internet at air@cs.cmu.edu.

MATCHING INPUT MODE TO ACTIVITY

Some input modes suit particular activities better than others. A ● indicates that the input mode is a good choice for the activity; a ◐ indicates that the input mode is merely adequate; and a ◑ indicates that the input mode is inappropriate for the activity.

ACTIVITY	SPEECH	STYLUS	KEYBOARD	POINTER/MOUSE
Editing (markup)	◑	●	◐	◐
Note-taking, dictation, and annotation	●	◐	◐	●
User verification	●	●	◐	●
Creating graphics	◑	●	◐	●
Form-filling	●	●	●	●
Check-off lists	◐	●	◐	●
Command and control, communications, and networking	●	◐	◐	◐
Spreadsheet and financial computation	◐	●	●	◐
Scheduling, planning, and organization	●	●	◐	◐

Or you could just repeat the word, and the speech recognizer places it in context and assumes that its original choice is wrong. It then quickly zeroes in on the word you want. To enter a term or acronym that is unfamiliar to the speech recognizer, you could write it; you could also then say it a number of times, and the speech recognizer would know it from then on.

Integrating Writing and Speech

In the examples above, the use of pen and voice alternates as you either speak or write to the system. Looking further ahead, more interesting possibilities arise

that rely on *simultaneous* speech and writing, which better mimicks human interactions. For example, while editing on the screen, you might say the following: "Move this sentence [indicating what 'this sentence' refers to by simultaneously circling the sentence] to the beginning of this paragraph [simultaneously circling the paragraph]; then move the whole works [pointing to where the paragraph begins] and change the formula to read as follows [writing out the equation]." To execute such a mixed speech and writing instruction properly requires an intimate integration of spoken-language and written-language technologies.

Imagine someone with poor handwriting and a strong accent trying to communicate to you the spelling of some long foreign city name. The communication would be a lot easier if the person could both say it and write it.

This analogy carries over to computers struggling to understand our writing and speaking without the benefit of sharing our common-sense knowledge about the world and the context. Concurrent writing helps the computer to better transcribe the speech signal, and vice versa. For instance, saying "Move this sentence over here" concurrently with circling a sentence and then pointing elsewhere in the text can

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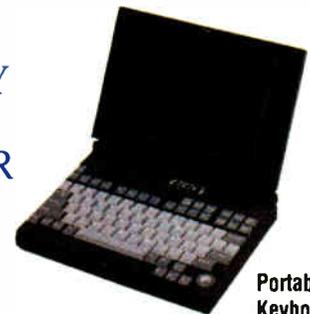
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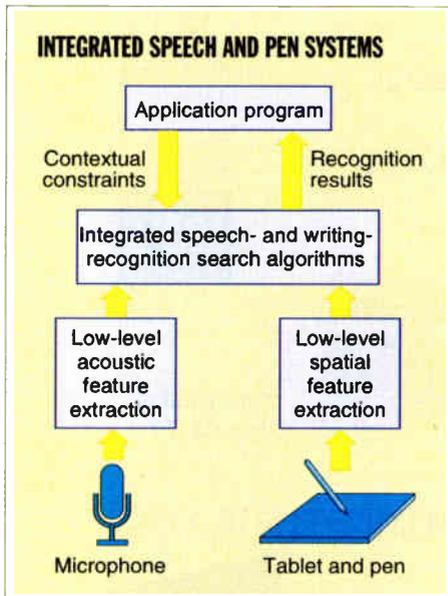
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Circle 173 on Inquiry Card (RESELLERS: 174).

State of the Art Pen and Voice Unite



Speech and writing recognition in computers of the future will be integrated above the low-level feature extraction stage, enabling both input signals to be jointly decoded into a single recognition result that is consistent with the current context set by the application program.

alert the speech recognizer to expect a command that involves a sentence and a point in the text. The actual timing of pointing relative to speaking the words could alert the speech recognizer when you are talking about the sentence and when you are referring to a place in the text. The computer can use the constraints derived from one input signal to help decode the other input, making both inputs more reliable.

A technological challenge occurs in moving from an alternating use of pen and voice inputs to concurrently interpreting both as a single message. No longer can the handwriting recognizer and the speech recognizer operate as independent software processes, each concerned only with its own signal (writing or speech), each examining only its own search space for likely hypotheses, and each outputting the most probable string of characters and words.

To accommodate concurrent multi-modal input in which one modality can affect the recognition of the other, the two recognition technologies will have to be

fused at some yet-to-be-determined underlying linguistic/semantic level. These fused writing/speech-recognition algorithms will need to model and analyze the temporal sequencing and interleaving of writing and speaking events to determine the single message the end user wants to communicate.

Combining pen and voice technologies will enhance the communication between humans and computers by allowing the strengths of one input method to overcome the weaknesses of the other. The results will be obvious in products that are easier, and more natural, to use. ■

Hewitt D. Crane is a senior scientific advisor at SRI's Sensory Science and Technology Center. He is also codeveloper of handwriting-recognition technology at SRI.

Dimitry Ritschev is a computer scientist in SRI's Speech Research and Technology Program. He is currently working on how speech recognition and natural-language technologies can lower linguistic and cultural barriers. You can contact them on BIX c/o "editors" or on the Internet at crane@sri.com and dimitry@speech.sri.com, respectively.

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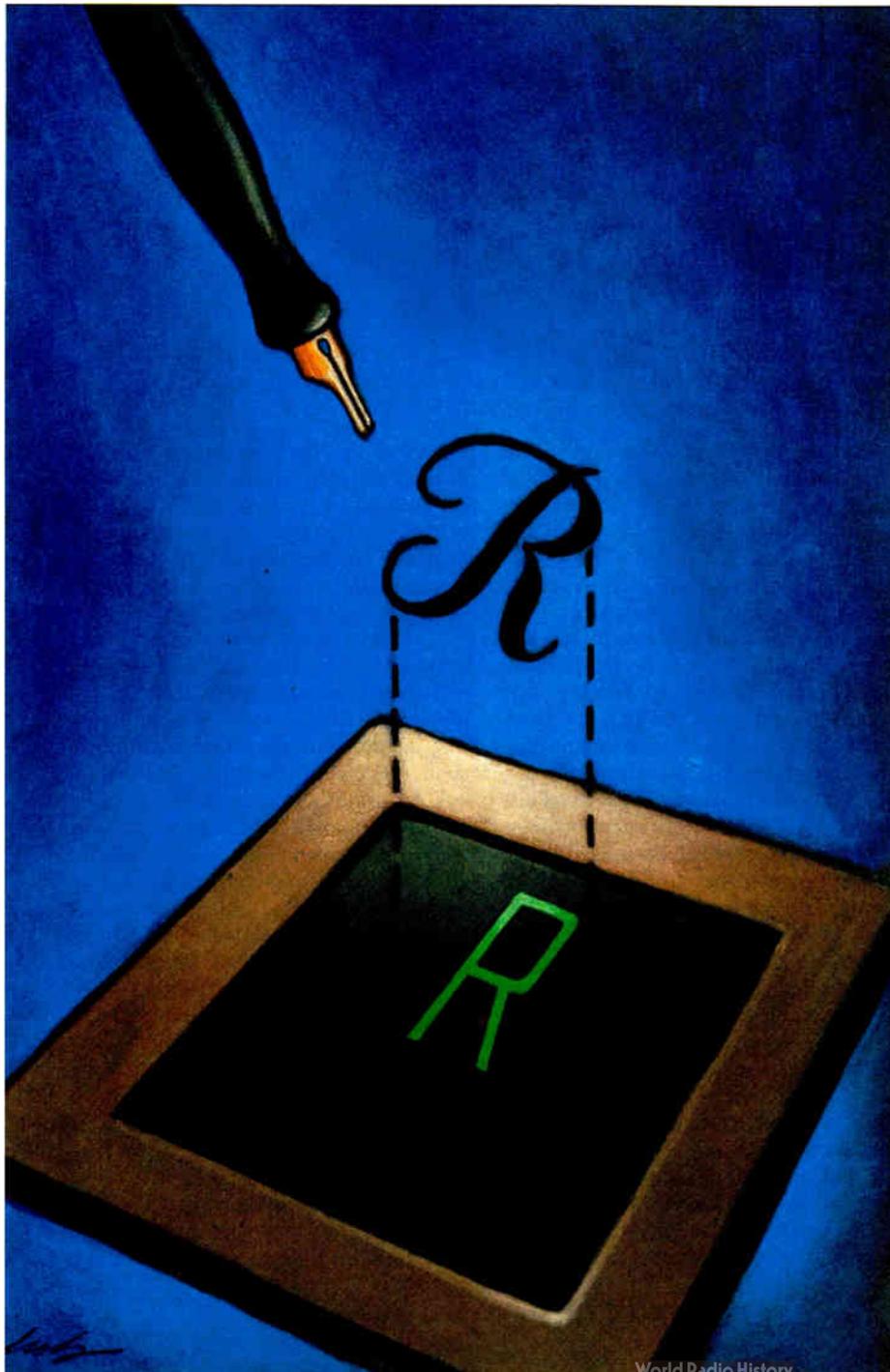
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PEN COMPUTING CATCHES ON

After a slow start, pen computing is establishing itself in a number of businesses. Currently, it is on the verge of entering the mainstream.

DAN MEZICK



Pen computing has experienced a rough childhood. Born to great expectations, the technology sputtered in 1992 as a lack of usable hardware and less-than-acceptable handwriting recognition left many people wondering if pen computing would survive infancy. But new and better pen-based hardware and software are starting to bring pen input into the mainstream.

As little as one year ago, available pen PCs, such as the NCR 3125, were shipping with less-than-acceptable disk storage and poor display quality. This year, choices in pen hardware are plentiful, with over 30 different pen-based PCs available. Active-matrix color displays are now appearing in pen units (e.g., NEC's Versa) and drive capacities are exceeding 200 MB. Other hardware features (e.g., bridge batteries) make it easier to utilize a pen computer in the field by letting you swap a new battery without requiring a reboot.

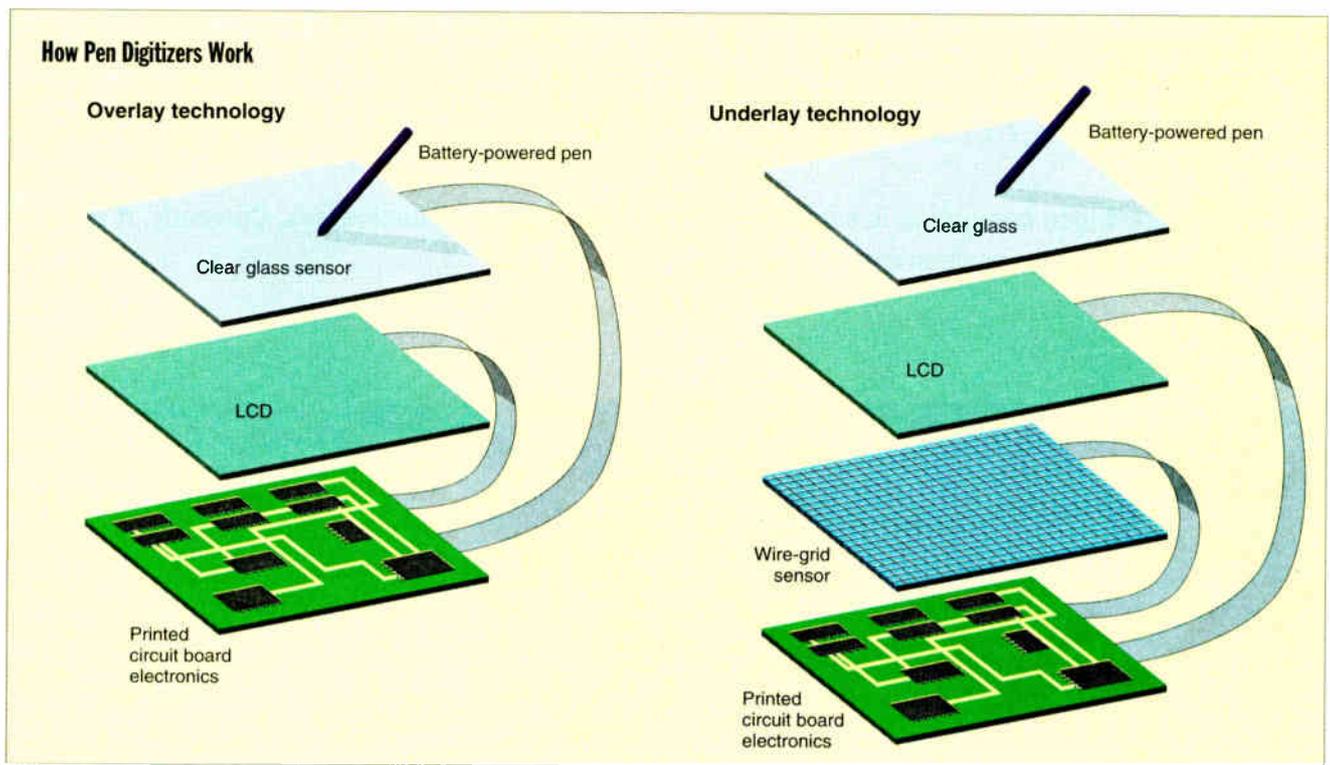
Pens and digitizers are now supported in desktop operating systems (e.g., IBM's OS/2 2.1), laptops (e.g., Apple's PowerBook), and hybrids (e.g., Grid's Convertible). A new class of systems called PDAs (Personal Digital Assistants) (e.g., Apple's Newton series and the Tandy/Casio Zoomer) feature the pen as the sole input method.

The primary advantage of the pen is not the ability to write but the ability to point, to manipulate the user interface without requiring a surface to rest the device. The pen enables mobility, and mobility opens up vast untapped domains for automation by computer. Any worker who collects information while walking or standing is a candidate for pen-driven automation.

For example, data collection during, say, facility or vehicle inspections, requires long battery life and light weight. It is also forms-based, letting you simply check off boxes or enter a few characters. And pen-based sales automation software allows

GARRY NICHOLS © 1993

State of the Art Pen Computing Catches On



Both overlay and underlay digitizers work similarly. First, the pen interrupts a sensor field, sending an analog signal of the x, y coordinates to the system. The system translates the signal from analog to digital and lights the appropriate pixel.

for data entry and note-taking that is less intrusive than typing on a keyboard.

Pen technology is beginning to creep into mainstream applications. Bill Lempe, publisher of the newsletter *PenVision News* (Pleasanton, CA), predicts that "pen, mouse, keyboard, and voice will coexist on the desktop of the future. No one input option will dominate. You'll select your input device based on applications and personal preferences."

Hardware Makes It Happen

Digitizer technology makes pen computing happen. A digitizer is a planar grid, capable of generating x, y coordinates when the pen is placed on or near it. A pen is said to be *in proximity* when you hold it close enough for the digitizer to detect it.

At interrupt time, digital ink may or may not appear. If you touch the pen in a region in which an application accepts writing, such as a data field, video display drivers handle the magic of making digital ink appear on the screen. If the pen touches a control such as a button, which does not expect writing or gestural commands, inking does not take place. In this case, the application recognizes the pen as a pointing device only.

Digitizer technology is varied. One type

of technology uses direct-contact resistance (overlay) digitizers, which are mounted above a unit's display; physical contact from the pen generates the interrupt. In this technology, the pen is connected via an electrical cable to the unit itself. A second type of technology uses transparent-resistive (underlay) digitizers, which generate interrupts when the pen tip temporarily forces the two conductive layers together; Apple's Newton uses this technology. A third type uses electromagnetic digitizers, which are mounted beneath the unit's display; the pen in proximity of the tablet display generates a hardware interrupt.

Pen computers are characterized by the type of digitizer they use. For example, Grid's GridPad uses a tethered pen because of its overlay technology. On the other hand, the Newton's pen isn't tethered to a unit, and it contains no electronics since it only momentarily connects two conductive layers. Units such as the Grid 2260 use electromagnetic digitizers, which require a specialized pen containing batteries, resistors, or capacitors to interact with a unit's digitizer.

Digitizers have resolution granularity, like video displays, and the two (more often than not) don't map precisely to the same x, y location. For this reason, pen-

input data that the digitizer reports must be calibrated to approximate the location of the video pixels that you view. This calibration often makes correct recognition more difficult than it would be if the digitizer and the video display coordinates were precisely the same.

How the pen "handles" also influences recognition rates: Recently, some pen systems have been equipped with etched display glass, which provides more paper-like drag on the pen. Users are more comfortable writing on glass, and characters are formed more precisely as a result.

Beyond the special hardware support for pen input, pen systems are nearly indistinguishable from conventional laptop computers. Hardware options—including PCMCIA slots, processors, rotating disks and CPUs—are virtually the same as those available in current laptop devices. While hard drives with capacities under 80 MB are common, many new pen models contain 200-MB or larger hard drives, making it possible to use one pen computer for all computing tasks, both desktop or nomadic.

User Interfaces

Pen computing is influencing the current state of the art in computer user-interface design. Norm Francis, president of pen

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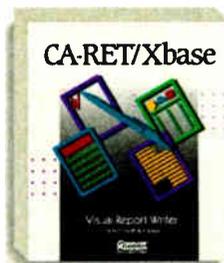
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World Radio History

State of the Art Pen Computing Catches On

software vendor PenMagic Software (Vancouver, British Columbia, Canada), credits Go Corp.'s PenPoint paper metaphor with furthering the evolution of user interfaces. Unlike the desktop, he says, "this new metaphor is more intuitive and simple: the document."

Novice computer users might not understand buttons, menus, and modal dialog boxes, but they do understand paper, forms, and notebooks. Microsoft's intention to implement a document model in future versions of Windows, says Francis, acknowledges that this metaphor eases the learning curve.

One largely undefined issue in pen applications design is the navigation from window to window. Microsoft's design guide included with its SDK (Software Development Kit) has little to say about navigation; Go's design guide is much the same. The reality is that developers are on their own until a market force or large vendor identifies acceptable alternatives to standard menu-command and command-button navigation.

For example, the Microsoft design guide doesn't discuss the use of a check box for navigating to a dialog box or other window: Menu commands or buttons are preferred for navigation. However, many pen applications automate paper forms. But often, forms have check boxes indicating that you must enter further information. On their way to standardizing pen applications, vendors must address problems such as this type of ambiguity.

Several interface issues are common to all pen applications. First, because forms on standard 8½- by 11-inch paper don't map directly to the smaller video displays, pen systems designers must segment the form into hidden and visible portions, with hidden windows accessible via a button or (perhaps) a check box. How to navigate gracefully from window to window and which windows to hide become issues for the pen user-interface designer.

Readability is another important component of navigation. The text and graphics must be easy to follow and view on the relatively low-contrast LCDs and where poor lighting conditions exist. Readability becomes even more important in face-to-face interaction with other people, when you must deftly navigate

a pen device while maintaining eye contact with another person. Good user-interface design for pen applications mandates enlarged controls; bold and oversized fonts; and consistent use of navigation controls.

Digital Ink, Gestures, and Jot Pen input can include handwriting and gestures. *Digital ink* is written user input, which is saved in a data structure. *Gestures* are handwritten symbols that function as application commands. For example, writing and circling the letter *H* tells your application to hide the window on which it is drawn.

Gestures embody both the command (e.g., Hide) and the parameters (e.g., "Hide this form"). Where a gesture is written is important because command parameters are derived from the precise location of the gesture. For example, the circled *H* may be ignored if written in your application's data field but recog-

BASIC GESTURES

Pen input lets you perform tasks with simple gestures. Below is a sampling of gestures available with Go Corp.'s PenPoint operating system.

 Caret opens a writing pad in text or creates a document.

 Check displays options for whatever you draw it on.

 Circle opens an edit pad.

 Insert space adds a blank space in text or boxed pads.

 Cross out deletes whatever is beneath it.

nized if written elsewhere within a window.

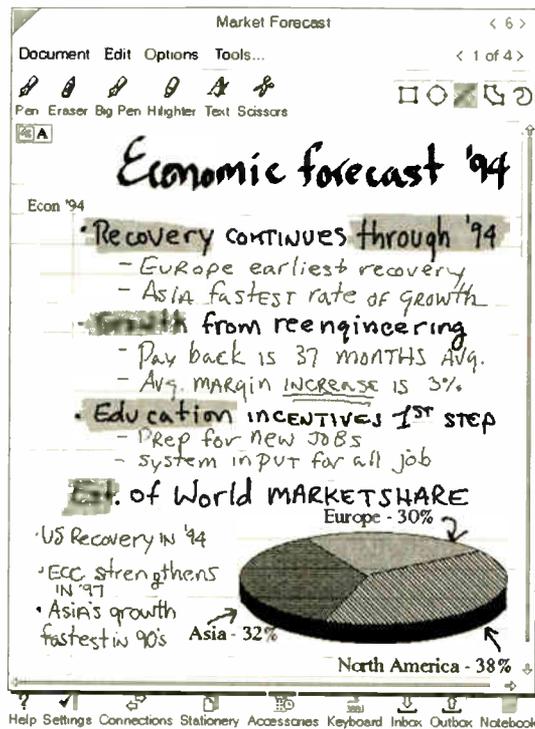
Gesturing capability provides you with a concise command interface. On the other hand, handwriting is typically used to enter characters in the absence of a keyboard. In this context, handwriting is immediately translated or saved in a digital-ink data structure for later recognition.

Support for digital ink requires a data structure to store the handwriting and an API for manipulating it. Digital ink is much more than a mere bit map. Stroke order and a time stamp, for example, are part of the data structure. In addition, optional information—if supported by hardware—includes tip pressure, tip angle, the state of buttons

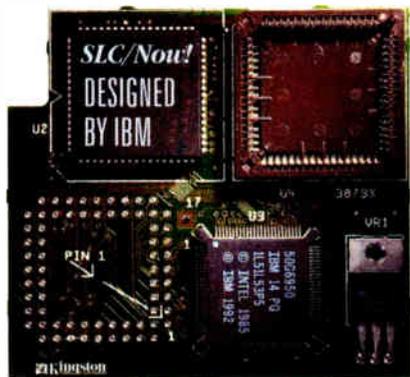
on the pen, and more. Recognizing the need for a standard data type for ink, industry leaders have partnered to create Jot. This standard will accelerate support for ink, even on platforms that don't currently support pen input (see the text box "Jot Defines Electronic Ink" on page 110).

The difficulty of implementing accurate handwriting recognition has caused vendors to promote digitized ink as a replacement for recognition. Project leader Ken Notestine co-developed the first pen application, which automates loss-control representatives in the field, for insurer ITT Hartford Insurance Group (Hartford, CT). Field personnel collect risk data for analysis by property-casualty underwriters. "Our intention was to minimize the use of digitized ink," says Notestine. "It became, however, the only practical way to capture the required information. Support for digital ink ultimately became a subsystem within our application."

However, digitized ink has its own set of problems. Compared to ASCII text, digitized ink is bulky to store, and until Jot is widely implemented, digital ink doesn't port well across platforms. For example, attempting to render ink captured from a Windows application in the IBM 3090 mainframe environment will be an



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Recount:	3:34 Min.	:29 Sec.	:38 Sec.	
Retail Price:		\$425	\$3,280	
486/Now!	PS/2 Model 70-25MHz	With 486/Now! SX 25	PS/2 Model 90-0H9	486/Now!
Landmark Speed 2.0:	39 MHz	84 MHz	84 MHz	IBM PS/2 Models 70 and 80, Compaq Deskpro Models 386/16, 386/23, 386/20c, 386/25, 386/25c, 386/33
Recount:	:55 Sec.	:39 Sec.	:38 Sec.	
Retail Price:		\$495	\$3,280	
MCMaster	PS/2 Model 55SX	With MCMaster SX 25	PS/2 Model 90-0H9	MCMaster
Landmark Speed 2.0:	16 MHz	84 MHz	84 MHz	IBM PS/2 Models 55, 56, 57, 65, 70, 80 and 90
Recount:	2:47 Min.	:36 Sec.	:38 Sec.	
Retail Price:		\$795	\$3,280	

All systems tested with 16MB installed except MCMaster tested with 38MB on-board and 8MB on mother board. All system prices are MSRP at standard configuration as of 1/91. Processor upgrade prices are MSRP as of 4/91. Re-counts conducted on IBM Excel for Windows spreadsheet generated by Kingston Technology.



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Circle 108 on Inquiry Card (RESELLERS: 109).

World Radio History

Jot Defines Electronic Ink

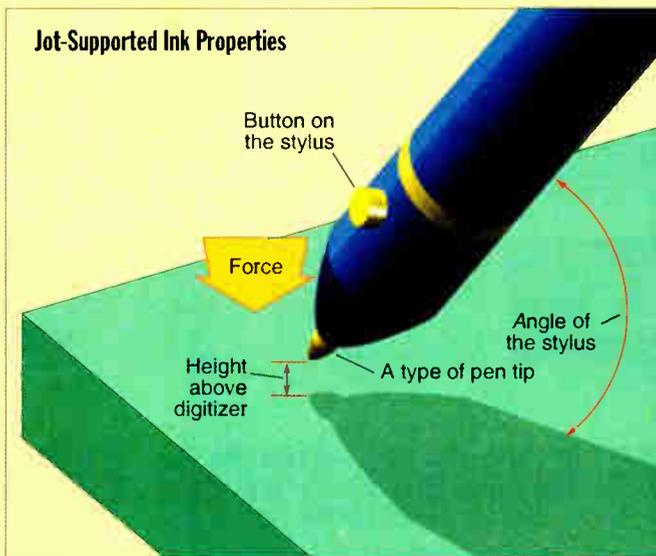
DAN BRICKLIN

Jot is a data-interchange standard with a difference: The data it defines is ink. Ink is not a traditional system data type, but it is an increasingly important one. Ink is the information your pen computer captures when you "write" on it.

Electronic ink is information you create when you use a stylus to draw strokes on the screen of a pen computer. The built-in digitizer captures the strokes and renders them to the screen, thus imitating how a pencil leaves marks on paper. The writing—whether it's words or shapes—may be kept as ink forever or later translated to ASCII text or graphics objects. Some obvious examples of ink are notes, signatures, sketches, and annotations on other documents. The ink data type lets you capture personal, unstructured data that your computer can store, manage, and communicate.

An important point is that ink is not just bit-map data. Although ink is represented as a bit map when it is rendered to the screen, the ink data type itself retains much more information than the *x, y* coordinates of "on" pixels. Ink stores how the information was created, as well as how it appears on the screen. Thus, ink data can include such components as the individual pen strokes, the timing of the strokes, the pressure used to create each stroke, the color of each stroke, and the relative scale and position of a stroke. Ink stores the direction and movements of the pen. In this regard, ink has much in common with MIDI data, which communicates information about what note to play and the pressure and duration used to play it as opposed to a straightforward

Jot-Supported Ink Properties



Jot captures a surprising number of ink properties, in addition to the coordinates of the path the pen takes, and stores them in an application-specific record. Besides the properties shown in the figure, Jot supports multiple strokes of ink combined into single objects, bounds, scale, offset, numbered groupings of strokes, color and opacity, and timing information.

ward recording of the sounds produced.

The Jot ink standard is a joint effort of Slate, Microsoft, Go Corp., Apple, Lotus, and General Magic. It is a platform- and applications-independent format. It can be implemented on any platform whether or not the platform supports a pen device; thus, it solves the problem of sharing ink throughout an organization. Ink stored in the Jot format can be retrieved by any application that needs to display the ink, print it, translate it to ASCII text or some other format, or even to perform special functions such as signature verification.

The Jot standard is designed to meet the following goals:

Keep it simple. Jot makes it easy to handle the most common ink operations (e.g., reading stroke coordinates). You can ignore complex information if your application doesn't require it.

Compact. If optional information such as color specifications are absent, the data definition does not devote any storage space to it.

Storage saving. The standard sup-

ports optional compression for stroke data.

Inclusive. Jot supports every current property of ink.

Expandable and compatible. You can add new properties to the standard without affecting the operation of current applications.

Putting Ink to Work

Jot has many uses. For example, Jot lets you store and transmit signatures electronically. Many companies want to preserve a person's signature (e.g., a doctor's) by using the pen at the time of a transaction. This signature may be written on a tablet-style system but need to be sent back into a corporate database for storing,

analyzing, or reporting. Jot makes it possible to gather the signature on one system and move it to another without any loss of data, all in a standard format.

Jot also plays a key role in letting people scrawl a handwritten E-mail message on their PDA (Personal Digital Assistant) device, send it to a colleague, and have it displayed on a desktop system that doesn't have a pen interface. It also lets you receive an E-mail message, mark it up with your handwritten response, and send it off again.

Jot is a rare example in the personal computer industry of companies establishing a standard in anticipation of customers' needs. The Jot specification is available to anyone, and any developer can incorporate and use the specification in its products. Developers can obtain a free copy of the specification from the Software Publisher's Association Mobile and Pen special-interest group by calling (202) 452-1600 ext. 336.

Dan Bricklin is vice president of new technology at Slate (Scottsdale, AZ). You can reach him on BIX c/o "editors."

State of the Art Pen Computing Catches On

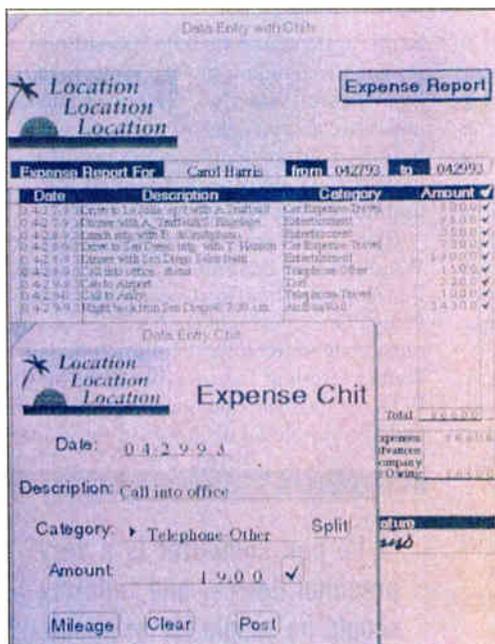
effort, because functions equivalent to Microsoft's Windows for Pen Computing API functions must be created to manipulate the Windows data structure in the host environment.

Nevertheless, entire applications are built on the notion that digital ink is adequate for data capture, storage, and retrieval. NoteTaker from Ink Development (San Mateo, CA), for example, is best described as a digital ink manager: The application captures, indexes, and manipulates digital ink on your behalf. NoteTaker recognizes text only when necessary to index digital ink for storage or when you indicate recognition is desired.

All pen operating systems support digitized ink and gestural command recognition. They handle hardware interrupts by passing *x, y* axes data to video device drivers capable of rendering digital ink. In addition to ink, video drivers must support reorientable displays (i.e., portrait or landscape orientation based on the application). Systems like PenPoint support dynamic reorientation of the screen, while systems with historical ties to the desktop (like Windows) require a reboot to affect the reorientation.

As hardware evolves to support pen input, vendors are positioning operating system offerings. Several choices are available: GEOS from GeoWorks (Berkeley, CA), OS/2 from IBM (Armonk, NY), PenDOS from Communication Intelligence Corp. (CIC) (Redwood Shores, CA), PenPoint from Go (Foster City, CA), PenRight from PenRight (Westlake, TX), and Windows for Pen Computing from Microsoft (Redmond, WA).

Technology planners must consider a range of issues including effective battery life and the relative sophistication of users when selecting an operating environment to utilize. GEOS, PenDOS, and PenRight bring pen input to lower-powered 808x devices; this is a plus for applications that require long battery life. PenPoint is one of the easiest systems to adopt, with its intuitive easy-to-learn user-interface "notebook" metaphor. It is best for new users and new applications. Microsoft's Windows for Pens is most attractive to corporate technical planners considering pen input for selected applications. Developers working with familiar Windows tools can slip-



PenMagic's Numero for PenPoint might be called a "financial processor." Perhaps its most interesting feature, however, is its MagicScript visual scripting facility, which can automate both Numero documents and PenPoint tasks.

stream pen input into current applications with a minimum of effort.

Handwriting-Recognition Technology

The translation of ink to text has been a problem for the pen industry. Overhyped as almost magical, the current handwriting translation engines have left several people wondering if they will ever work. Users are demanding high recognition rates of both cursive and printed characters. Handwriting recognition is difficult to implement, and researchers and companies employ various strategies to effect recognition.

Generally speaking, handwriting technology uses one of several approaches—neural networks, HMM (Hidden Markov Modeling) (see "Talk to Your Computer"

on page 113), or basic template-matching paradigms. Products available include Longhand from Lexicus (Palo Alto, CA), Handwriter from CIC, NestorWriter from Nestor (Providence, RI), and Calligrapher from Paragraph (Boulder, CO), which is licensed for use in Apple's Newton.

Handwriting is either *unconstrained*—meaning that you use a mixture of cursive and printed letters—or *discrete*—meaning that you neatly print a letter and then lift the pen before forming subsequent letters. Each type of writing mandates a different approach.

Lexus refuses to discuss its recognition engine, but according to someone who has studied the product, it uses the Horabach mathematical model to recognize cursive unconstrained writing. The

Horabach model defines a set of simulated hand motions based on circular movements. This approach is especially good at recognizing cursive text, but it isn't optimal when recognizing neatly printed uppercase characters, because this type of writing is not based on cyclic pen movements.

Paragraph, too, is playing its recognizer cards close to the chest. Its product reportedly uses a more intuitive approach involving templates of patterns. In this method, the recognizer tries to match one of eight basic patterns against the strokes to be recognized. These in turn are subdivided into 20 or 30 subalphabets, which are used to map the input to language-specific alphabets during the recognition process.

Regardless of the approach used, handwriting recognizers come in two forms: trainable and untrainable. A trainable recognizer is one that can be taught the nuances of a specific user's handwriting style. The algorithmic approach used in a recognizer is a factor in the recognizer's ability to be trained.

IBM is developing recognizers for unconstrained and discrete handwriting, as well as for signature verification. "IBM's solution to the handwriting recognition problem is optimized for training," says Tetsu Fujisaki, IBM's manager of handwriting systems. IBM's approach recognizes discrete handwritten input by a combination of elastic matching

CHOOSING THE APPROPRIATE PEN ENVIRONMENT

Needs of Application

Battery life
Preemptive multitasking
Nonpreemptive multitasking
Compatibility with DOS
Compatibility with Win3.1
Virtual memory
GUI: existing users
GUI: new users

Operating Environment

GEOS, PenDOS, PenRight (808x)
PenPoint
Windows
PenDOS, PenRight
Windows for Pen Computing
PenPoint, Windows
Windows
GEOS, PenPoint

State of the Art Pen Computing Catches On

and neural networks.

During recognition, elastic matching and neural networks work in parallel to obtain an output decision represented as a voting result. Because the technologies are complementary, the accuracy prior to training is substantially better than any known single-technology approach. User training further improves accuracy and can also reduce the number of computations necessary during the recognition process.

This hybrid approach allows user training to have a great impact on the recognition process. "Users want immediate increases in recognition rates after a short training session—no more than 15 minutes," says Fujisaki. A flexible, probabilistic algorithmic approach allows immediate responsiveness to a user's brief training session, he adds. But there is a price to pay: Robust support for training requires more computational power.

Pen systems designers recently discovered that electrical interference from the digitizer itself interfered with the "raw material" going to the recognizer. The latest systems compensate for this. This compensation combined with the use of etched-glass displays, which help you write more precise characters, is boosting overall recognition rates.

Tools

Selecting development tools is critical to successful pen applications. Like operating systems, development tool selection is highly dependent on the problem and on the issues of performance and maintainability. Not all tools run on all operating systems, making tool selection dependent on the operating-system platform.

You can program 808x devices with PenPal from PenPal Associates (Los Altos, CA) or with PenRight. PenPal supports a high-level language popular with non-technical users. PenRight includes a DOS run-time module and an SDK for C; the tool is popular with vertical developers. For applications designed for existing users, database applications, or applications developed to corporate specifications, Windows for Pens is an option. Tools under Windows include its SDK, as well as C language, PenApps for Windows, and Microsoft Visual Basic.

Databases must support digitized ink storage and seamless data exchange with existing systems. This means support for the binary large object and robust import/export facilities. Mobile databases must recover gracefully from sudden pow-

er disruptions and operate robustly on a resource-lean mobile device. Watcom SQL by Watcom (Waterloo, Ontario, Canada) and the relational database manager Quadbase-SQL from Quadbase Systems (Sunnyvale, CA) are especially suited for the mobile pen environment.

Slate's PenApps is the first to bridge Windows and PenPoint. Properly coded, PenApps applications port across platforms. One disadvantage here is that you must code to the lowest common denominator, forgoing features like PenPoint's EDA (Embedded Document Architecture) and Window's DDE, because these fea-

The pen computer is a very personal device, and tailoring should be simple for everyone, not just programmers.

— Norm Francis, president,
PenMagic Software

tures aren't common to both platforms. PenApps generates applications rich in pen capabilities. Gesture support is fully integrated into the tool's design, along with many other innovative features.

For example, Input targeting is a feature that recognizes where you intended to write, even if the input extends beyond the boundary of an input region. Markup mode is a feature that provides the ability to capture and store user annotations written on your application's windows.

Despite PenApp's pen-oriented features, corporate developers are gravitating toward Visual Basic. ITT Hartford's Notestine says, "Visual Basic's attractiveness is that it is extendable, and not just through custom controls. The availability of the Windows for Pens API functions gives the developer a great deal of flexibility."

Visual Basic 3.0, released earlier this year, is gaining momentum. Its new features are of interest to pen developers. Microsoft's Access 1.1 database engine, included with Visual Basic 3.0, supports digital-ink storage via the binary data type. Visual Basic's enhanced support for OLE 2.0 provides the ability to create applications with embedded instances of other executable files, such as spreadsheets and graphics applications. These new features, paired with Visual Basic's adequate support for pen input, are attractive to devel-

opers considering a Windows for Pens application.

Visual Basic supports pen computing primarily through two controls: the handwriting edit (Hedit) and the boxed edit (Bedit), included in its Professional Toolkit. Using Visual Basic for pen input, however, poses challenges. Programming gestural commands requires knowledge of the Windows API, Windows for Pens API, and the RCRESULT event unique to Hedit and Bedit. The RCRESULT event, specific to pen control, provides an opportunity to examine (and possibly alter) recognition results just before the application gains access to them.

In contrast, PenApps offers pen-centric and cross-platform capabilities, but it is relatively immature (in release 1.0), doesn't support custom controls, and takes longer to master. Both tools use BASIC and support external function calls via DLLs.

Who's Buying What?

According to *PenVision News*' Lempesis, pen-based products are segmenting into four domains: deskbound devices, pen-only tablet machines, convertible (i.e., pen and keyboard) systems, and PDAs. Lempesis projects sales of all devices with pen input to hit \$740 million this year and \$8.7 billion in 1996. Lempesis expects that all laptops will support pens within four years.

Recently, the notion of "diagonal" applications has taken root. Diagonal applications are horizontal products that allow you to easily configure them to your specific needs. For example, PenMagic's Numero, a highly intelligent financial application, combines a rich features set with a visual scripting facility called MagicScript.

PenMagic's Francis notes that "the pen computer is a very personal device, and tailoring should be simple for everyone, not just programmers." MagicScript is not limited to automating Numero documents; it automates any routine task, providing a batch facility for PenPoint users.

Pen computing has finally left infancy behind. Hardware and software improvements have freed users and technical planners to make real the promise of pen technology. For mobile workers, pen-enabled computing has indeed arrived. ■

Dan Mezick is the president of New Technology Solutions (North Haven, CT). He has provided developer training and pen systems engineering to corporate clients since 1991. You can reach him on BIX c/o "editors," on the Internet at dmezick@world.std.com, or on CompuServe at 71773,3612.



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No Longer
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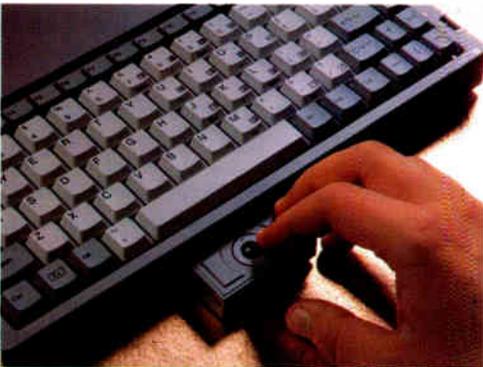
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- 2 PCMCIA Type II Slots
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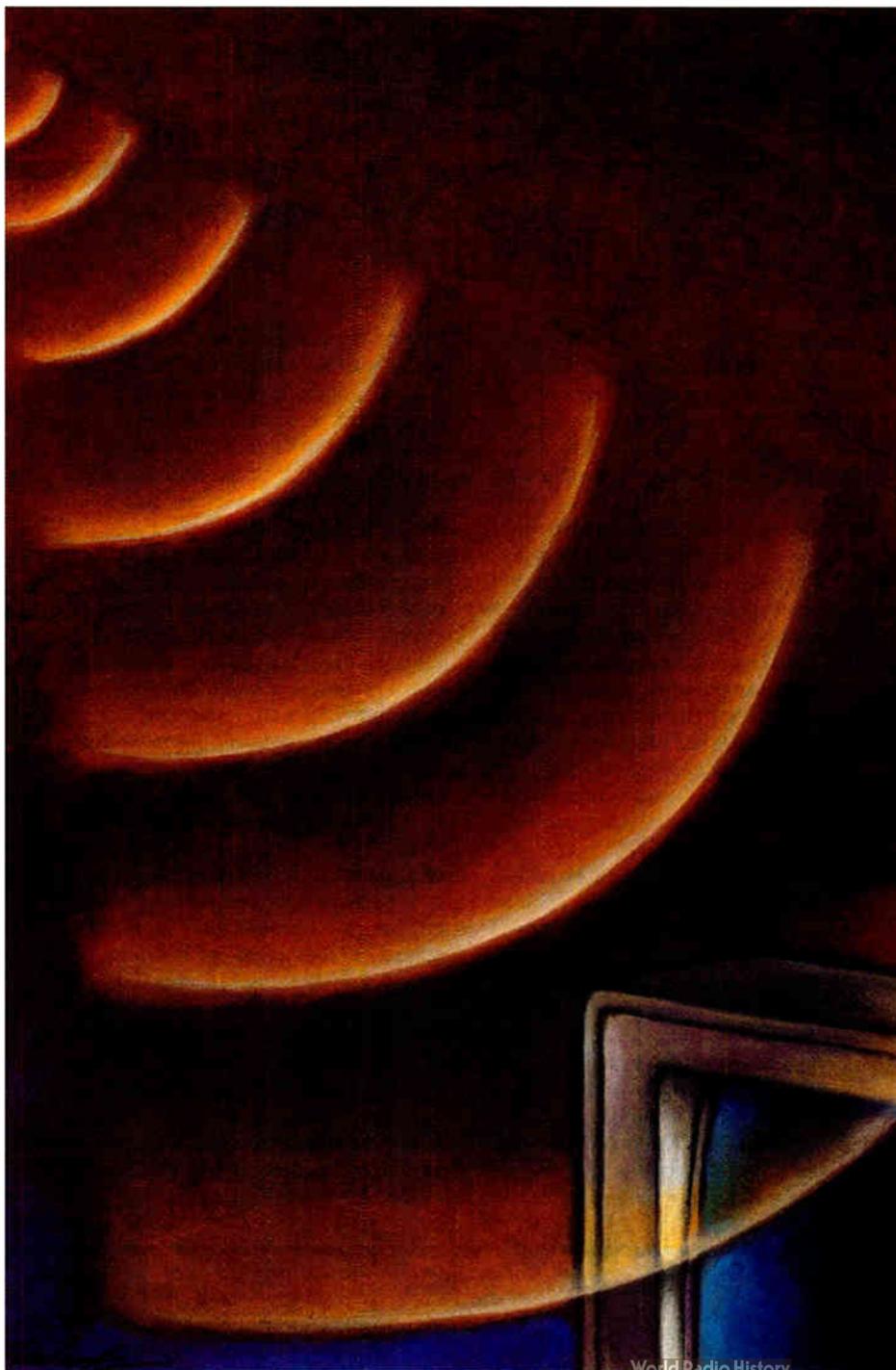
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TALK TO YOUR COMPUTER

Voice technology lets you verbally command your computer or convert speech to text

WILLIAM S. MEISEL



Attach a microphone to a personal computer, and it has a whole new set of capabilities. It can store voice notes or act as a telephone. It can use the content of the speech to verify the speaker's identity for security purposes or to recognize the words in the speech. Of these functions, speech recognition has the greatest potential for fundamentally changing the way you interact with your computer. The technology is producing a new human-computer interface.

"Speech recognition is one of the business consumer's hot buttons," says Bob McBreen, product manager for Microsoft's Windows Sound System. He believes that speech recognition will be "an integral part of computing in the future."

To date, speech recognition has been largely confined to niche applications. But a new generation of powerful speech-recognition technology is becoming commercially available in software that's low cost and that runs on standard PC hardware. The focus now for developers is to move from basic technology to the development of good applications software.

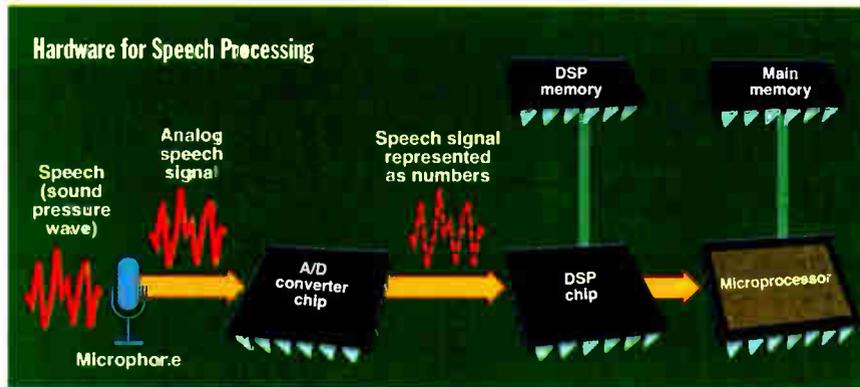
Hardware and Software

The minimal hardware required to support speech is a microphone and an ADC (A/D converter) chip. A DSP (digital signal processor) is not strictly required, but if used, it at least doubles the processing power for speech recognition. Gene Frantz, applications manager for DSP at Texas Instruments (Houston, TX), points out that DSPs are better than general-purpose microprocessors for real-time signal processing.

Developers creating voice systems choose different types of DSPs depending on their specific needs. Some DSPs serve a number of purposes, acting as a fax or a modem, performing video data compression, or processing speech, while the CPU is free to do what it does best (see "Inside

GARRY NICHOLS © 1993

State of the Art Talk to Your Computer



The speech-recognition hardware must convert the analog speech into digital form. Once in digital form, the speech is data that a DSP, a microprocessor, or both can process.

Signal Computing." November 1992 BYTE). Apple chose AT&T's DSP for its new Macintosh AV series in part because

it serves multiple purposes, according to Chester Anderson, technical marketing director for AT&T's Center of Excellence

for Voice Processing (Middletown, NJ).

DSP manufacturer Analog Devices (Norwood, MA) has created a Personal Sound Architecture. Many firms such as Borland International, Lotus Development, and Microsoft have announced support for it. Analog Devices is trying to make it easy for systems developers to assemble a system by choosing modular hardware and software. Lernout & Hauspie Speech Products (Woburn, MA) and Dragon Systems supply speech-recognition software for the Personal Sound Architecture. AT&T is similarly using speech algorithms developed at Bell Labs to motivate use of its chips. IBM and Texas Instruments have teamed to create the MWave architecture with similar goals.

In any case, the minimal hardware for

Voice Recognition over the Telephone

DAVID B. ROE

Voice interactions with computers are often more practical than data connections, because there might be no visual display or keyboard available. Voice telecommunication is universally accessible to anyone, from anywhere, at any time. Speech-recognition technology offers a way to go beyond existing voice messaging and voice response services, to the concept of "voice information."

For example, if you were lost on the highway, you could telephone a "Directions Hot Line" and ask the computer questions about the simplest route. Or to keep track of that hot stock you are watching, you could call an up-to-the-minute stock price system and get a quote just by speaking the name of the stock. Not only will you be able to control your system by voice commands when you are physically present, but ultimately, you will be able to call and command your computer over the telephone.

Speech recognition is still an imperfect technology, and the errors that speech recognizers inevitably make are magnified over the telephone network.

Line quality varies considerably, especially in cellular or cordless telephones and with speakerphones. Telephone calls are often made from noisy places, and the background noise of other people talking can confuse a speech recognizer.

Most over-the-telephone applications must be speaker-independent, and recognizers must cope with a wide variety of voice types (e.g., male, female, or child), as well as regional dialects and foreign accents. These applications must also face practical difficulties of understanding speech. For instance, a voice-dialogue system has to recognize when people become confused and don't say the "right" thing, and a recognizer should start listening when people try to interrupt the machine.

Hidden Markov Modeling, or HMM, has been the most successful technique for speech recognition on the telephone because it is able to model a number of types of speech variability that are encountered. Starting with speech recorded from a wide variety of speakers and a number of types of telephone conditions, the HMM technique builds a statistical model of the speech sounds (or phonemes) and the expected variations of those sounds. Techniques like *word spotting* allow the recognizer to

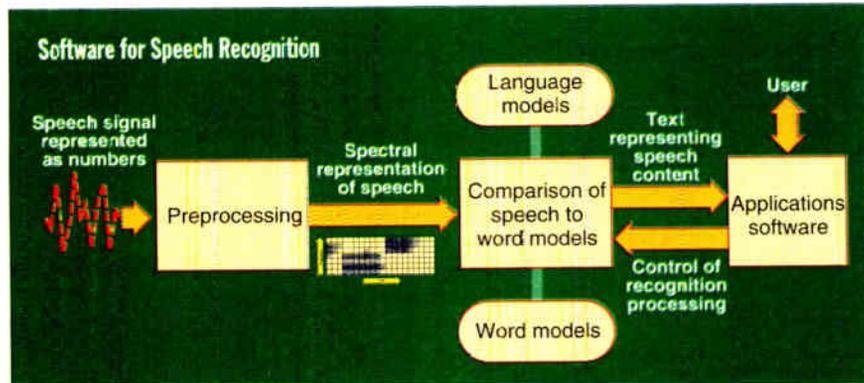
lock in on the keyword in a phrase, which can help deal with "ums" and "ahs." Another technique called *barge-in* uses echo cancellation, which removes spurious signal reflections over the telephone line, to eliminate the speech prompt from the machine when the caller interrupts.

Some systems already use speech recognition successfully. AT&T has deployed voice-recognition call-processing systems throughout much of the U.S. These systems recognize a vocabulary of seven phrases, including "collect," "operator," "person-to-person," "yes," and "no." Collect calls can now be fully automated, and the operator is involved only if the caller says "operator" or if the caller fails to speak one of the keywords. Word spotting and barge-in are important technologies in this application because a high percentage of the callers say phrases like "operator, please," or they speak before the end of the prompt. These systems have already handled over 1 billion long-distance calls.

A newer system is a stock-quotation prototype called StockTalk that Bell Northern Research built in conjunction with Northern Telecom. StockTalk provides current quotes on any stock traded on the New York, Toronto, or NASDAQ

State of the Art Talk to Your Computer

speech input is becoming ubiquitous on desktop computers. Sun Microsystems' workstations come with a microphone port and A/D conversion. Silicon Graphics also has a DSP in its workstations; in fact, its new Indy system comes standard with voice-recognition capability. The latest Macintoshes, the Centris 640AV and Quadra 840AV, also recognize speech out of the box (see "Apple, SGI Blaze Video Trail," September BYTE). Some Compaq PCs come with built-in speech hardware support and include Microsoft's Voice Pilot speech-recognition software as part of the Windows Sound System. For PCs without built-in speech input, audio boards are available for a few hundred dollars. Sierra Semiconductor, which supplies sound chips, estimates that 3 million sound



Speech-recognition software first converts the speech into its frequency components. It then uses stored models of expected word order to make a good guess as to what was said. The applications software can then display the text or take an action consistent with what was said.

boards will be sold this year. Several of these boards now ship with limited speech-recognition software.

Speech-Recognition Software

Speech-recognition software operates on a digitized speech signal to perform one of two tasks: convert spoken words to text or perform a spoken command. First, a preprocessing step converts the speech signal into a form that exposes its spectral content. The spectral representation of each basic speech sound—each phoneme—has a characteristic form that shows up in the spectrum. Then, the spectrum of the incoming speech is compared to a library of word models—acoustic models of how the word sounds—to see which it matches best.

Acoustic models usually show how the spectrum of the speech varies over the duration of the word. The simplest acoustic model describes a single typical way in which a word is pronounced. This *template* represents a frequency time picture of the word. An unknown spoken word can then be identified by comparing it to templates of all the words in the vocabulary and finding the best match.

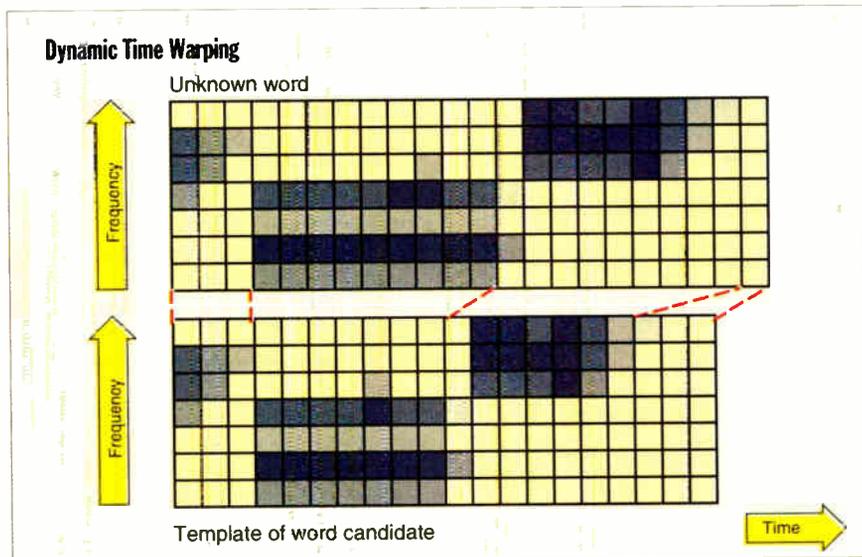
But a word varies slightly each time you pronounce it (e.g., you can say it quickly or slowly). In an attempt to handle this variation, the first generation of speech-recognition software mathematically distorted the time axis of each template until it best fit the unknown speech, a technique called Dynamic Time Warping, or DTW.

DTW proved too limited an approach

markets. You simply speak the name of the company, say "General Motors." This speaker-independent recognizer uses phoneme HMMs to build up the pronunciation models for over 5000 stock names. Because this system gives a response quickly, you can easily correct the occasional confusion between similar-sounding company names by repeating the name of the stock or saying "wrong stock" and hearing a list of alternatives.

As speech-understanding accuracy continues to improve, more sophisticated telephone applications will be deployed. Voice access to "yellow pages" information and voice directory assistance will only be the first steps. Ultimately, the challenges that face speech recognition over the telephone will be overcome, and people will converse with machines on the telephone just as fluently and easily as they talk with people.

David B. Roe is a supervisor in the speech-research department of AT&T Bell Laboratories (Murray Hill, NJ). His work includes the development of single-chip speech-recognition algorithms for cellular telephone and of speech recognition on massively parallel systems. You can reach him on BIX c/o "editors" or on the Internet at roe@hogpb.att.com.



When an unknown word is spoken, it is compared to stored templates (i.e., frequency time pictures) of each word to get the best match. Dynamic time warping allows a match to be made so that the best-matching parts of each word align, making the match less sensitive to the speed of speaking.

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State of the Art Talk to Your Computer

for larger vocabularies, continuous speech, and speaker independence—a single template could not describe the full variability of pronunciations. A second generation of technology put the variability in the model instead of in the matching process, using a technique called Hidden Markov Modeling, or HMM.

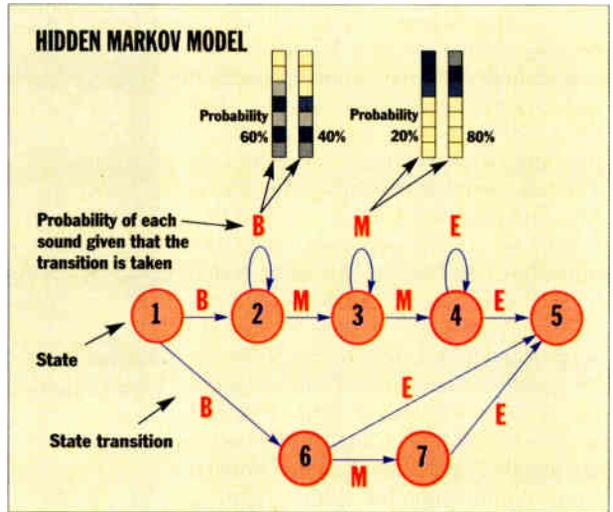
An HMM is created from as much speech data as possible, statistically modeling the variation seen in that data. HMM methods have led to steady accuracy improvements, as measured in yearly workshops of the Speech and Spoken Language program of the U.S. Department of Defense's ARPA.

An HMM can create word models from examples of full words, or it can create them by putting together models of the phonemes composing the word. In the latter case, to add new words without spoken examples, you enter a phonetic spelling. To complicate the matter, the "a" sound in *bake* looks quite different acoustically than the "a" sound in *rain*. Researchers who use phonetic models have found they can further improve performance by modeling such variation.

If the speech from which the word models were created comes from many speakers, the system will be speaker-independent—you can walk up to the system and use it immediately. A speaker-dependent system requires that you give examples of your speech before using the system. Some systems start out with a speaker-independent model and adapt to an individual's idiosyncrasies.

A language model is used to improve recognition accuracy. The simplest form of a language model is a list of words or phrases that you can speak legitimately in the current context. If the system asks how many copies to print, it is expecting a number. If the system asks for verification of a command to delete a file, it is expecting a "yes" or a "no."

A more complex language model as-



An HMM is a statistical model that represents how a word's spectrum varies over time, essentially a flexible template of a word. An HMM has parameters that are estimated from spoken examples of a word to best model the observed variations. Once the parameters are estimated, any path through an HMM graph has a certain probability. In taking a path, each transition generates a spectral slice of speech that could have come from speaking the word. The most likely path through the graph and the most likely spectral slices generated taking that path create a likely spectrum-time picture of the word. An observed unknown word can be compared to the HMM of a known word to get the likelihood that the unknown word is modeled by the HMM. Likelihoods of HMMs for different words are compared to get the best match.

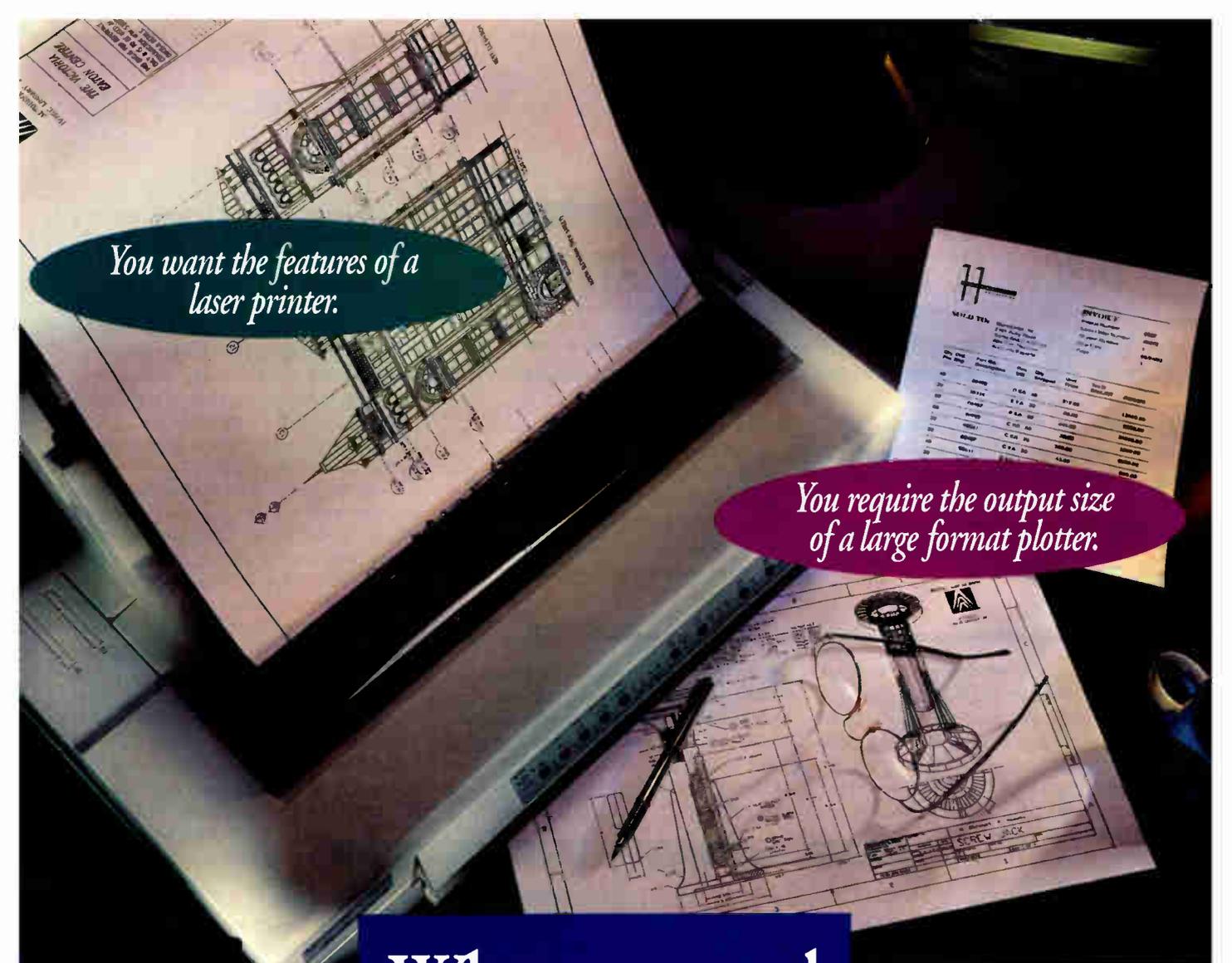
signs a likelihood to word sequences. A language model can indicate that "they read" is more likely than "they red," allowing the speech-recognition algorithm to use word context to improve accuracy.

Speech into Text

You can use speech to create text. You say something and the computer types an exact transcription. Speech-to-text is often thought of as a keyboard alternative, particularly for those who have difficulty typing or for small systems without a full-size keyboard.

Dragon Systems (Newton, MA), IBM, and Kurzweil Applied Intelligence (Waltham, MA) offer general speech-to-text systems. Dragon's DragonDictate offers complete hands-free operation, making it particularly suitable for use by the physically disabled. In part for this reason, IBM sells a version of the Dragon system, as well as its own. These systems require that you speak one word at a time. No commercial systems can transcribe continuous speech for general dictation, although Dragon and other researchers have demonstrated limited prototypes.

The systems differ in vocabulary size, price, the platforms on which they run,



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PACIFIC DATA
PRODUCTS

DISCRETE VOICE-CONTROL SYSTEMS

Simple discrete-command voice-control capability is offered on a number of sound boards and systems, each using one of several standard packages:

- Microsoft, Media Vision, Articulate Systems, and IBM use a voice-control package with technology from Dragon Systems.
- Creative Labs uses technology from Voice Processing in some of its Sound Blaster boards.
- Several board manufacturers that use an audio processor from Sierra Semiconductor (e.g., Diamond Computer Systems) offer Aria Listener voice-control software from Scott Instruments.
- Silicon Graphics' Indy workstation also bundles a version of Scott Instruments' technology.

and features. The vocabulary size ranges from 7000 words to 50,000 words; some of the words you add as you use the system. The Dragon and Kurzweil systems are speaker-adaptive; the IBM system requires that you spend about an hour of your time providing speech examples before you use the system. In return for the hour of time, the IBM system gives high accuracy immediately; it also improves over time by adjusting its language model as it learns how you use words.

DragonDictate and Kurzweil run under DOS on a PC. IBM's Speech Server Series, or ISSS, requires a Unix workstation, but IBM says a PC version will be available within a year. Elton Sherwin, IBM's manager of Speech Recognition Market Development, said that IBM had chosen to use an approach that required more computation to get more accuracy. According to Sherwin, ISSS uses more complex preprocessing and a more complex language model than the other commercial systems. He indicated that the IBM system gets better than 95 percent accuracy with an active 20,000-word vocabulary. IBM's research, he added, shows that only highly motivated people will use a system with less accuracy.

Prices range from \$2000

for a single-user software package to \$8000 for a complete system including hardware. Consequently, the installed base of such systems has only recently topped 1000. But prices will drop. "As DSP chips are built into computing platforms—be they palmtops, PCs, or workstations," says

AT YOUR COMMAND

The ability to use continuous speech allows a more flexible command language than using discrete commands. For example, you can do the following:

- PC system control: "Change display to 24-bit color."
- PC application control: "Open spreadsheet, expand it to fill the screen."
- Word processing: "Make this paragraph Palatino font, 12-point italic."
- Graphics: "Change line width to two points."
- Calendar management: "Schedule an appointment on Friday at 10:00 a.m. with John Doe."
- Order execution: "Buy 400 ABC Corp. at 48%, good till canceled."
- Telecommunications control: "Send fax to George."
- Voice dialing: "Call home."
- Factory inspection: "Dent in right front fender."
- Data entry: "Nine of model 4A96."

Continuous Speech-Command Systems

Apple's PlainTalk—standard on new Mac AV-series systems.

The IBM Continuous Speech Series—\$299 per user for AIX, OS/2, and Windows.

Hark from BBN Systems and Technologies (Cambridge, MA)—\$3000 per user, running on various workstations.

Decipher from SRI—price varies, runs on workstations.

PE400 from Speech Systems (Boulder, CO)—\$3495 for Intel-based PCs.

Listen for Windows from Verbex Voice Systems (Edison, NJ)—\$495 for Intel-based PCs.

Janet Baker, president of Dragon Systems, "even the most sophisticated speech technologies will be available as simple software solutions."

Sherwin would like the 486 version of ISSS to ship bundled with PCs and be priced accordingly. The idea is intriguing. Dictating one word at a time is analogous to typing one letter at a time. If computers come standard with the ability to voice-type and touch-type, many people might prefer voice to the keyboard.

General speech-to-text systems usually come with a macro feature. For example, a trigger phrase like "finish letter" might print out the closing and signature line of a letter. Some of these systems are report generators; they extend the concept of macros to accelerating the preparation of a report. The defining characteristic of report generators is that you speak fewer words than appear as final text. Most speech-based report generators have been developed for medical dictation and cost \$15,000 and up. Most of that price, according to Ray Kurzweil, chairman of Kurzweil, is for the applications design and embedded knowledge rather than the speech recognition.

Speech as a Command

The defining characteristic of general dictation systems is their broad scope, creating the need for huge vocabularies. If you specialize the application, however, you can use speech recognition effectively with smaller vocabularies.

Data entry is an application that sometimes allows for small vocabularies. If you fill out a form, each space on the form asks for different information. Although the entire form may require a large vocabulary, each space has a much smaller vocabulary than the whole. If the system knows which space is being filled in, it can constrain the grammar for that space. For example, it can limit an entry to only numeric or alphabetic data.

You can use speech to control a system, as well as to enter information. The simplest voice-control software uses

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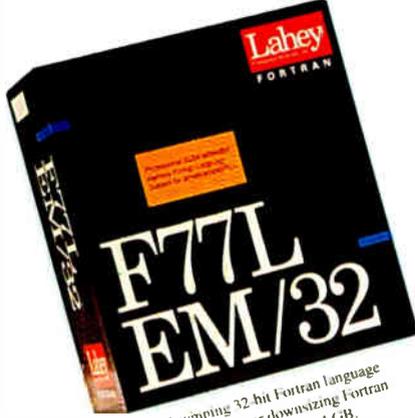
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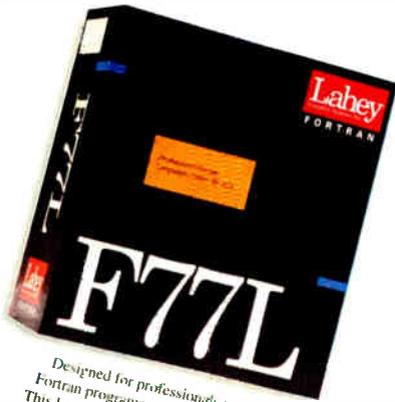
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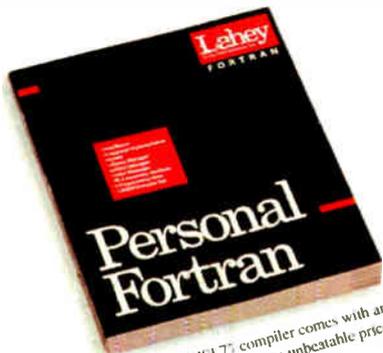


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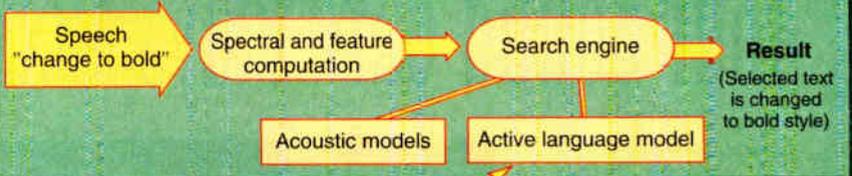
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HOW PLAINTALK WORKS

Apple PlainTalk Speech Recognizer



PlainTalk Interface Manager

Speech rules for context 1 converted to a recursive graph structure

- Language models
- Context 1
- Context 2
- ...
- Context n

Interface

Application

```

Speech rules
%define style
bold
italic
underline
%end
%rule
<:style>
change to <:style>
%context application "word"
%action
tell application "word"
set style of selection to (meaning of s)
%end
%end
    
```

← Category used later

← What can be said

← What happens when it is said

Apple's PlainTalk speech-recognition software allows continuous speech for command and data entry. An applications developer can use data structures called "speech rules" to define what speech the systems will understand in specific contexts (e.g., within a specific application). The resulting action is also specified within the rule.

isolated word or phrase recognition—discrete voice control. For example, you can voice the name of a menu in a Windows application and then voice an item from that menu. Speech allows a much longer list of active commands than it is feasible to put on a menu. Typically, discrete voice-control software can distinguish more than 60 words at one time, but it can handle over 1000 words by switching context (see "Discrete Voice-Control Systems" on page 118).

Continuous speech-command systems are more powerful and natural than discrete-control systems (see "At Your Command" on page 118). Typical continuous speech-command systems are speaker-independent, allow fluent speech, and let you spell or say each new word you want to add. These systems typically let you use several hundred words in each context.

Companies that sell continuous speech-command systems provide development software that lets you create vocabularies and language models to turn the raw recog-

ognition system into a useful product. Even with tools, developing a good speech-recognition application can be difficult. "If the software controlling the speech-recognition engine isn't highly tailored to the application, you will frustrate the user," says Adithya Padala, CEO of Umecorp (Novato, CA), a speech-recognition system developer. For example, in building workstations for Wall Street traders, developers must be aware of how a broker voices stock names and prices.

Customers and developers are just beginning to understand where speech recognition will really pay off. The creativity of applications developers will determine whether a microphone on a computer is just a novelty or whether it fundamentally changes the way we use our machines. ■

William S. Meisel, Ph.D., of Encino, California, wrote the first textbook on computer pattern recognition and ran a speech-recognition company for 10 years. He publishes Speech Recognition Update, a newsletter on the speech-recognition industry. You can reach him on BIX c/o "editors" or on the Internet at 72162.3175@compuserve.com.

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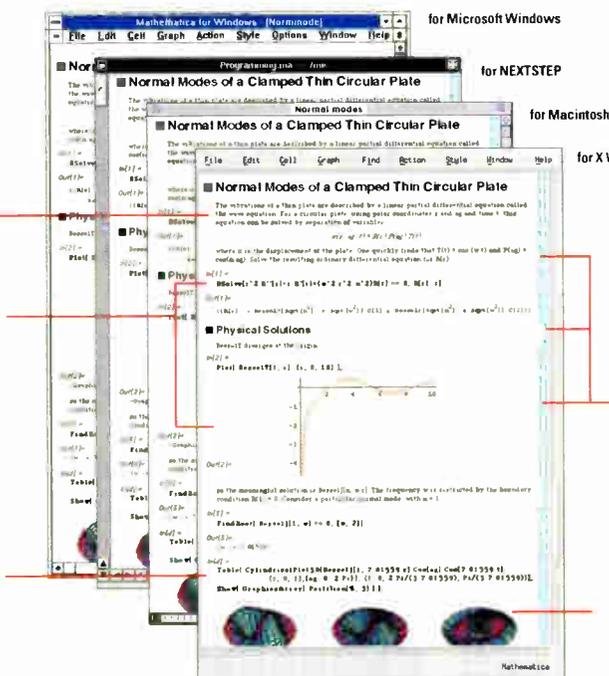
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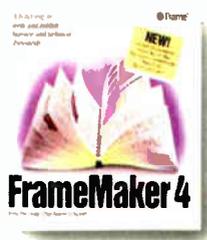
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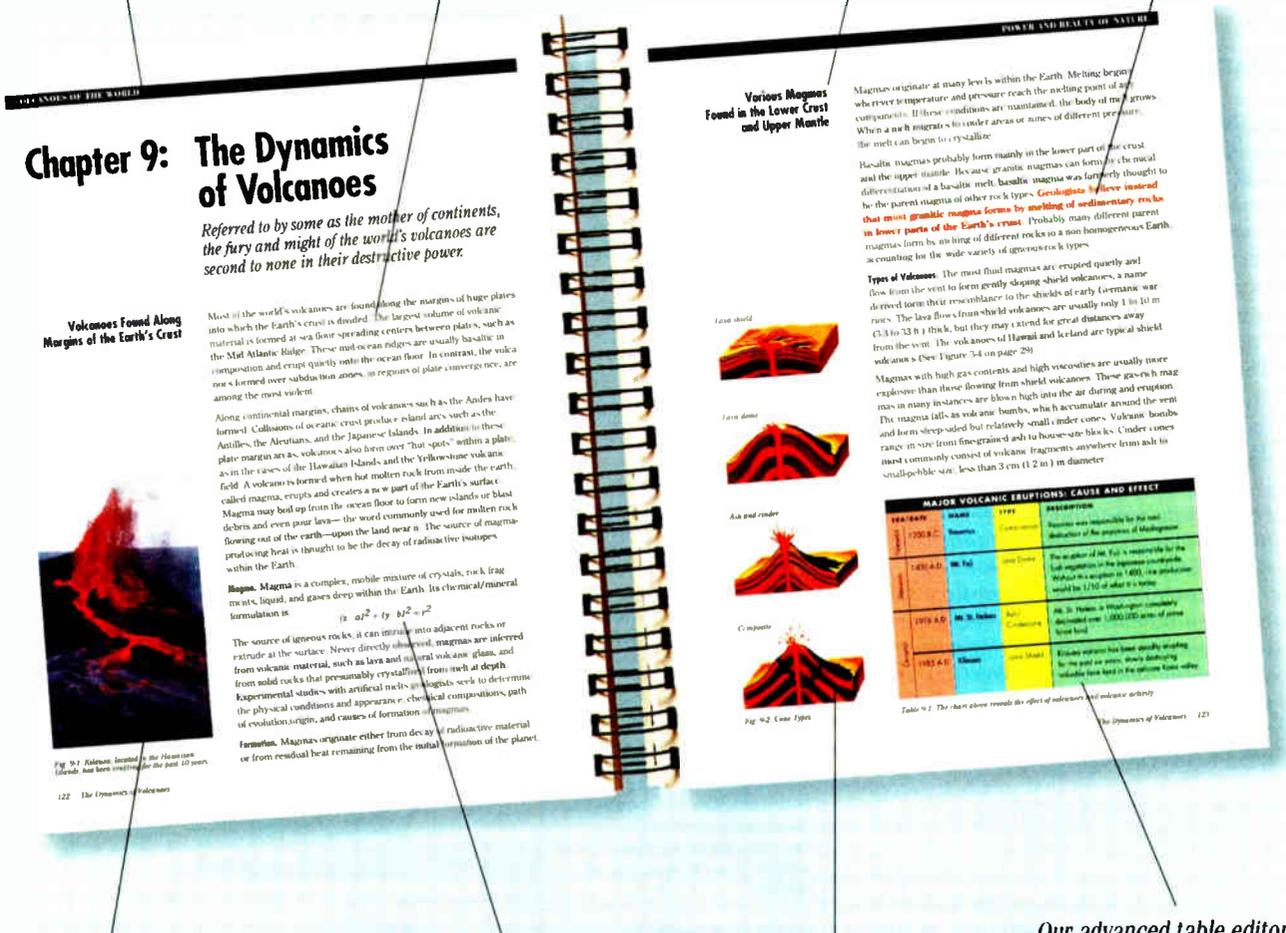
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Chapter 9: The Dynamics of Volcanoes

Referred to by some as the mother of continents, the fury and might of the world's volcanoes are second to none in their destructive power.

Volcanoes Found Along Margins of the Earth's Crust

Most of the world's volcanoes are found along the margins of huge plates into which the Earth's crust is divided. The largest volume of volcanic material is formed at sea-floor-spreading centers between plates, such as the Mid-Atlantic Ridge. These mid-ocean ridges are usually basaltic in composition and erupt quietly onto the ocean floor. In contrast, the volcanoes formed over subduction zones, in regions of plate convergence, are among the most violent.

Along continental margins, chains of volcanoes such as the Andes have formed. Collisions of oceanic crust produce island arcs such as the Antilles, the Aleutians, and the Japanese Islands. In addition to these plate-margin arcs, volcanoes also form over "hot spots" within a plate, as in the cases of the Hawaiian Islands and the Yellowstone volcanic field. A volcano is formed when hot molten rock from inside the Earth, called magma, erupts and creates a flow of new islands or basalt. Magma may build up from the ocean floor to form new islands or basalt debris and even pour lava—the word commonly used for molten rock—flowing out of the earth—upon the land near it. The source of magma-producing heat is thought to be the decay of radioactive isotopes within the Earth.

Magma is a complex, mobile mixture of crystals, rock fragments, liquids, and gases deep within the Earth. Its chemical/mineral formulation is

$$(a)^2 + (b)^2 = c^2$$

The source of igneous rocks, it can intrude into adjacent rocks or extrude at the surface. Never directly observed, magmas are inferred from volcanic material, such as lava and natural volcanic glass, and from solid rocks that presumably crystallized from melt at depth. Experimental studies with artificial melts and natural magmas seek to determine the physical conditions and appropriate chemical compositions, path of evolution, origin, and causes of formation of magmas.

Magmas originate either from decay of radioactive material or from residual heat remaining from the initial formation of the planet.

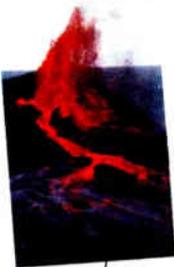


Fig. 9-1. Ashfall caused by the Hawaiian Islands has been continuing for the past 10 years.

122 The Dynamics of Volcanoes

Various Magmas Found in the Lower Crust and Upper Mantle

Magmas originate at many levels within the Earth. Melt begins when temperature and pressure reach the melting point of any components. If these conditions are maintained, the body of melt grows. When a melt migrates to cooler areas or zones of different pressure, the melt can begin to crystallize.

Basaltic magmas probably form mainly in the lower part of the crust and the upper mantle. Because granite magmas can form by the partial differentiation of a basaltic melt, basaltic magma was formerly thought to be the parent magma of other rock types. Geologists believe, however, that most granite magmas form by melting of sedimentary rocks in lower parts of the Earth's crust. Probably many different parent magmas form by melting of different rocks on a non-homogeneous Earth, accounting for the wide variety of igneous rock types.

Types of Volcanoes. The most fluid magmas are erupted quietly and flow from the vent to form gently sloping shield volcanoes, a name derived from their resemblance to the shields of early Germanic warriors. The lava flows from shield volcanoes are usually only 1 to 10 m (3.3 to 33 ft) thick, but they may extend for great distances away from the vent. The volcanoes of Hawaii and Iceland are typical shield volcanoes (See Figure 9-4 on page 29).

Magmas with high gas contents and high viscosities are usually more explosive than those flowing from shield volcanoes. These gas-rich magmas in many instances are blown high into the air during an eruption. The magma falls as volcanic bombs, which accumulate around the vent and form steep-sided but relatively small cinder cones. Cinder cones range in size from fine-grained ash to house-size blocks. Cinder cones consist mostly of volcanic fragments anywhere from ash to small boulder size, less than 3 m (12 ft) in diameter.



Fig. 9-2. Cone Types

YEAR	NAME	TYPE	DESCRIPTION
1783 A.D.	Hawaii	Cinder Cone	Caused the destruction of the island of Matheran.
1783 A.D.	St. Helens	Composite	The eruption of Mt. St. Helens is considered to be the first eruption in the United States since 1792, the production of 1,700,000 cubic feet of ash.
1783 A.D.	St. Helens	Composite	Mt. St. Helens in Washington completely obliterated over 1,000,000 acres of forest land.
1783 A.D.	Yellowstone	Shield	Yellowstone has been steadily erupting for the past 10 years, slowly destroying valuable forest land in the national forest.

Table 9-1. The chart above shows the effect of volcanic and volcanic activity.

The Dynamics of Volcanoes 123

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Personal Databases

For many applications, an inexpensive Windows database will get the job done more easily than traditional solutions

MATT TRASK AND DON SORENSEN

Personal databases form one of the hottest product categories on the market today. The term *personal* does not denote recipe files or other home uses; it simply means that the products in this category usually reside on a local hard disk and track information that is not used corporatewide.

Databases can be intimidating things: They're big, complex, expensive, and programmable. Complex databases can hold megabytes of the most mission-critical data in an organization; such an organization needs to have a database administrator to keep track of it all. When something goes wrong, you call the database administrator to straighten it out.

Personal databases can take some of the burden off the database administrator and return control of the data to a department or workgroup. Personal databases work well for an individual who must track information that the entire organization does not need to access regularly, or for a department or workgroup that needs to access interdepartmental data and doesn't require a customized application.

For the purposes of this review, we define a personal database as one that is useful for a workgroup, department, or small business; has no programming language (macros are permitted); and carries a retail price of under \$400. All the databases we reviewed run under Windows 3.1.

What to Look For

So you think you've got an application that's suitable for a personal database. You want to get a package that's easy to use, but you don't want to sacrifice any of the features you'll need. Once you've determined the application, you need to ask some questions about the database you're considering.

Is the package relational? Arguments persist over what constitutes a true relational database. In general terms, a *relational* database can join two or more database tables using a common field. For example, a personnel file could contain ZIP codes for each record, and a different file could hold the city and state informa-

DataEase International's DataEase Express for Windows permits wild cards in its search criteria. One of the wild cards, Soundex, ignores vowels within a portion of the search argument. DataEase supports both OLE and DDE, enabling embedded multimedia objects and dynamic updating of shared data.

Scandinavian PC Systems' SPCS PrimaBase supports seven bar code standards. You can use input from a bar code reader in search arguments applied to the database.

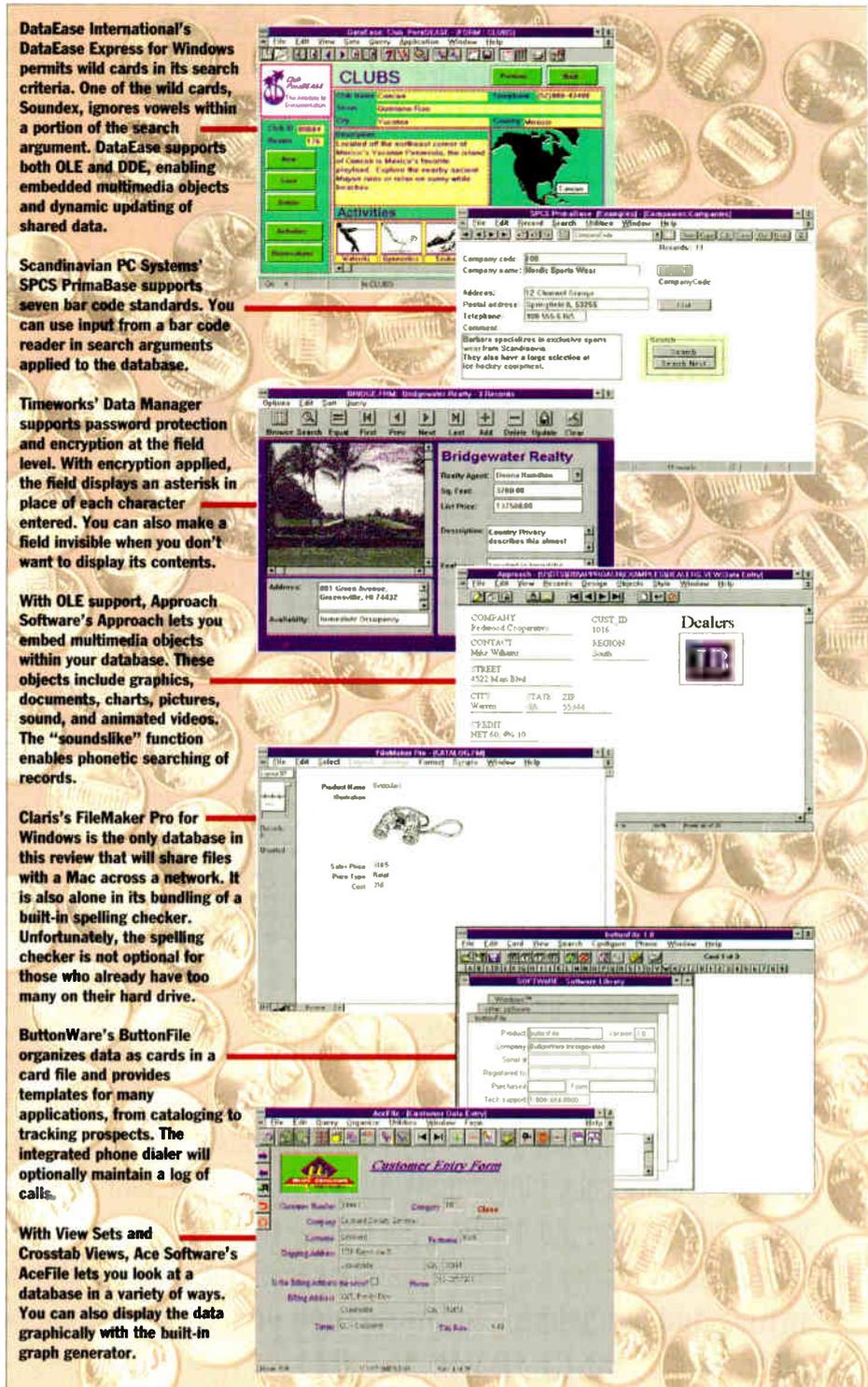
Timeworks' Data Manager supports password protection and encryption at the field level. With encryption applied, the field displays an asterisk in place of each character entered. You can also make a field invisible when you don't want to display its contents.

With OLE support, Approach Software's Approach lets you embed multimedia objects within your database. These objects include graphics, documents, charts, pictures, sound, and animated videos. The "soundslike" function enables phonetic searching of records.

Claris's FileMaker Pro for Windows is the only database in this review that will share files with a Mac across a network. It is also alone in its bundling of a built-in spelling checker. Unfortunately, the spelling checker is not optional for those who already have too many on their hard drive.

ButtonWare's ButtonFile organizes data as cards in a card file and provides templates for many applications, from cataloging to tracking prospects. The integrated phone dialer will optionally maintain a log of calls.

With View Sets and Crosstab Views, Ace Software's AceFile lets you look at a database in a variety of ways. You can also display the data graphically with the built-in graph generator.



tion for each ZIP code. When city and state information is required, the database could perform a join of the two tables using the ZIP code field as a key. Relational capabilities are particularly useful when you need to reuse your database in many different ways—reentering the data multiple times requires much more disk space than is otherwise necessary.

Does the personal database you're considering provide ready-to-use templates for forms and reports? Such templates make it easier to set up a database and to produce good-looking reports. The template should be easy to modify to match your particular requirements.

Is mail merge available to combine names and addresses with letters? Sometimes a database exports names and addresses to a word processor for this purpose. Can labels be formatted and printed? These features eliminate the need for reentering data for mailing and shipping applications. Is auto-dial available? For applications requiring a lot of phone activity, automatic dialing can add up to a meaningful savings of time and energy.

How well does the database work over a network? When multiple users access the same database, data integrity becomes an important issue. If two people change the same field at the same time, integrity is lost. Features such as read-only fields and record locking prevent such problems and guarantee the integrity of the database. And you may need password and encryption features if you're tracking sensitive information, such as your personal stock portfolio or employee salary records.

Group Overview

All the personal databases reviewed here have much in common—database programs are all expected to do certain things. For example, every package can apply filters, sort entries, and search for a match to a supplied argument. And all of them can import and export data to and from common file formats (see the table "Personal Database Features").

All are also easy to use. They share a common form-building orientation, which focuses on letting you quickly build forms for data entry or browsing.

You'll find that most of what differentiates these packages is around the periphery: a card stack metaphor, unusual data types, or bar code support.

As a result, our individual reviews will concentrate only on the aspects of each database that make it stand out from the rest of the pack.

AceFile 2.0



AceFile features two views in addition to the typical list and form views. The View Set consists of one or more views from one or more databases that have been saved together. For instance, you could use a View Set of an appointment schedule, a phone book, and a to-do list as a PIM (personal information manager). If your monitor has a large enough screen, you can simultaneously open up to 20 views from up to 10 databases with up to 10 index files each.

A Crosstab View is a matrix displaying the relationship between two fields. The relationship may consist of summarized data or calculated minimized, maximized, or averaged values portraying trends or patterns in the data. You can display or print Crosstab information in 16 styles of graphs, including variations on column, area, bar, line, and pie graphs (many in either two or three dimensions).

AceFile, like all these personal databases, reads .DBF files directly, and .DBF files are AceFile's native format. However, you can't create a form to connect fields from several databases.

You can record repetitive sequences of keystrokes and mouse movements as macros and play the sequences back at any time. The main toolbar has icons for recording, stopping, and playing macros. Macros can simulate virtually any repetitive task.

AceFile provides a large number of operators and functions that you can use, along with wild-card characters, in expressions. Expressions combine one or more fields in a formula for defining index keys and filters. Add a number of provided field macros (not to be confused with the recorded macros described above), and you have all the tools you need to format displays and reports.

This feature, along with mail merge, label printing, the auto-dialer, and DDE support, make AceFile a fairly comprehensive package. Its \$199 price puts it in direct competition with less fully featured systems such as Data Manager and PrimaBase. We do wish AceFile used the standard Open dialog box from Microsoft's Common Dialog library, however. If databases are maintained in different directories, it's sometimes difficult to reach the database desired. Use of the standard Open dialog box would have made this task much easier.

Approach 2.0 for Windows



Approach's support for OLE permits a database to contain not only graphics but also documents, charts, pictures, sound, and animated videos. A special PicturePlus field contains these multimedia elements.

Networks are supported with file and record locking, password protection, and read-only fields. Record locking can be full or optimistic (which is the default setting) when dealing with either Paradox or dBase databases. Full record locking prevents all other users from updating a record for as long as the record is "out" for modification. Optimistic record locking allows two users to modify the same record simultaneously, locking the record when one person writes it back to the network and giving the other person an error message with an override option.

Using the many provided operators and functions, you can write formulas to analyze fields and display the results in a calculated field. These calculations can summarize data in a group of records, an entire database, or several databases. We particularly liked the "soundslike" function: When you're unsure of a word's correct spelling, you can search for the record phonetically.

The package supports mail merge, label printing, and macros. Buttons on a form or a report can launch user-defined macros. One small complaint: We found the tiny font used on the status bar nearly unreadable, even at 640- by 480-pixel resolution, and the font is not configurable.

ButtonFile 1.0



This package is the definitive easy-to-use information manager. ButtonFile's database is called a Deck; a record is called a Card; and a field is known as a Data Box. For a work space, ButtonFile uses the Microsoft MDI (Multiple Document Interface). Cards are displayed in a traditional list view, or in a continuous loop like a Rolodex. Just below the menu bar is an optional Index Button row (consisting of A through Z and 0 through 9). Clicking on an Index Button quickly positions you at the point in the Deck where the index starts with that character. A ButtonFile Deck is compatible

PERSONAL DATABASE FEATURES

Personal databases are very affordable and surprisingly powerful. These databases support a wide range of file formats and networks.

(● = yes; ○ = no.)

	ACEFILE 2.0	APPROACH 2.0 FOR WINDOWS	BUTTONFILE 1.0	DATAEASE EXPRESS FOR WINDOWS 1.1
Company	Ace Software	Approach Software	ButtonWare	DataEase International
Price	\$199	\$399	\$89	\$395
Minimum requirements				
Processor	286 or higher	286 or higher	286 or higher	286 or higher
Memory	2 MB	2 MB or higher	1 MB or higher	2 MB or higher
Hard disk	3 MB	2 MB	2 MB	6 MB or higher
Mouse/pointing device	Required	Required	Optional	Required
Maximums				
Records per file	1 billion	1 to 2 billion*	Limited by disk space	2 billion
Fields per record	254	255	40	255
Characters or notes per field	5120	4,294,967,295	8192	4000
Indexes per database	10	255	1	Unlimited
Files open at once	60	30 to 60*	Limited by memory	100
Database features				
Operators	●	●	○	●
Relational	○	●	○	●
Password protection	○	●	●	●
Encryption	○	○	●	●
Read-only fields	●	●	○	●
Automatic record locking	●	●	● (network version)	●
DDE support	●	○	○	●
OLE support	○	●	○	●
Mail-merge letters	●	●	Export to word processor	○
Print labels	Avery predefined	Avery predefined, custom	●	●
Templates provided	●	●	●	●
Auto-dial phone	●	○	●	○
Functions	●	●	○	●
Create new macros	●	●	○	○
Report generation	●	●	●	●
Graphs	●	○	○	○
Store pictures/graphics	●	●	○	●
Store sound	○	●	○	●
Other databases supported				
DB2	○	●	○	Optional
dBase	III Plus import/export	●	III import/export	File access via ODBC
DRDA Access	○	○	○	●
EDA/SQL Access	○	○	○	●
FoxPro	○	●	○	○
Microsoft SQL	○	●	○	Optional
ODBC Access	○	●	○	●
OS/2 Database Manager	○	○	○	Optional
Oracle SQL	○	● (versions 6.0 and 7.0)	○	Optional
Paradox	○	●	○	File access via ODBC
Rapid	○	○	○	○
AS/400	○	○	○	Optional
Sybase	○	○	○	Optional
ASCII text files	●	Import/export	Import/export	●
Lotus 1-2-3	Import/export	Import/export	Import/export	●
Microsoft Excel	Import/export	Import/export	○	○
Symphony	Import/export	Import/export	○	○
Image formats				
BMP	●	●	○	●
CGM	○	○	○	○
DIB	○	○	○	○
DRW	○	○	○	○
EPS	○	●	○	●
GIF	○	●	○	●
PCT	○	○	○	○
PCX	●	●	○	●
PIC	○	○	○	○
TIF	●	●	○	●
WMF	○	●	○	●
Networks supported				
3Com 3+Open	●	●	○	●
Banyan Vines	●	●	○	●
IBM PC LAN Program	●	●	○	●
LANtastic	●	●	○	●
Microsoft LAN Manager	●	●	○	●
Novell NetWare	●	●	○	●
Novell NetWare Lite	●	●	○	●

*Lower limit = dBase/FoxPro; upper limit = Paradox.

tection and encryption at the field level. With encryption applied, the field displays an asterisk in place of each character entered. You can also make a field invisible if you don't want to display its contents.

There were two things we didn't like about this product. One is that the over-size icons on the menu bar left less room on the screen and required frequent use of the vertical scroll bars to access the entire database form. We also disliked the message that appears every time you tell Data Manager that you wish to exit. The message tells you how long the program has been active and asks if you *really* want to exit. After a while, this becomes irritating. Worse, if you have an unsaved modified database loaded and answer "yes" to this question, you lose all your changes. We'd much prefer to receive a warning that the modified database had not been saved and otherwise be able to exit with no questions asked.

FileMaker Pro 2.1 for Windows



FileMaker Pro has two features that are unique among this group of products: a spelling checker and cross-platform file sharing. The program's spelling checker can check a selected word or passage, all the text in the current record or a set of records, or field names on the current layout. When it finds a questionable spelling, it provides a list of possible replacements. You can replace the word with a selection from the list, add the word to the dictionary, skip the word without adding it to the dictionary, or cancel.

While this feature may be very desirable if you're a particularly bad speller, the installation routine should give you the option of refusing to load it. With hard disks already littered with the huge spelling checkers included with word processors and other programs, the last thing many people need is another spelling checker.

Cross-platform file sharing can take place between FileMaker Pro for Windows and its Mac version running on a Mac on the same network. For network security, password protection is available, and fields within records can be defined as read-only or hidden.

FileMaker Pro understands an unusually large list of file formats, making it possible to import and export files with Microsoft Word and Excel, BASIC programs, VisiCalc, Lotus 1-2-3, dBase III

and IV, and many other programs accepting tab- or comma-delimited text files. This makes it possible to perform a mail merge by exporting necessary fields from your database to a word processor.

The package's ScriptMaker feature enables you to write scripts that perform a series of actions. Scripts can execute sub-scripts (which are like subroutines) or external scripts (from other database files).

Although OLE is not directly supported, similar functionality permits graphics, pictures, or sounds to be stored in a picture/sound field. You can use the bundled form templates as is or modify them to suit your own requirements.

SPCS PrimaBase 3.1



SPCS PrimaBase supports seven bar code standards: the full ASCII Code 39, the numeric Interleaved 2/5, three U.S. standards (UPC/A, UPC/E, and U.S. Postnet), and two European standards (EAN/13 and EAN/8). You can print bar codes, and if your hardware includes a bar code reader, you can use bar codes as input to search for records in a database.

You can use the instant-search feature at any time in either form or list mode. You just type in a character, and the current record pointer goes to the record whose key begins with that letter. Enter a second character, and the pointer again moves to the key beginning with the two typed characters, and so on. This feature gives you fast access to a desired record.

Network support includes passwords with various levels of protection. You can set access rights to read/write or read-only, and you can determine whether a user can authorize exclusive access or modify forms and reports. PrimaBase can also encrypt files.

PrimaBase's mail-merge support is unique—other database managers have simple word processors or export formatted data for use by other programs. PrimaBase can perform merges with letters created by Windows Write or within PrimaBase's report generator. Expressions are supported for calculated fields with provided operators and functions.

A Personal Preference

These database packages have many interesting features, ranging from bar code support to custom-defined functions to an integrated spelling checker. If you have specific requirements, your choices may be limited. For a rich feature set and both DDE and OLE support, the only choice is DataEase. FileMaker Pro is the way to go if you require a spelling checker or Mac file sharing. And SPCS PrimaBase is the only database package in the group with bar code support.

If ease of use is important to you, ButtonFile is a good choice. Predefined templates make it ideal for tracking and cross-referencing simple lists such as business contacts or small inventories. For the best mix of features and ease of use, we like FileMaker Pro. ■

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Approach Software Corp.

(a subsidiary of Lotus Development Corp.)
(Approach 2.0 for Windows)
311 Penobscott Dr.
Redwood City, CA 94063
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fax: (415) 368-5182
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ButtonWare, Inc.

(ButtonFile 1.0)
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Bellevue, WA 98009
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fax: (206) 454-1838
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Claris Corp.

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P.O. Box 58168
Santa Clara, CA 95052
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DataEase International, Inc.

(DataEase Express for Windows 1.1)
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(203) 374-8000
fax: (203) 365-2317
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Scandinavian PC Systems, Inc.

(SPCS PrimaBase 3.1)
P.O. Box 3156
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(504) 338-9580
fax: (504) 338-9670
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Timeworks, Inc.

(Data Manager for Windows)
625 Academy Dr.
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(708) 559-1300
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- ▶ Built-in declarative referential and entity integrity
- ▶ Visual Basic Interface
- ▶ Bi-directional, scrollable, updatable cursors
- ▶ Row-level locking
- ▶ ANSI SQL and IBM SAA compatible
- ▶ Full transaction processing support with checkpoint log and forward transaction log
- ▶ Multiple simultaneous application connections
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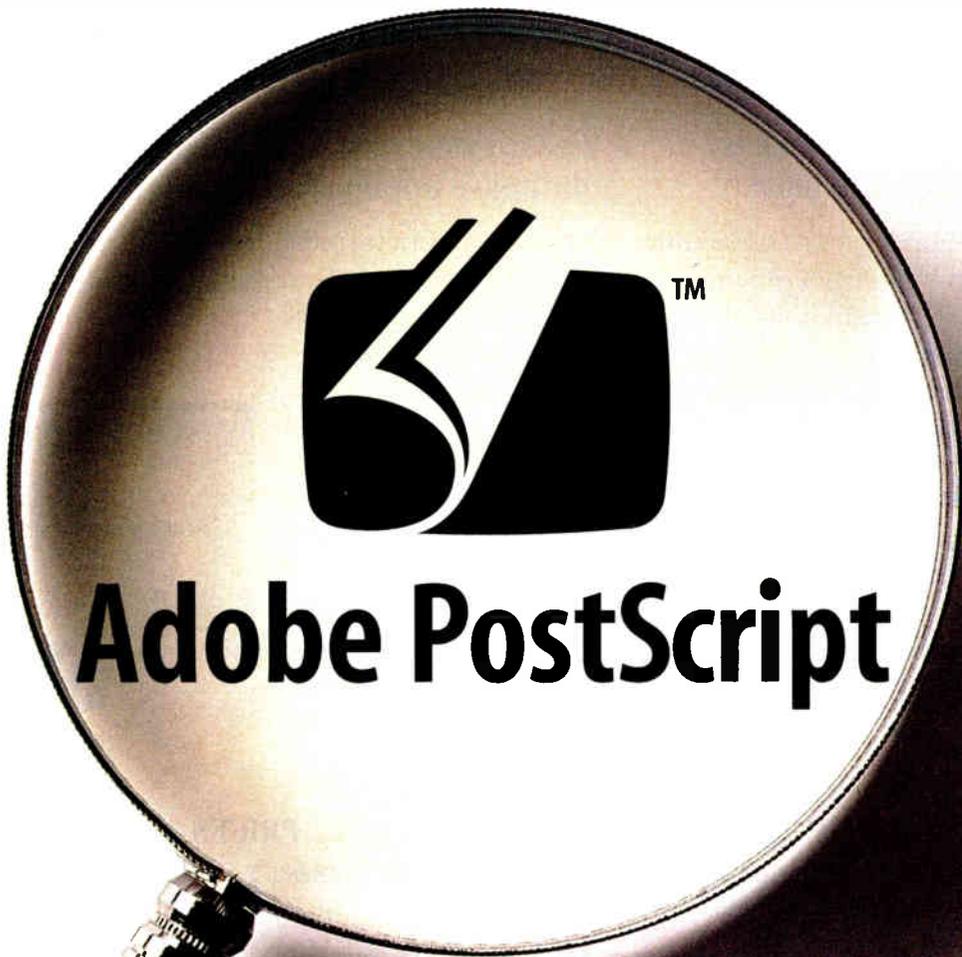
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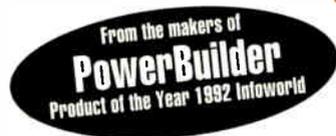


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Acrobat vs. Common Ground

Adobe Systems and No Hands Software offer two different ways to distribute electronic documents

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Consider it a pothole in the digital highway. Amid the promise of electronic information delivery, we still don't have a reliable and efficient medium for communicating via formatted electronic documents.

We could continue to send unformatted ASCII text back and forth, but the style and layout of a document offers more than just a distinctive look. A document's design helps a reader better understand the information. But unless the document's recipient shares the same platform, the same applications, and the identical fonts as the document's creator, a meticulously designed report can fall apart, dropping its page formatting and, more important, some of its information content. In some cases, the recipient may not be able to access the document at all.

Enter Adobe's Acrobat and No Hands Software's Common Ground, two competing technologies for creating cross-platform, application-independent documents. Both technologies are compelling and workable. Each has clear advantages and disadvantages. Both show the potential power of a cross-platform document format. And both need some work.

Applications for document distribution are vast. With portable documents, corporations can electronically distribute telephone lists, manuals, or company newsletters throughout the organization.

The PostScript Solution

To provide a format for electronic-document distribution, a technology must retain the layout, the graphics, and the distinctive look of the original document. The digital document must be compatible with a wide range of output devices and, ideally, available to the widest possible audience. Acrobat and Common Ground take different approaches to this same end.

Adobe Systems has leveraged its experience on two fronts, PostScript and fonts, to devise a portable-document strategy. As the creator of PostScript and an industry leader in font technology, Adobe has



► **Common Ground's tools are available from a floating palette. The information box lets you know which fonts were used in the original document.**

impressive credentials in both areas.

Acrobat is actually a family of products, three of which are shipping. Acrobat Exchange (\$195) creates electronic documents through the printer-driver mechanism on a Mac or on a Windows-based PC. You can then view the document, search it for individual words, print it, or embellish it with annotations and hypertext links. Acrobat Reader sells in bundles of 50 (\$50 per user), 100 (\$40 per user), or 500 (\$35 per user). Acrobat Reader lets you view, navigate, or print Acrobat documents, but you can't create them. Acrobat Distiller (\$695) takes raw EPS (Encapsulated PostScript) files and converts them to portable documents.

Acrobat's PDF (Portable Document Format) uses PostScript to describe the text, graphics, and images in a file. Because it uses PostScript, a PDF file is device- and resolution-independent, so it will reproduce at the highest resolution that your output device supports. You can view a page on a high-resolution display system at multiple magnification levels, and you can print to any device, from a 300-dpi laser printer to a Linotronic image setter. Adobe has published PDF as an open standard, allowing developers to support the format in third-party applications.

To reproduce a document's fonts, Ac-

◀ **Acrobat delivers a strong set of navigation features. Double-clicking on the thumbnails sends you to the selected page, or you can go to a specific page number. The controls on the tool ribbon let you step through a document, or you can go directly to the first or last page.**



robat comes bundled with ATM (Adobe Type Manager) and its font-substitution technology. If a font is missing from a document, ATM substitutes one of two multiple-master fonts (serif or sans serif) to match the general style of the missing font. The substituted font will also duplicate the missing font's metrics. For basic fonts, this technology works well. The substituted font retains the weight and width of the original font. However, the distinctiveness of ornate fonts is lost, because ATM substitutes only a basic serif or sans serif outline and cannot replicate the actual font design. But by retaining the metrics of fonts on the page, ATM ensures that all lines break properly and that the page layout is duplicated exactly, even when complex fonts are unavailable.

Building DigitalPaper

Common Ground from No Hands Software sells for \$189.95 and creates documents via the printer-driver mechanism on the Mac. A Windows version should be available by the time you read this. Instead of PostScript, Common Ground uses a proprietary format called DigitalPaper

Reviews Acrobat vs. Common Ground

- abcdefghijklmn- wilke italic 12
- abcdefghijkl -palatino 15 bold
- abcdefghijklmnopqrst - goudy 13

- abcdefghijklmn- wilke italic 12
- abcdefghijkl -palatino 15 bold
- abcdefghijklmnopqrst - goudy 13

To retain the distinctive look of a page, a portable document technology must handle fonts that are not available on a recipient's system. Acrobat's font-substitution method retains the metrics of a font and thus retains proper page layout, but it often loses the decorative design of more ornate fonts such as Goudy. Common Ground's proprietary technology precisely mimics the font's appearance (right).

for creating and displaying its electronic documents. Embedded graphics are rendered by using the host-imaging system (QuickDraw on the Mac, and the Windows Graphical Device Interface, or GDI, when the Windows version ships) to build a scalable image. Using the host-imaging system saves memory overhead, because it does not require an additional imaging component.

Acrobat Exchange requires 2 MB of application RAM on the Mac; Adobe recommends 4 MB. Common Ground requires only 700 KB, but the company recommends about 1.2 MB.

Common Ground's font description is the proprietary part of Digital-Paper. The characters are not embedded outlines or bit maps (a common misunderstanding about Common Ground). To a first approximation, Common Ground sprays rectangles across the page and describes the contents of each rectangle in vector format. The first time a unique character is encountered, it is described and stored. When the same character occurs again, only location information is stored, with a reference to the original description of the character. The vector information tells Common Ground how to rebuild characters at fixed resolutions (72 and 100 dpi for screen display, 200 dpi for faxing, and 300 dpi for printing) with pixel-for-pixel fidelity. Although No Hands Software plans to increase the available resolutions in future versions, Common Ground will al-

ways be less flexible than the resolution-independent technology of Acrobat.

Perhaps Common Ground's greatest asset (in addition to small memory requirements) is its ability to attach a mini-viewer to an electronic document. With this run-time viewer attached, the recipient requires no additional software to view the document. The mini-viewer offers no searching and only basic navigation features, but it is freely distributable (up to 100 copies for each document).

Acrobat's lack of a run-time viewer

The Feature Set

When it comes to current features, a general theme comes clear: If you could somehow combine the functionality of Acrobat and Common Ground into a single application, you would end up with a well-rounded solution.

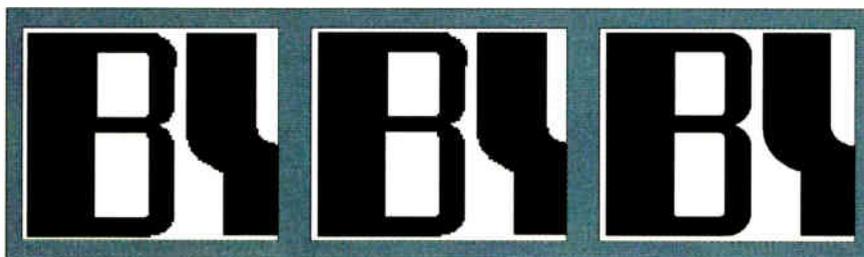
Common Ground includes security features (e.g., password protection for a document) that Acrobat should have. In addition, Common Ground lets you search for phrases, expanding on Acrobat's limit of single-word searches. However, Common Ground lacks Acrobat's hypertext linking, which lets you link to a specific view or magnification level. It also lacks any annotation features, while Acrobat lets you annotate a document with "sticky" notes. All told, Acrobat's interface is more fully featured.

The two products support thumbnail views of a document. Acrobat places the thumbnails to the left of the current page view, so you can conveniently turn to a specific page by double-clicking on the thumbnail. You can create bookmarks in an Acrobat document to quickly build a table of contents or an index of a document. Common Ground does not support a bookmarking facility. Acrobat supports magnification levels of from 12 percent to 800 percent in 1 percent increments; Common Ground's magnification levels are preset to 25 percent, 50 percent, 100 percent, 200 percent, and 400 percent.

Common Ground uses an I-beam for text selection, the standard method for selecting text in a graphical document, and captures graphics in bit-map or PICT format. With Acrobat, you draw a rectangle around text to select it. This method is a bit more cumbersome, and you can select only complete lines, not selected phrases within a line. In addition, you can't cut and paste graphics with Acrobat.

ACROBAT	COMMON GROUND
<ul style="list-style-type: none"> • resolution independence • hypertext linking • bookmarks (index creation) • higher-quality EPS files • smaller electronic documents • text annotations 	<ul style="list-style-type: none"> • lower resource requirements • distributable viewer • password security • phrase searching • cut-and-paste graphics • faster performance

could be a serious pitfall. If you want to establish a universal format for document transfer, you shouldn't expect everyone to buy a \$50 reader program. On the other hand, Adobe may be more effective in establishing a standard than No Hands Software because of its preeminent presence in the market. If Adobe can attract licensees in the same way it did for ATM—in effect, letting vendors evangelize the product by shipping an Acrobat reader with shrink-wrapped software—or if it really gets aggressive and ships an Acrobat viewer with ATM, the company could establish Acrobat by brute marketing strength.



Common Ground (left) and Acrobat Exchange (middle) create electronic documents by servicing print calls from the application. Using this method, both technologies process the low-resolution preview image of an embedded EPS graphic. Acrobat Distiller converts EPS files directly, resulting in much higher-quality output (right).

Testing the Technologies

To test out these two technologies, I generated an assortment of documents with a wide range of Mac software (e.g., Adobe Il-

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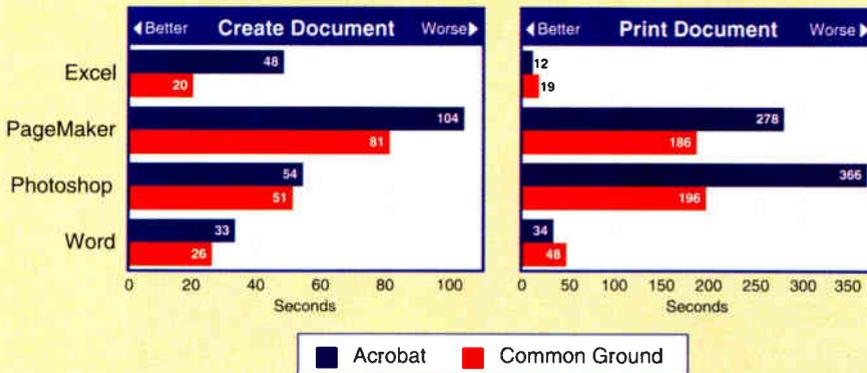
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World Radio History

Reviews Acrobat vs. Common Ground

Electronic Document Performance



Common Ground consistently outperformed Acrobat on the Macintosh. Acrobat's on-the-fly file compression slows performance but results in significantly smaller electronic documents.

Illustrator, Adobe Photoshop, Aldus PageMaker, Claris FileMaker Pro, Claris MacWrite, Informix Software Wingz, Microsoft Excel, Microsoft Word, and QuarkXPress). I transported the Acrobat files back and forth between a Mac and a PC running Windows.

On Windows, I tested Acrobat with PageMaker 4.2 and 5.0, Word for Windows, WordPerfect for Windows, Lotus 1-2-3 release 4, Excel, Photoshop, Picture Publisher, and CorelDraw. I used a system with a minimum configuration (a 16-MHz Mac SE/30 with 5 MB of RAM or a 25-MHz Dell 486SX with 4 MB of RAM), as well as a higher-end system (a 25-MHz Mac Quadra 800 with 8 MB of RAM or a 66-MHz Gateway 2000 486DX2 with 16 MB of RAM).

I ended up with electronic documents incorporating elements from all this software, but not without running into quirks. I created some PostScript files under Windows that the Mac version of Acrobat Distiller couldn't handle. An image embedded in a Word document displayed fine from the Mac version of Acrobat Exchange but didn't display on the Windows version. Adobe acknowledges some problems in its release notes, but a problem such as "canceling printing from PageMaker may cause a crash" is no less disconcerting just because it's documented.

Both products have some basic limitations. On low-end machines, I could process only simple documents, and graphics performance was slow. In general, lack of available memory was a persistent problem. And if your original document includes hyphenated words, neither product will be able to find the hyphenated occurrence of the word, an understandable lim-

itation but still a problematic one.

As you might expect, the Acrobat technology handles EPS files more efficiently than Common Ground does. Both products create documents by accepting application calls to the printer driver, so the low-resolution preview image of the EPS file is processed. Acrobat Distiller converts EPS files directly, resulting in higher-quality images. In fact, in its release notes for Acrobat, Adobe suggests using Acrobat Distiller if you run into problems with the PDF Writer.

Common Ground was faster than Acrobat at creating a portable document and printing it. The Acrobat files are smaller, though, thanks to various compression schemes, including LZW (Lempel-Ziv-Welch), RLE, CCITT Group 3 and 4, and JPEG.

Common Ground documents are approximately the same size as the original file. For simple documents, this is sufficient, but when I put together a PageMaker document with multiple 24-bit images, file sizes became a significant factor. The Acrobat file was about 4 MB in size, while the Common Ground file ballooned to over 20 MB. You can control the size of a DigitalPaper file by reducing the bit depth of your monitor to match the intended output. If you need only black-and-white output, you can set your monitor to 1 bit and decrease file sizes significantly. Once

again, Common Ground's approach is less flexible than Acrobat's.

A Portable Format for the Future

Clearly, the time has come for a cross-platform standard for electronic documents. Now that the Acrobat and Common Ground technologies are in place, we can expect that future software releases will improve the performance and address some of the shortcomings of the current offerings.

If you're looking for today's best solution for corporatewide document distribution (e.g., memos, telephone lists, reports, and simple manuals), Common Ground is it. Your low-end machines will not be left out of the mix, and with the distributable viewer, you can send electronic documents off-site. It's a solution for simple correspondence and communication. Documents with large 24-bit images will be too big until DigitalPaper incorporates a good compression scheme.

Adobe is going to have trouble migrating Acrobat down to low-end systems. Based on PostScript and ATM font substitution, the Acrobat technology will require resources above and beyond the capacity of today's low-end systems. You'll have to decide if the requirement of a 4-MB or, preferably, an 8-MB system is too high for your organization.

I think the resource requirements will keep Acrobat from becoming a wide-spread standard in the short run. But as mainstream systems become more substantial, Adobe has what it takes to build a long-term standard: a proven technology, strong partnerships, an open standard, and a formidable market presence. The company has already announced technology partnerships to make future versions of Acrobat compatible with popular style sheets and style codes such as SGML (Standard Generalized Markup Language). The current proliferation of ATM also helps. In the long run, Acrobat will be the standard to beat. ■

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Stanford Diehl is a technical editor for the BYTE Lab. Formerly, he worked for a large defense contractor, creating database applications and electronic training programs for a wide range of customers, including the United Arab Emirates and the Canadian Air Force. You can reach him on BIX as "sdiehl."

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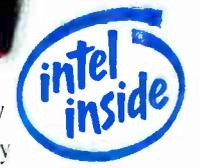
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Mac for Workgroups

Apple's Workgroup Server 95 combines high-speed SCSI and larger cache with faster AppleShare software to make a killer Mac server

RAYMOND GA CÔTÉ

Very little is constant in today's computer domain. The title of *fastest or best performer* is perhaps the most fleeting. It seems like just the other day I was enthralled by the speed and throughput of a Mac Quadra 950, an ideal server or workstation system. Today, it's a second-rate machine.

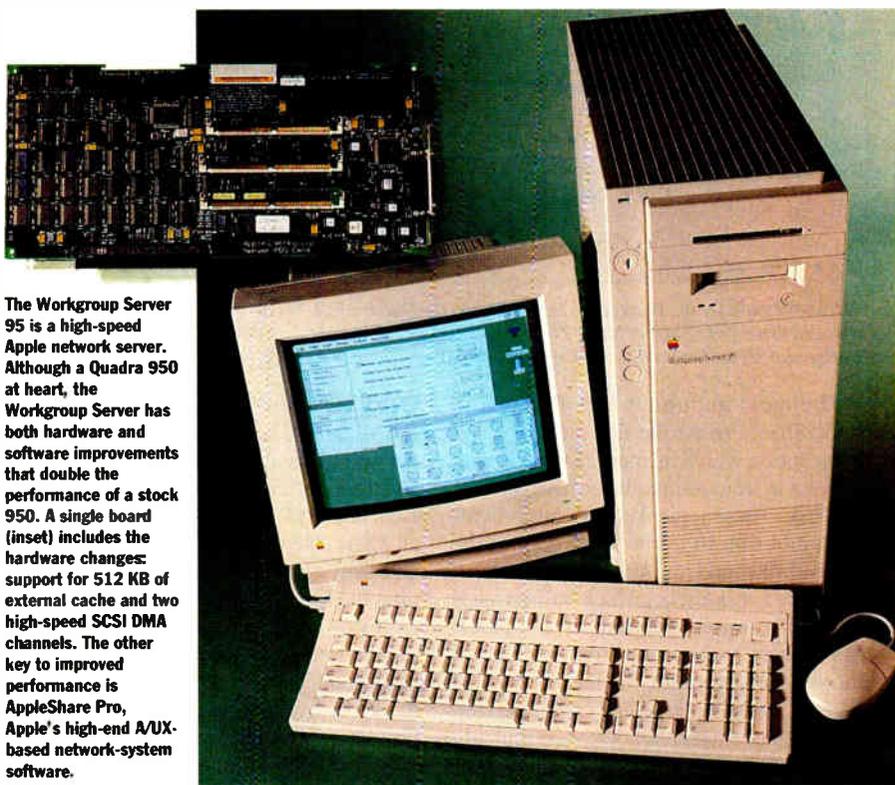
The Apple Workgroup Server 95 is the latest record setter and the newest high-performance Mac. Essentially a Quadra 950 with some minor, but important, modifications such as high-speed SCSI with DMA support and 512 KB of secondary cache, the Workgroup Server is an excellent server platform. These two hardware modifications, along with AppleShare Pro, combine to create a system that runs file I/O tests typically twice as fast and sometimes nine times as fast as a Quadra 950.

The Basics

The Workgroup Server 95 is built on a Quadra 950 base: It has a 33-MHz 68040 microprocessor, 16 MB of RAM, and 128 to 512 KB of secondary cache. You can expand on-board RAM to 256 MB.

System software consists of Apple's A/UX Unix system, Retrospect Remote backup software, and AppleShare Pro 1.0 for file and print sharing. This new Unix-based version of AppleShare, which can have up to 5000 open files, is rated for use by 200 simultaneous users. Up to 50 of these users can be what Apple calls "highly active" users. Although *highly active* is not defined, you can assume it to mean heavy file I/O use. To put this in perspective, AppleShare 3.0 running on System 7 can handle only 120 simultaneous users, approximately 350 open files, and only 15 highly active users.

The Workgroup Server's performance as a file server is optimized by its four SCSI channels, which provide support for up to 20 devices. Two of the SCSI channels are available at the back of the box for external connections and the other two are only available internally. The SCSI connections are also divided by speed: One high-speed DMA channel is available ex-



The Workgroup Server 95 is a high-speed Apple network server. Although a Quadra 950 at heart, the Workgroup Server has both hardware and software improvements that double the performance of a stock 950. A single board (inset) includes the hardware changes: support for 512 KB of external cache and two high-speed SCSI DMA channels. The other key to improved performance is AppleShare Pro, Apple's high-end A/UX-based network-system software.

ternally, and one internally; the other two are standard Quadra-style SCSI connections. This arrangement lets you place your inherently slower devices (e.g., tape drives and CD-ROMs) on your non-DMA interface and reserve your high-speed interface for your hard drives.

Of course, having multiple high-speed SCSI interfaces would not provide much extra speed if your system software could not keep up with them. This is where the next level of server efficiency becomes critical—A/UX.

Speedy System Software

For maximum performance when communicating with multiple devices and clients, you need a true multitasking operating system. As wonderful as Apple's System 7 is, it is simply not a preemptive multitasking environment.

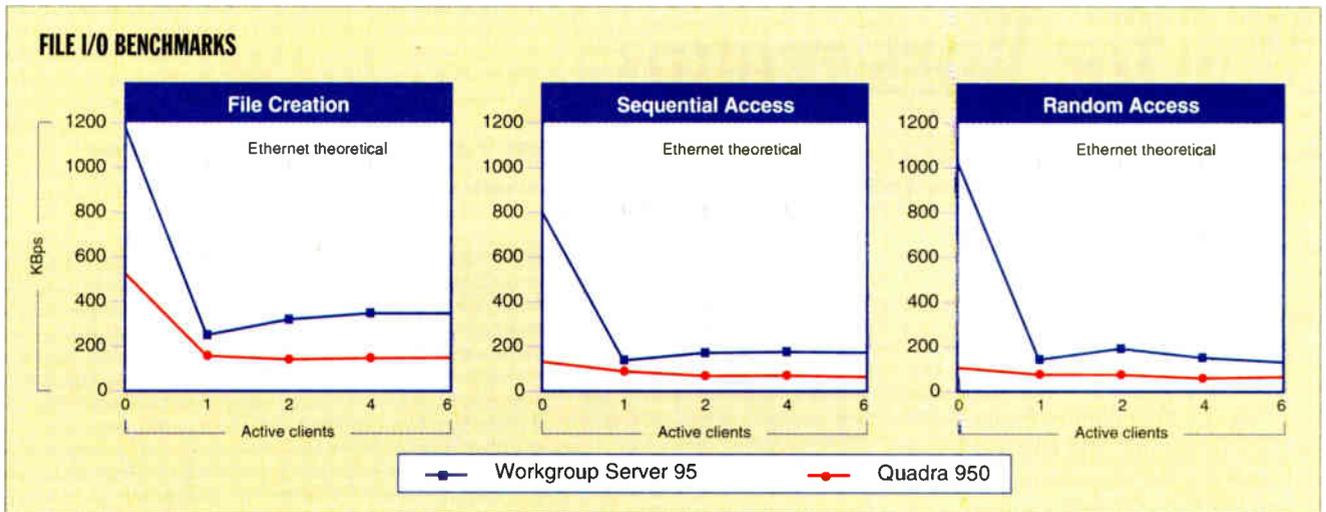
The Workgroup Server comes with A/UX, on top of which runs Mac System 7.0.1. This combination provides not only the preemptive multitasking needed to pro-

vide higher throughput but also the ability to run all your standard Macintosh software.

A/UX also provides support for asynchronous SCSI I/O transfer. This allows the system to start multiple-transfer operations (e.g., seeks, reads, and writes) on different SCSI devices and then accept them in the order in which they appear. At no point does the software need to wait around for a response.

On top of all this sits AppleShare Pro 1.0, the successor to AppleShare 3.0. If you've been using AppleShare 3.0, you'll immediately be familiar with AppleShare Pro, as very little of the interface has changed. In fact, you may not realize you're actually running Unix; you can configure the system so it boots you directly into the AppleShare Administration shell, and you can comfortably administer the system from there. If you really feel the need to delve into the Unix portions, a command-line interface is provided for full access to the A/UX environment.

continued



File I/O benchmarks for the Workgroup Server 95 and the Quadra 950. The Workgroup Server had a 500-MB hard drive and 16 MB of RAM to the Quadra's 230-MB hard drive and 12 MB of RAM. The figure shows aggregate network throughput while creating files and during sequential and random access. The Workgroup Server maintains a high network throughput at up to six highly active clients, although, of course, still well below theoretical Ethernet bandwidth.

The most important new features in AppleShare Pro are the file, directory, and icon caches, which increase the speed with which a system returns information to the network. These logical caches are provided in addition to a low-level disk cache for overall speed improvements.

Unlike a disk cache, which buffers reads and writes on a track and sector basis, AppleShare caches store frequently used entities. For example, the icon cache can store all the icons presented on the desktop so the system does not need to continually read these from disk each time the Finder opens a shared volume. Also, frequently accessed directories are kept in memory to reduce the amount of time needed to open a folder. A separate file cache maintains complete copies of frequently accessed files.

Workgroup Server Workout

The tests I ran for this evaluation were a variant of the file I/O tests BYTE has used in the past to test network file servers. Each client workstation first creates 10 2-MB files by writing multiple 1-KB chunks. The sequential test consists of walking through each of the 10 files by reading three 1-KB chunks and then writing one. The random file I/O test builds a random array of file offsets that are identical for each client. The test then reads 1 KB of data from the first three offsets and writes 1 KB of data to the fourth. My test network consisted of six identically configured Mac Centris 650s running System 7.1.

The Workgroup Server 95 is an impressive performer when stacked up against a

Quadra 950 (the Quadra 950 had 12 MB of RAM and a 230-MB hard drive). A comparison of the two servers running the file I/O tests is shown above in "File I/O Benchmarks." Note that these numbers are an aggregate of all clients on the network and that "zero clients" is the result of running the tests locally.

"File I/O Benchmarks" also calls out the theoretical maximum through an Ethernet connection. You can quickly see that the Workgroup Server was able to use approximately twice the available bandwidth that the Quadra 950 could use. Although it is difficult to tell how frequently our test environment was causing network collisions (and thereby slowing the overall test environment) the Workgroup Server was able to maintain a much higher bandwidth than the Quadra 950. And, in this case, increased network loading is the key to productivity. Only on the random-access test is any saturation noticeable as performance degrades between two and four clients. On the file creation and sequential access tests, the Workgroup Server does not saturate with up to six active test clients.

For file creation at zero clients, the Workgroup Server is over twice as fast as the Quadra 950. The sequential read/write test shows a five-fold improvement, and the random I/O test demonstrates a speed improvement of nearly 10 times due to the use of a large disk cache.

The Workgroup Server running A/UX makes excellent use of a disk cache. This is a big improvement over a Quadra running System 7.0.1. Under System 7, a larger disk cache can produce horrendous speed penalties. At one point during my testing, I had set the Quadra 950's cache to 3 MB to approach the 5 MB of cache reserved in the Workgroup Server. At this setting, the file-creation test times went from 38 seconds to several minutes. I found that a minimal cache setting of 32 KB was ideal for a Quadra running System 7.

Right for the Workgroup?

The Apple Workgroup Server 95 is Apple's speediest system yet. The high-speed SCSI DMA and secondary processor cache aid in the overall excellent performance, and network testing shows the Workgroup Server is a big improvement over a standard Quadra 950.

The system I tested goes for \$8838, including 512 KB of cache and a 2-GB 4-mm DAT (digital audiotape) drive for system backup. That makes this machine not only a reasonably priced server but also a good choice for a high-end development system or workstation. ■

Raymond GA Côté is a BYTE contributing editor and is the publisher of The Robot Explorer newsletter. He has extensive experience in Macintosh program development. You can reach him on BIX as "rgacote" and on the Internet at rgacote@world.std.com.

About the Product

Apple Workgroup Server 95 \$8838

AppleShare Pro 1.0 \$2399

System configuration: a 500-MB hard drive with 16 MB of RAM, a 2-GB 4-mm DAT drive, and 512 KB of secondary processor cache.

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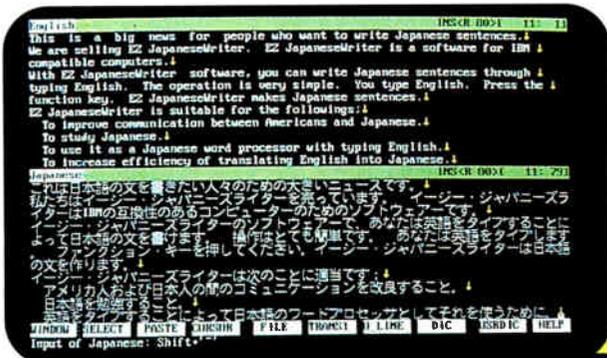
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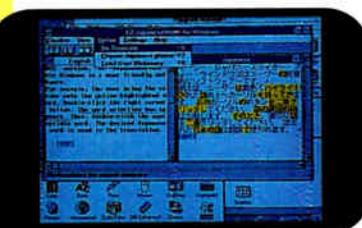


English and Japanese window

DOS Version



Combined English / Japanese window



Windows Version

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IBM

Compatible Software

Q1. How does the software work?

A1. Type an English sentence in the English window and the translated Japanese sentence is displayed. Then, in the Translation-Fine-Tuning mode, you can select the appropriate Japanese word relying on the given English definitions, rephrase sentences, and add new words into User Dictionary etc.

Q2. Is it a translation software?

A2. Although EZ JapaneseWriter has a basic capability of translation from English to Japanese it is not enough to translate your English as it is since it is made without consideration for computer translation. In order to achieve a good translation, the user should follow the rules required by EZ JapaneseWriter. Basically, the English sentence should be relatively short, grammatically structured and use carefully chosen vocabularies.

Q3. Is the translation word-for-word, or sentence-to-sentence?

A3. Sentence-to-sentence.

Q4. How accurate is the translation?

A4. It could be 60% to 100% depending on the structure and vocabulary of your sentence.

Q5. How can I make sure that the translated Japanese correctly relays the message to my receiving party?

A5. EZ JapaneseWriter® displays/prints in the combined English and Japanese format in which an English sentence is immediately followed by the corresponding Japanese sentence, one by one. When you send your fax/letter in this format, it will allow the Japanese to grasp the essential points by scanning the Japanese version and then reviewing the English, if required, in more detail. As a result, you can get a quicker response from Japan.

Q6. Japanese uses Kanji, Hiragana and Katakana. Which characters does EZ JapaneseWriter® use?

A6. All of the three different characters are properly mixed.

Q7. I understand that Japanese uses thousands of Kanji. How can a computer handle Kanji?

A7. EZ JapaneseWriter® software includes Japanese font files or KanjiBoard™ in which the Kanji fonts are stored.

Q8. How about terminology and names?

A8. In addition to 60,000 vocabularies in the system dictionary, you can add up to 30,000 words into the User Dictionary. You can create as many User Dictionaries as you want and choose one for translation.

Q9. Can I import the files made by a word-processing software?

A9. Yes. You can load any ASCII text file into the English window. Similarly, the translated Japanese sentences are saved on Japanese industry standard text files which are compatible with most Japanese softwares.

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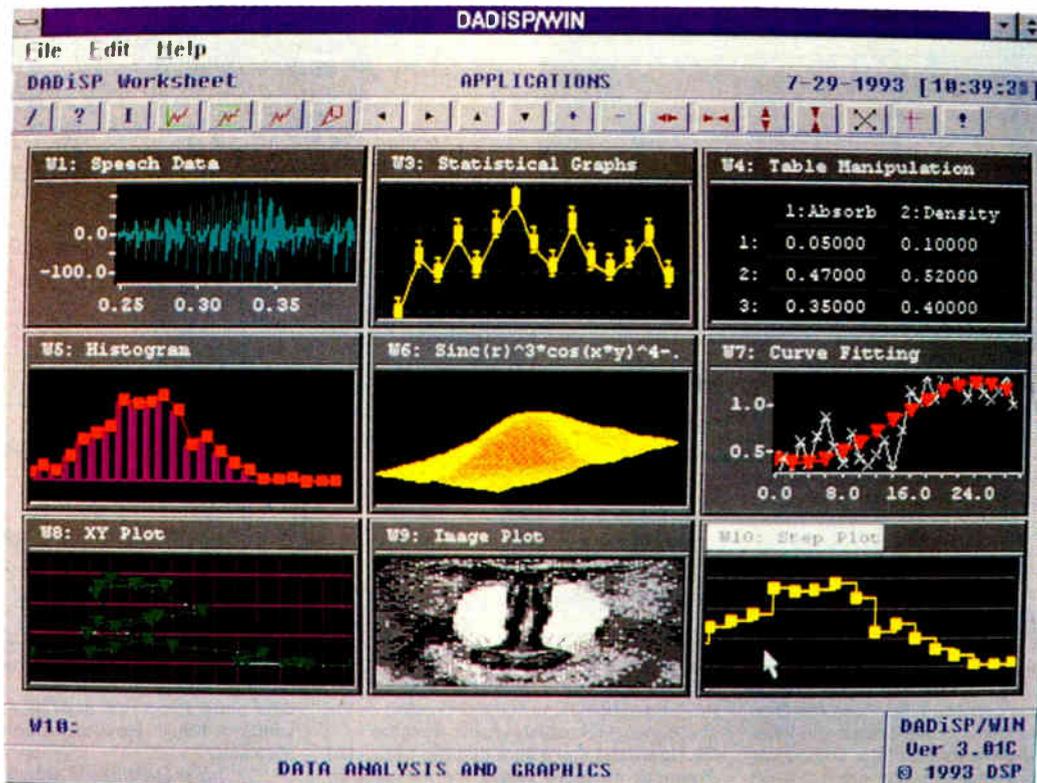
KanjiBoard version DOS 3.3 or higher, 640K RAM, 3MB Hard disk, one AT Bus expansion slot

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BASIC Windows Programming

CA-Realizer 2.0 and Visual Basic 3.0 make it easy to build interactive Windows applications

MICHAEL C. WIGGINS

What's the fastest way to write a professional-looking Windows application without driving yourself crazy? How about BASIC? Specifically, how about Computer Associates' CA-Realizer 2.0 or Microsoft's Visual Basic 3.0?

Both programming systems have been updated and vastly improved, especially VB. Realizer and VB have much in common, such as complete access to the Windows API and to external DLLs, an integrated database engine, and DDE links to share data with other Windows applications. Best of all, if you know even a little BASIC, they'll give you the means to create professional-looking, interactive Windows programs in no time—without learning C or the SDK (Software Development Kit), and without headaches.

Two to Savor

Realizer 2.0 offers a complete set of multiplatform development tools. It comes with a visual report generator, the ability to import and export Xbase (.DBF) files, access to ODBC (Open Database Connectivity) drivers, and OLE 1.0 support. It ships in Windows and OS/2 versions. I tested the Windows version.

VB comes in Standard and Professional Editions. Both ship with the Access 1.1 database engine, OLE 2.0 support, and Setup Wizard, an application for making distribution disks. I reviewed the Professional Edition, which has custom controls, a visual report generator, and full ODBC support, with drivers for Microsoft SQL Server, Sybase SQL Server, and Oracle.

At the heart of each system is a screen designer that helps you build interactive GUIs quickly. You select control objects from a toolbox and place them wherever you want on the screen. (If you need to, you can build custom control objects; in VB, you have to write custom controls in C.) Once you've painted your screens, you simply add a few BASIC statements to do the real work, and your program is ready.

Realizer and VB differ in one big way: programming approach. VB relies on an event-driven programming model. Each

control element—a button, for example—has code attached to it. When you click on a button, the attached code runs. Realizer, however, lets you write out your application's core as a procedural program, complete with subprograms and functions. Clicking on a Realizer control object queues up the event. Your program sees the queued event and dispatches a handler through SWITCH or CASE statements.

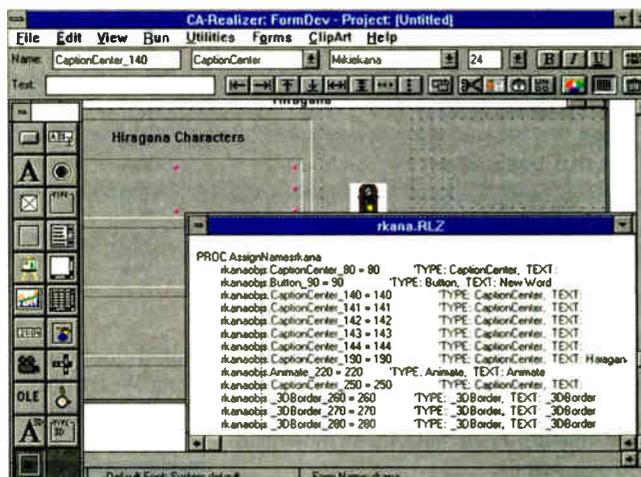
Konnichiwa

I used Realizer and VB to develop a Japanese-language vocabulary aid called Kana Workbook. Kana Workbook is a flash card-style program that displays one English word or phrase and five words in hiragana, one of which matches the English word. The goal is to pick the right match; for example, you'd match *konnichiwa* with *good afternoon*. I created my own hiragana character set, converted it to a Type 1 PostScript font, and installed it into Adobe Type Manager. I designed Kana Workbook so that any answer will change the background color and cause an animated sequence to run.

Kana Workbook makes good use of animation, event trapping, menu creation, the MDI (Multiple Document Interface), and object controls. I stored the vocabulary words in each programming environment's native database format.

CA-Realizer 2.0

The first step in building a Realizer application is to create your screen, known as a *form* in Realizer parlance. FormDev is Realizer's visual design tool, and it's easy to use. For example, to paint the display screen, you select control objects from the Object Palette and position



CA-Realizer 2.0's application screen and the underlying code generated by FormDev. This code is called from the main project program to display the screen at run time. The form code is a procedure function written in Realizer BASIC.

them. For a more professional appearance, you can use an optional grid to snap the objects into alignment.

Your form can be anything from the main application window, a dialog box, or an About box. You can move or resize items until you get the desired effect.

Kana Workbook uses the Label object for both English and Japanese vocabulary words. Each label is surrounded by a 3-D border, creating a chiseled look. A New Word button moves you to the next word in the lesson. To animate objects, you supply a series of bit maps as .BMP files and set their frame-per-second rate. The `AnimateFrame` command starts the action.

FormDev provides the usual assortment of control objects for most applications. Its toolbar gives you a quick way to change an object's characteristics—an improvement on version 1.0's endless barrage of dialog boxes. Computer Associates has also added a bunch of new objects to Realizer 2.0, most notably scroll bars and a graphics tablet region that can display lines and circles. Also new is the ability to add custom controls to the Object Palette, multilevel menus, and database forms.

Once you've drawn a form, FormDev generates a Realizer BASIC file. You have the option of generating code for the form, for your entire project, or for a stand-alone program. Computer Associates claims that

CA-REALIZER 2.0 VERSUS VISUAL BASIC 3.0

	CA-Realizer 2.0	Visual Basic 3.0	
		Standard	Professional
Database engine support	Xbase, text, Lotus 1-2-3, Excel, CA-SuperCalc	Access 1.1, dBase, FoxPro, Paradox, Btrieve	Access 1.1, dBase, FoxPro, Paradox, Btrieve
ODBC?	Yes	No	Yes
Server drivers provided	None	N/A	Microsoft SQL Server, Sybase SQL Server, Oracle
Report generator	CA-RET	None	Crystal Reports
Direct database access?	Yes	N/A	Yes
OLE?	1.0	2.0	2.0
API, DLL, DDE support?	Yes	Yes	Yes
MDI?	Yes	Yes	Yes
Communications (serial)?	Yes	No	Yes
Develops OS/2 applications?	Yes	No	No
Custom controls?	Yes	Yes	Yes

N/A = not applicable.

Realizer BASIC has better compatibility with Microsoft QuickBasic than VB does. I don't know if that's true or not, but I do know that it's a rich dialect with more than 350 commands.

Realizer's built-in debugger lets you step through your program, add watch expressions, and view data structures. I wish it were easier to set breakpoints, and when single-stepping, I'd like to see source lines on both sides of the current line. Otherwise, the debugger worked well and is a vast improvement over the debugger supplied with Realizer 1.0.

Realizer's visual report generator, CA-RET, is as easy to use as FormDev. It gives you the tools to create sophisticated reports from dBase files, entirely on-screen, without writing any code. Its Report Definition holds all the essential elements to produce a report, such as telling CA-RET how to access database tables and where to place the fields in the report.

You define your query with Realizer's Query Builder. After declaring the database table, you select the fields and any necessary conditions. Query Builder automatically generates the necessary SQL statements to retrieve the data. You can create a report query that uses information from multiple database tables.

After defining the query, you use the report editor to design your layout. Besides a do-it-yourself, freestyle layout, you can choose one of the report editor's standard layouts: tabular, form, or label. Reports are divided into header-/body-/footer-type sections, making layouts easier to define.

CA-RET is chock full of functions for everything from doing simple math to printing the current date. Altogether, it

took a good evening's work to get my Kana Workbook application up and running. I consider that a success.

Visual Basic 3.0

Inspired by my success with Realizer, I rewrote Kana Workbook using VB 3.0. The process was virtually the same as with Realizer: Design the screens, place the objects, set their attributes, and write the underlying code to do the fancy things.

VB presents four independent windows: the main menu/toolbar, the Toolbox, the Project, and a blank form/grid. These disjointed windows can be confusing at first, especially if the Program Manager is running underneath or if you have busy wallpaper, but the tools work together smoothly. At times, I found it useful to maximize the form window, but that obscures the Toolbox and menus. A function key brings up the main menu from which you can retrieve the other tools. It would be helpful if future versions of VB tied these windows closely or provided hot keys to switch between them.

Kana Workbook uses VB's MDI capability to display multiple lesson plans simultaneously. New MDIForm, from the File menu, creates a parent form, but parent forms accept only picture box objects for creating the tool or status

bars—I wanted a Common Dialog object on the parent form. So I created a toolbar out of a picture box, made it zero length (i.e., invisible), and placed the Common Dialog object on it. Kludgy, but it worked. To create a child window, just open a new form and set its MDIChild property.

Earlier versions of VB saved programs, forms, and projects as binary files, readable by VB only. VB 3.0 provides a default that you can set to text. It's convenient to edit your files outside of BASIC or to generate forms programmatically.

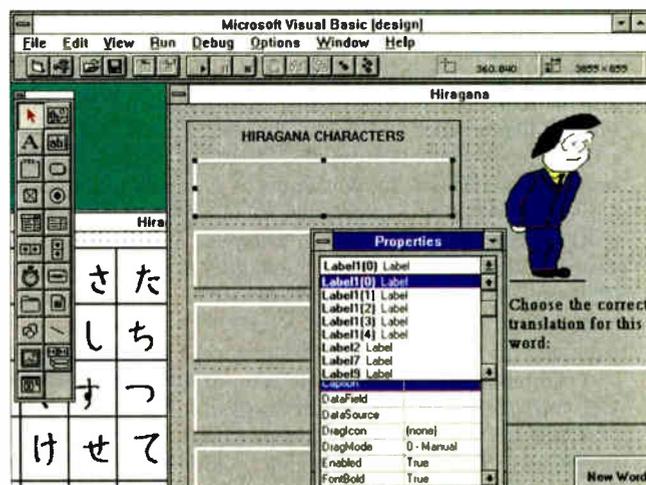
Database Access

VB's hottest new feature is the Access 1.1 database engine. Access gives you native support for such popular database formats as Btrieve, dBase, and FoxPro. The Professional edition adds full ODBC support for client/server applications, which gives you unprecedented control over enterprise-wide data.

Access is a good addition to VB. If it worked completely, it would be a great addition. For example, it's supposed to support Paradox files. But after trying the suggestions in the manual and tinkering with every setup file I could find, my attempts to use Paradox files only got me "Cannot find installable ISAM" messages.

My Kana Workbook didn't take full advantage of Access, but I was able to write a program to display and move through an Access database that I generated for another project. From within VB, you can use a Data Manager tool to handle database tables and fields.

Writing a database front end is easier with VB 3.0 than with earlier versions. Its



The development of the hiragana screen using Visual Basic 3.0. The five label objects, used to display the Japanese words, are set up in a control array for easier program handling. VB will ask if you want an array when you copy and paste multiple objects or give two similar objects the same name.

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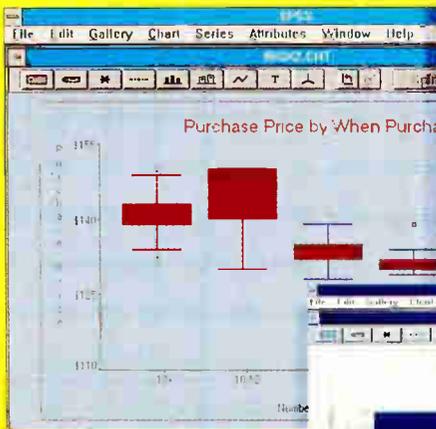
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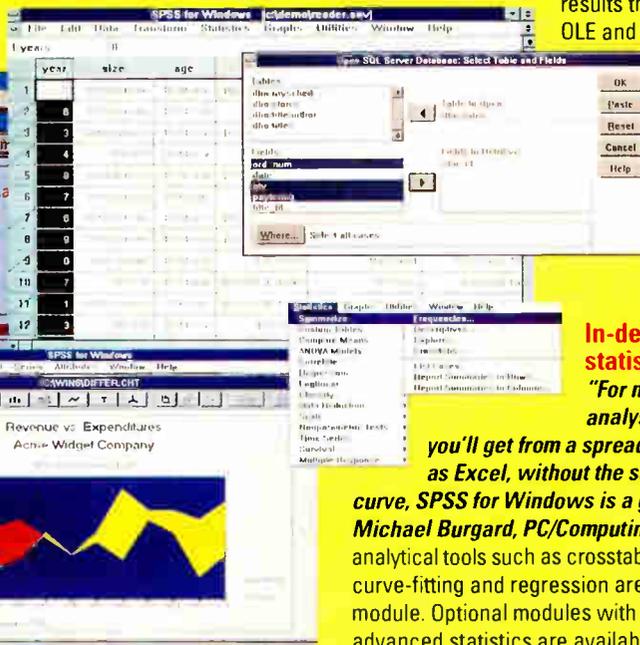
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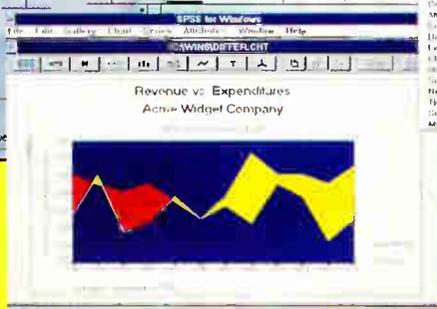
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Reviews BASIC Windows Programming

new data-aware controls can be drawn on the screen and used programmatically from within the code. This means you can link controls directly to the database query by setting properties. Most of VB's standard form objects are now data-aware.

OLE 2.0 automation is yet another avenue for data sharing among Windows applications. Incorporating OLE support in your program is no different from using any other toolbox object: You click and place the OLE object on the form and then set up the link with the properties window.

VB comes with the Crystal Reports 2.0 report generator, which uses Access to produce professional-looking reports. Similar to CA-RET, Crystal Reports lets you use a visual design environment to create the report layout.

VB's most intriguing new feature is Setup Wizard, an application delivery system

for creating distribution disks. Rather than manually copying all the font and DLL files onto a floppy disk for distribution, I ran Setup Wizard and generated an installation disk with all the DLLs and supporting files.

However, Setup Wizard may take a bit of tweaking to work. It bashed heads with SHARE.EXE when I tried to compress some DLL files. Rebooting my system without SHARE.EXE got Setup Wizard to work correctly.

C You Later

Realizer 2.0 is a significant improvement over version 1.0. For example, FormDev has more capable layout functions, and the debugger is much better. These enhancements, the new report generator, and its database functions make Realizer 2.0 a capable challenger of VB.

If I could fix just a few things, I'd add a Delete key to FormDev's editor, simple

graphics such as lines and circles to the Object Palette, and OLE 2.0 support. I'd also like to see more details in the help files. Mind you, I'm not complaining—Realizer 2.0 should make any Windows programmer take another look at BASIC and reconsider working in C.

VB 3.0 is a real improvement over version 2.0—and if you're using VB 1.0, the 3.0 upgrade is mandatory, in my opinion. If nothing else, the Access engine is worth the price of admission. My VB wish list includes fixing Setup Wizard, adding hot-key access to the editing windows, and cleaning up those loose threads in Access.

If you're under the gun to get a Windows application out right away and don't know how, try Visual Basic 3.0. It offers more control and greater flexibility for databases and client/server architectures than does CA-Realizer 2.0. ■

Michael C. Wiggins, a founder of MultiMate International, owns a programming consultancy in South Windsor, Connecticut. He's been programming PC applications for more than 12 years. You can contact him on BIX c/o "editors" or on the Internet at editors@bix.com.

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DOS Dilemma: Word or WordPerfect?

High-end word processors bypass Windows in the quest for the perfect balance of powerful features and ease of use

SELINDA CHIQUOINE

WordPerfect 6.0 and Microsoft Word 6.0, both for DOS, are powerful, full-

featured word processors with similar command sets and interfaces. Windows may be all the rage for PC applications, but if generating good-looking documents is your primary concern and you can live without multitasking, it will pay to buck the trend with one of these packages. A foundation in DOS means you can use these applications on systems with fewer resources and get much better performance than you can reasonably expect running through Windows' graphical interface.

These aren't toy packages, and they don't represent a step backward to mandatory keyboard templates or Byzantine command sets. Besides the familiar keystroke sequences and command lines that longtime users will find natural, each presents a Windows-type editing interface that new users may adapt to quickly. Both packages are quite similar in form and function, although WordPerfect is packed with more features (e.g., fax and sound support), and Word offers a simpler interface.

Resource Requirements

Both word processors run in either text or graphics mode. Text mode is, of course, more responsive when writing or editing flat-out. Both packages easily kept up with my typing in text mode, but Word's graphics mode is more responsive than WordPerfect's. However, WordPerfect's graphics mode is WYSIWYG, except it doesn't display headers, footnotes, or page numbers; you have to switch to a page mode to view those details. Word's graphics mode is less complete: It only displays file information for embedded graphics. You have to switch to the print preview mode to see images, line graphics, or WYSIWYG fonts.

Graphics gobbles memory, and

WordPerfect's graphics mode ▶ displays 24-bit WYSIWYG graphics and is capable of irregular text wrap and drag-and-drop image manipulation.

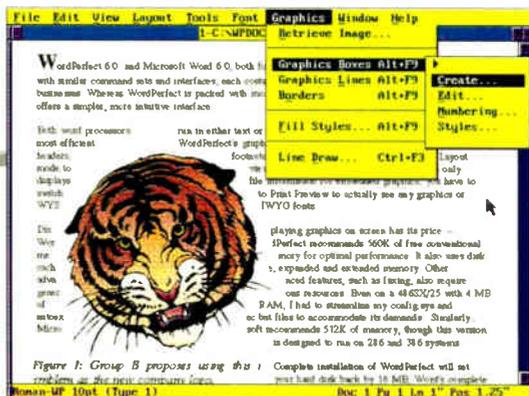
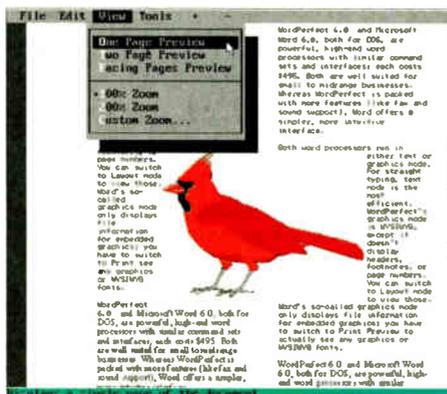


Figure 1: Group B proposes using this... Complete installation of WordPerfect will set...

because WordPerfect has greater graphics capability than Word, it has more stringent requirements. WordPerfect recommends 520 KB of free conventional memory for optimal performance. Microsoft recommends 512 KB for Word. However, you can get each to work with considerably less if you need to run them on an IBM AT-class machine.

Complete installation of WordPerfect takes 16 MB of hard disk space; Word's complete installation fills 5.5 MB. You can trim those numbers down as far as 7 and 1.5 MB, respectively, again by sacrificing some utilities.

WordPerfect is filled with features that require more resources. It can use expanded and extended memory, but on my 4-MB 25-MHz 486DX (networked and running DOS 6.0), I still had to stream-

line my configuration to satisfy its demands for conventional memory. Even after loading every driver high that could be loaded high, I still had to swap out the sound-card driver and fax-board driver, depending on which device I was planning to use for each session.

Interface Issues

By adding pull-down menus in version 6.0, WordPerfect lessened the grade of its learning curve immensely. In previous versions, I had to reference the Help menu two times just to accomplish a single command that might require three or more keystrokes. WordPerfect gurus who mastered version 5.1 will be happy to find that version 6.0 supports the same keyboard command sequences and lets you hide those pesky pull-down menus. Microsoft, ahead in the GUI field, already offered pull-down menus in Word 5.5.

Now, the new versions of Word and WordPerfect have customizable menu bars and drag-and-drop editing. You can turn on or off status bars, style ribbons, and horizontal and vertical scroll bars. Both packages allow you to split the screen in various dimensions, with nine windows open at a time. Each has a screen setup utility letting you control the timing of automatic saves. The basic data-entry and editing

Best New Features in Versions 6.0

Microsoft Word 6.0 for DOS

- One-step table creation
- Drag-and-drop text editing
- TrueType fonts
- Automatic numbering or bulleting of text
- Style ribbon for quick formatting changes
- Grammatik grammar checker
- Help menu for WordPerfect users

WordPerfect 6.0 for DOS

- Fax and sound support
- TrueType, Bitstream, Type 1, and Intellifont font support
- WYSIWYG graphics and page modes
- Document compare
- Grammatik grammar checker
- Spreadsheet capability in tables
- Drag-and-drop graphics

Reviews DOS Dilemma: Word or WordPerfect?

WORD 6.0 VS. WORDPERFECT 6.0

WordPerfect offers more high-end features, but Word is somewhat simpler.

	MICROSOFT WORD 6.0 FOR DOS	WORDPERFECT 6.0 FOR DOS
Memory (recommended RAM)	512 KB	520 KB
Storage (max./min. installation)	5.5 MB/1.5 MB	16 MB/7 MB
Typefaces	11	13
Font formats	TrueType, Word	TrueType, Bitstream Speedo, Agfa Intellifont, Adobe Type I
Number of printers supported	About 300	About 900
Label/envelope support	Mail merge, macro support	Mail merge, automatic address insertion, bar-code support, and label printer support
Fax support	No	Yes
Import formats	Word 4.0 and higher, Word for Windows, DCA/RFT, RTF	Fax, Lotus 1-2-3, Word, WordPerfect (all previous versions), DisplayWrite, MultiMate, DIF, WordStar
Export formats	Word 4.0 and higher, Word for Windows, DCA/RFT	Fax, Word, WordPerfect (all previous versions), DisplayWrite, MultiMate, RTF, DIF, WordStar
Graphics file support	HPGL, EPS, PIC, PCX, TIFF	BMP, CGM, DXF, EPS, HPGL, PIC, PICT, PCX, TGA, TIFF, WMF, WPG, WPG 2.0
Close and save all files	Yes	No, but it can exit and "mark all"
Merge files	Uses main document and data files, conditional fields	Form file template, data files for merging, includes 81 merge programming commands
Password security	Document level	Document and macro levels, file encryption
E-mail links	No	WordPerfect Office, MS-Mail, cc:Mail, MCI Mail
Import from Windows Clipboard	Text and bit maps	No
Indexing/TOC generation	From outline or tagged text	Concordance file or tagged text
Leaders	Dots, hyphens, underscores	Any symbol
Mark revisions	Insertions, deletions, replaced and moved text	Marks deltas
Tables	One-step formatting, but WYSIWYG only in Print Preview	WYSIWYG table editing, 98 math functions, can link cells to text
Drag-and-drop editing	Text only	Text and graphics
Bookmark	Cross-referencing and automatic numbering	QuickMark and named bookmarks
Graphics tools	Screen-capture utility	Rotate, crop, control contrast and brightness, distort, and flip

menus for both packages conform to CUA (Common User Access).

Word and WordPerfect have improved automatic table of contents and index generation, as well as new bookmark and outline features. In Word, outlines are integrated as structural views of text documents that you can expand and collapse; you can toggle back and forth between the document or the outline view. In WordPerfect, outlines are also collapsible, and you can convert them to text, but the integration is not as complete as Word's.

Although I've used WordPerfect for years, I still don't like its file management system. It's powerful, but as is common in WordPerfect, simple operations require twice the keystrokes they should. You can develop elaborate document summaries for file queries or devise your own "Quick-

Index" cataloging scheme. If you're working with numerous versions of files, you can compare documents by words, phrases, sentences, or paragraphs, and mark all the revisions. The Master Document feature expands and collapses linked sections of long documents at your command.

Word's file management is refreshingly simple. Its document summary information doesn't offer all the hooks of WordPerfect's, but you don't need intensive training to master it.

Fonts and Printing

DOS word processors don't share fonts with other applications as do Windows applications, so the fonts each supplies is an important consideration. However, both Word and WordPerfect support scalable (and shareable) TrueType fonts.

As with the font selection, printer support is a critical issue for DOS applications, since you can't share printer drivers as you can under Windows or on the Mac. Both Word and WordPerfect support color and network printing. From both packages' print menus, you can also select resolution and any printer drivers you've installed. Word supports approximately 300 printers, and WordPerfect supports around 900.

The main difference in print capability is WordPerfect's faxing module; WordPerfect can print directly to any FaxBIOS, Type I, Type II, or CAS-compliant (Communications Applications Specification) fax card. Many fax boards qualify; I had an Intel Satisfaxtion Modem/200 that fit the bill. As long as you feed your system the recommended 520 KB of free conventional RAM, faxing works like a charm. When I tried to fax a graphics file with less, WordPerfect hung up the system.

Tables and Spreadsheets

WordPerfect excels at tables. Its graphics mode makes creating tables a quick drag-and-drop affair. Contrast that with Word, where you need to imagine how cell borders will look, since dotted grid lines appear where real borders should be. In Word, you must manipulate cells by changing coordinates rather than directly with a mouse.

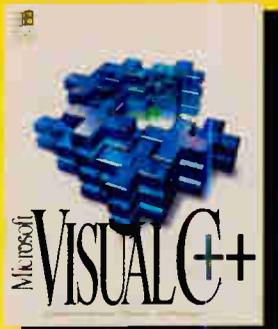
WordPerfect tables handle many spreadsheet functions including cell formatting, naming and linking ranges, and calculations on ranges. The Floating Cell feature lets you link a section or value of a table to any other area in your document. For instance, you could reference a sales figure in your text and rather than type in a static number, insert its cell address. Your document would always reflect an updatable value. You could use the same technique to embed a larger portion of a table.

Word includes math functions, even though you have to select text that includes an operator and then go to a pull-down menu to activate the command. Alternatively, you could write a macro to perform the math. WordPerfect has similar math features. In addition to the basic math commands also supported by Word, WordPerfect's math command calculates sub-totals, grand totals, and averages across rows or columns.

Graphics

In these versions, WordPerfect's support for graphics is a league beyond Microsoft's. But you pay for this luxury with a resource load that slows performance considerably. WordPerfect has various graphics editing

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Circle 126 on Inquiry Card.

World Radio History

Reviews **DOS Dilemma: Word or WordPerfect?**

tools like cropping, flipping, sizing, and adjusting brightness and aspect ratio. You can also drag and drop your graphics and view them in up to 16 million colors (assuming you have a 24-bit graphics card). Word supports only 16 colors.

WordPerfect allows you to zoom in on text while editing in graphics or page mode. In Word, zooming is only possible in print preview mode. The two packages support word wrap. With Word, however, you can wrap text around rectangles only, not around irregularly shaped pictures as with WordPerfect. Both applications will print over graphics, even though WordPerfect has a Watermark dialog box specifically for printing over shaded graphics. For simple graphics work, WordPerfect supplies most of the tools you need. In contrast, with Word, you need to handle image manipulation before importing.

Frills

No word processor would be complete without a spelling checker; both packages offer one. Amazingly, WordPerfect's spelling checker is simpler than Word's. Word and WordPerfect also sport a decent thesaurus and bundle the sometimes helpful Grammatik grammar checker.

WordPerfect includes some impressive—although exclusive—frills. Hypertext lets you link parts of your document to one another or to a macro. Once you create a link, you click on a highlighted section in your document to activate the link. The cursor then jumps to the linked text or executes a macro. Word lets you link tables to external spreadsheets, and it lets you import live sections of other Word documents, but it does not support executable hypertext. If you're planning to capitalize on hy-

per-text, remember whoever's receiving your files must also have WordPerfect to use the links.

WordPerfect can embed and play MIDI or WAV sound clips in your documents. Although this is an interesting feature, as with hypertext, you benefit from it only if your target audience has WordPerfect 6.0 or 5.2 for Windows and the same sound drivers you do.

Brand Loyalty

How do you choose between these two? Unless you need WYSIWYG graphics (in which case, you should choose WordPerfect), familiarity has to come first. But if you can make an unencumbered choice, you should choose on the basis of features versus resources and complexity. WordPerfect delivers more features for the money. But if your hardware is modest, you might be happier with Word's more intuitive command set and simpler interface. ■

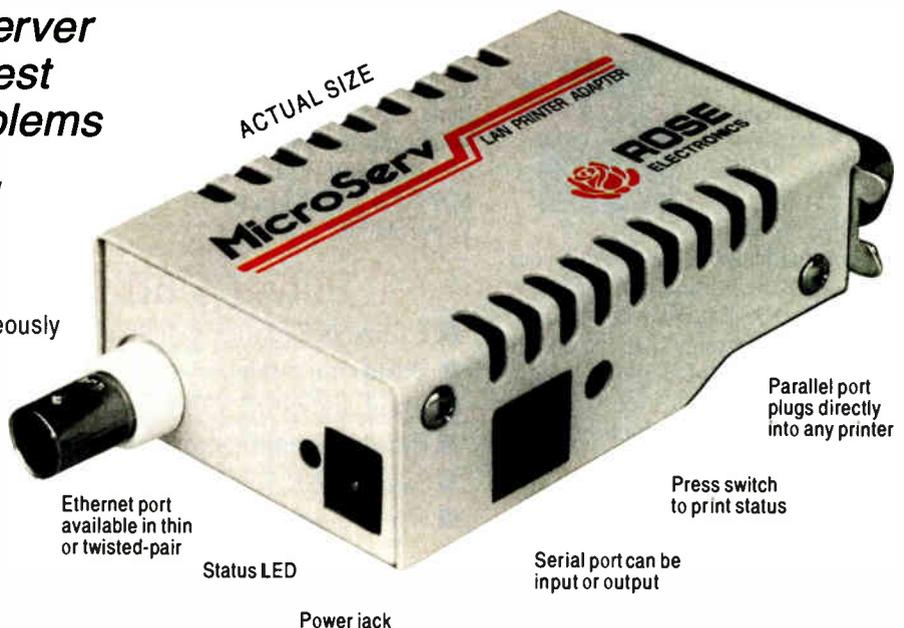
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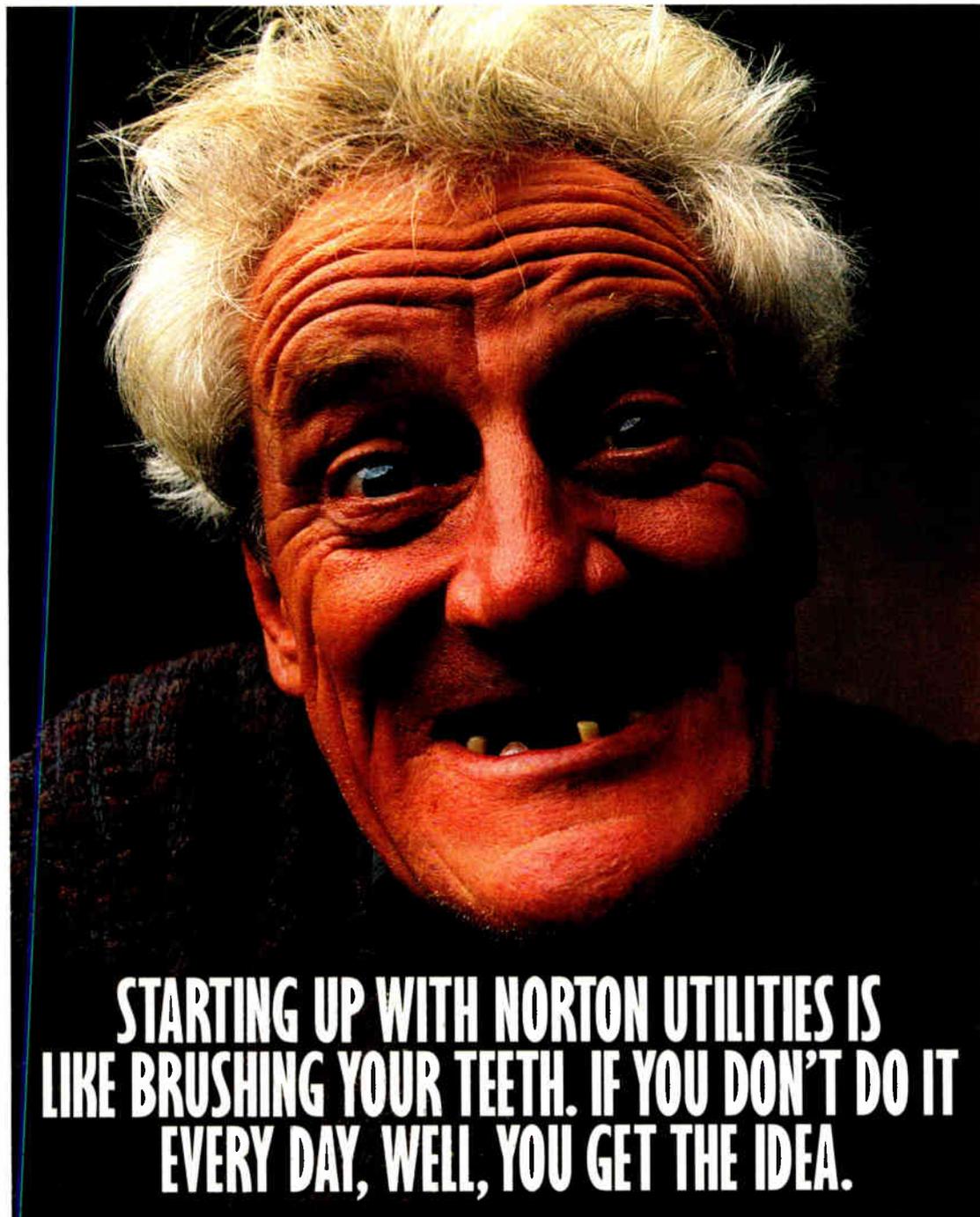


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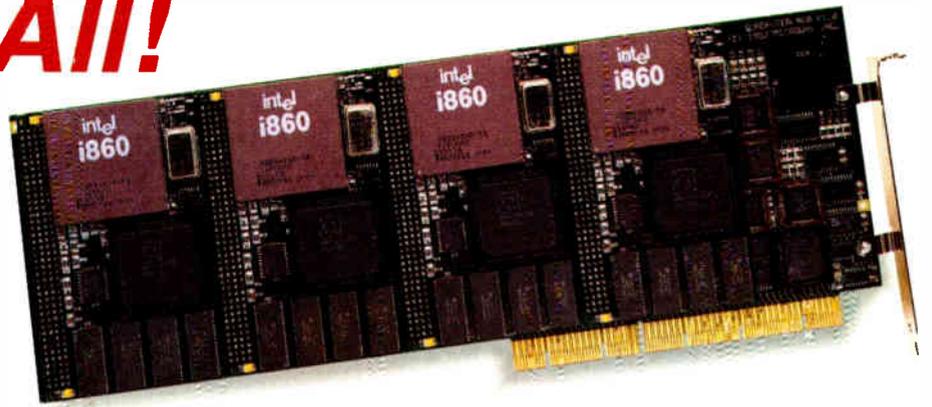
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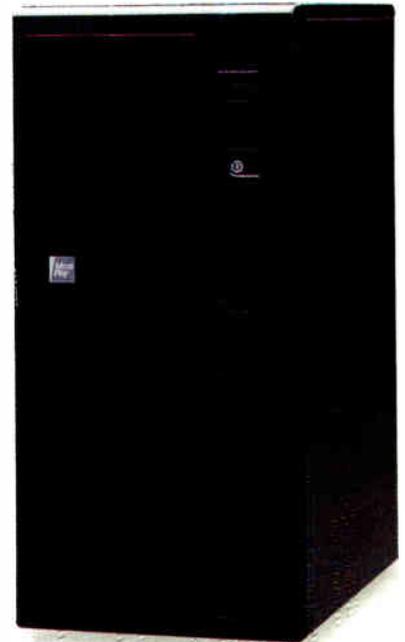
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Integra VDB

You can use Coromandel's Visual Database Builder with C++ or Visual Basic to write programs that work with any ODBC data source

JON UDELL

Not to brag, but I can build the C++ and Visual Basic applications you see on this page from scratch in 5 minutes. They're not too fancy, but they're not trivial, either. Each uses a master query bound to a combo box (for author names) to trigger a detail query bound to a two-table join (for article information). The data can come from any ODBC (Open Database Connectivity) source. I've run these programs with identical results against FoxPro, dBase, and Access files and against two servers—SQL Server and Coromandel's Integra.

The secret to this rapid development of flexible applications is Coromandel's Integra Visual Database Builder, or VDB, a set of tools for creating database-oriented Windows applications with Visual C++ and Visual Basic. Each kit includes Integra, a single-user SQL engine that natively supports ODBC. Integra's ODBC driver is the most advanced that I've seen yet, offering level 1 API conformance and extended SQL grammar. You also get a data management tool, a query builder, a set of Visual Basic custom controls for interactive database development, and a library whose functions marry the data controls to the ODBC interface.

You can do quite a lot with the custom controls alone. I built my test programs exclusively in what Coromandel calls *automatic mode*. That means you simply drop data-aware controls onto a form and edit their properties in order to bind them to data.

Like Visual Basic 3.0, Integra VDB provides simple data-aware controls, like checkboxes and text boxes, that can bind to individual database fields. Unlike VB 3.0, it also gives you data-aware versions of the controls that are most crucial for working with columns and entire tables of

data—the listbox, the combo box, and the all-important grid. Another control performs operations on a SQL cursor, including fetch (next, previous, first, or last), insert, delete, update, and query by form. Still other controls name data sources, define queries, and bind result sets to user-interface controls.

For more advanced work, you can code

directly to the Integra API using either C++ or Visual Basic. The boundary between VBX (Visual Basic custom controls) property-editing and coding is fluid, though, and the ability to combine both styles in a single application makes Integra VDB extremely potent. Coromandel's showpiece sample application, for example, features a master-detail view that is

This Integra VDB C++ application required just four lines of C++ glue code. Everything else—writing queries, binding queries to data-aware controls, linking the master and detail cursors—was accomplished by editing properties of Visual Basic custom controls.

You build the Visual Basic version of the application the same way you build the C++ version—by editing VBX properties. For advanced work, the Integra VDB API is as accessible from Visual Basic as it is from C++.

Integra VDB form, query, and data-source controls on the VB toolbar

Integra VDB data-aware interface controls on the VB toolbar

An instance of a query control

Editing the SQL statement property of a query control

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56	304020	93-08	Hands On
57	305039	93-09	Opinions
58	307004	93-09	Features
59	307010	93-10	Opinions
60	307012	93-11	Hands On
61	301042	93-13	News

article	issue	dept	title
51	217027	93-04	Hands On
52	303000	93-06	Features
53	304012	93-08	Reviews
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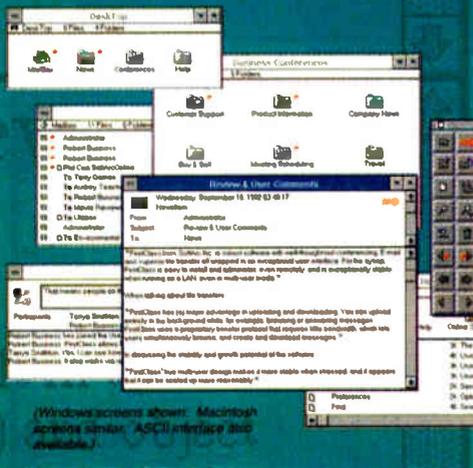
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Reviews **Integra VDB**

You write just four lines of C++ code for a simple Integra VDB application like the one shown on page 151. In this example, the OnFileNew handler generated by ClassWizard starts the database application by passing the ID of a database dialog box to Coromandel's SqcStartApp() API function. Lines in black were generated by ClassWizard; lines in red were added.

```
#include "sqcform.h" // Include the Integra VDB API definitions.

void CByteView::OnFileNew() // Handler for the File New menu
// selection.
{
    static UINT dlgid[] = {IDD_DIALOG1,0}; // Declare array of database
// forms.
    SqcStartApp(this,dlgid,1); // Activate the database forms.
}

void CByteView::OnFileSave() // Handler for the File Save menu.
{
    SqcEndApp(); // Deactivate the database forms.
}
```

completely dynamic. The user can pick which table to bind to a master listbox and which to bind to a detail grid. This multi-purpose form efficiently displays a half-dozen different data relationships.

You can't achieve such effects just by twiddling the properties of data-aware controls. Lines of C++ or Visual Basic code have to be written to prepare and execute queries, bind their results to controls, and dynamically connect master and detail tables. But those lines of code are relatively few, and they integrate smoothly into an application that is otherwise mostly codeless.

VDB for the Visual C++ Programmer

Coromandel's C++ implementation relies on Microsoft Visual C++'s ability to support VBXs. You begin an Integra VDB project by checking AppWizard's VBX option, so the new program skeleton it writes will contain the function call that initializes VBX support, as well as declarations for VBX event notification codes. Then you add the VBX itself to the project, along with Coromandel's supporting library and a simple application framework that knows how to load and activate the forms you create.

Now the scene shifts to AppStudio, where most of the "programming" can take place. In version 1.0 of VDB, you had to create form, data-source, and query controls, and then manually synchronize various properties of these controls. Version 1.1, which I received while working on this review, adds a form builder that simplifies things even more. Now, when you create a new dialog box and drop a VDB form control onto it, the form builder automatically pulls in supporting data-source,

data, and query controls.

You can define the SQL property of a query control using an interactive query builder or (if, like me, you find that tool to be less than intuitive) by just writing the SQL code yourself. The form builder asks which data control you'll use for each query and binds the control to the query. For a master-detail view, it helps you define a trigger that connects the detail cursor to the master. These triggers are a powerful feature of Integra VDB. They can cascade and can synchronize cursors both within and across forms. Complex multi-form applications are beyond the scope of the form builder, however. You create these by manually editing form and query properties that define bindings, SQL statements, and queries.

Next, you launch ClassWizard from within AppStudio to wire in the Integra VDB function calls that activate and deactivate your database forms. Coromandel's application framework reduces this to a trivial exercise for applications (like mine) that don't handle VBX events (see the listing). Real applications, of course, must respond not only to application events like File New but also to database events like insert, update, and delete. But the model is the same. You tell ClassWizard which events you want to handle; it generates handler skeletons; you flesh them out.

Finally, you build and run your C++ application and then, of course, immediately begin to tweak it. If you haven't worked with VBXs in C++ before, you may be shocked to discover how quickly you can modify and test your application. All the properties of the database custom controls live in the application's resource file. When

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Reviews Integra VDB

you add forms, modify SQL queries, re-write triggers, switch data controls, and tinker with database operations, you can test your changes almost immediately. If you haven't touched any event handlers, the compiler sits idle and a rebuild boils down to the few seconds AppStudio takes to update the resource file and bind it to an otherwise unmodified program.

The Visual Basic Option

I also tested the Visual Basic version of Integra VDB 1.1, using Visual Basic 3.0. Having used the C++ version, I already knew how to proceed: Add the VBX to a new project, load a file of API declarations, create a new form control, and use the form builder to orchestrate the form's data controls, queries, and triggers. A Visual Basic handler for the form's Load event, installed automatically by Coromandel, makes the API call that activates the database controls on the form.

Queries run as fast in Visual Basic as they do in C++, because the work gets done either by an ODBC driver (in the case of single-tier drivers like those for FoxPro, dBase, and Access) or by a server (in the case of multitier drivers like those for Integra and SQL Server). And while Coromandel says C++ programs that manage lots of database forms can process those forms faster than the Visual Basic equivalents, I found no noticeable difference in speed between the two environments. That's because in both cases the VBX, not your code, does the work. The Visual Basic version also gives you full access to the Integra VDB API, and Coromandel reproduces the dynamic master-detail example to prove that Visual Basic can wield that API as flexibly as C++ can.

Why, then, would you ever want to use C++ to develop Integra VDB applications, or indeed any VBX-intensive application? What you want from C++, presumably, is the ability not just to reuse but also to extend software components. VBXs are reusable but not extensible. While Visual C++ emulates Visual Basic to give you access to a rich selection of useful VBX components, it can't magically transform these into true C++ classes.

What the C++ programmer really needs, Coromandel admits, are database-aware document and view classes. The company is now designing such classes, and until they're available, I'd incline toward the Visual Basic version of Integra VDB. It's a bit simpler to use, and it's almost equally flexible and powerful. Nevertheless, I'm glad the C++ version is available. If

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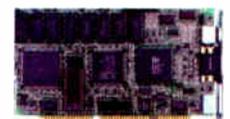
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World Radio History

your project happens to rely on home-grown or commercial C++ class libraries and needs an injection of database support, you'll find Integra VDB to be a welcome ally.

Managing Data

Central to Integra VDB's database model is a scrollable, updatable cursor. ODBC level 2 drivers have the same capability, but currently they're hard to come by. Coromandel's API implements forward- and backward-scrolling cursors on top of the much more common level 1 drivers that I used for this review. Insert and delete operations logically renumber a cursor's record set, but invariant physical record numbers are also available for the life of a cursor. Specialized cursors support SQL-driven import and export operations to and from dBase III, delimited ASCII, or Lotus 1-2-3 files. For high-performance lookup, you can stash data temporarily in a memory cursor.

To create, load, and query databases interactively, you use the Visual Data Manager. It gives a common visual interface to CREATE TABLE and ALTER TABLE

commands for any ODBC data source, supports ad hoc queries (you either type these or invoke the visual query builder to construct them), and performs import/export operations. It's a Swiss Army knife for ODBC data sources, but I found it most useful for creating, altering, and querying databases. As a database loader, its performance lagged behind that of Microsoft Access, and it won't build database schemata automatically, the way Access will. Coromandel acknowledges both problems and says they'll be fixed.

Betting on ODBC

Coromandel has bet the farm on ODBC—wisely, I think. This summer marks the arrival of the first two boatloads of ODBC drivers. One set of drivers comes from Microsoft; the other is from Pioneer Software, whose Q+E Database Library and drivers delivered ODBC-like benefits long before ODBC became a hot topic. (A spokesperson says that Pioneer will soon

offer its own ODBC-aware application toolkit.)

Common data access, long a dream of database developers, is fast becoming a reality. I maintain a hefty FoxPro application that wants to become a client/server application, and making part of that application run against five different data sources was a real thrill.

Integra VDB adds value to raw ODBC in two key areas. The API library layers much-needed abstractions onto ODBC, notably scrollable cursors and triggers, and the visual controls connect users to data quickly and easily. Coromandel is moving fast—the 1.1 release arrived a scant three months after the 1.0 version—and I expect that this already-excellent toolkit will keep improving, as will the ODBC driver foundation on which it rests. ■

About the Product

Integra VDB 1.1
for Visual C++\$499
for Visual Basic\$499
Coromandel Industries, Inc.
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Bounds Checker for Windows

Nu-Mega's Bounds Checker catches Windows programming errors that other tools miss

STEVE APIKI

Bounds Checker for Windows 1.0, in the words of one especially enthusiastic developer I spoke to, is "a gift from the gods." While maybe not worthy of praise usually reserved for discoveries of the significance of fire, Bounds Checker deserves serious consideration by C developers plagued by the mysterious, hard-to-repeat, and almost impossible-to-catch bugs symptomatic of memory violations under Windows.

Bounds Checker is a debugging tool that does what no other Windows debugging tool can do: It tracks down errors like NULL pointer dereferencing, array boundary overruns, memory leaks, and bad parameters passed to Windows API functions. It runs on Windows 3.1 only and requires a 386-class processor.

I ran Bounds Checker against two Windows programs. As this review went to press, Nu-Mega was finishing up version 2.0 of Bounds Checker for Windows; I tested version 1.0 but also worked a little with a beta release of version 2.0. My primary test program was JView, an image-file viewer that I'd written using ObjectWindows Library, or OWL, and Borland C++ almost a year ago and that has been mostly working fine ever since. JView is a 250-KB program built under the medium memory model. As a test using large applications, I also ran a huge, commercial application coded straight to the Windows API; this is a program at the beta-test stage that's just over 4.5 MB, including debugging information, and it's built using the large memory model. Bounds Checker did an outstanding job on JView, finding some real problems that may never have otherwise been caught. It also unraveled lots of hard-to-find errors on the larger executable file but had some problems of its own with an odd-size custom stack used in the program.

What It Can Tell You

Bounds Checker provides a nice Windows user interface, although the guts of the interface require a virtual device driver. You

Bounds Checker for Windows waits in the background as your program runs—when it encounters an error, it pops up a dialog box and freezes execution.

The **Call Stack Arguments** button toggles between showing function arguments as addresses or values.

Call Stack shows a stack trace of calls leading up to the errant routine.

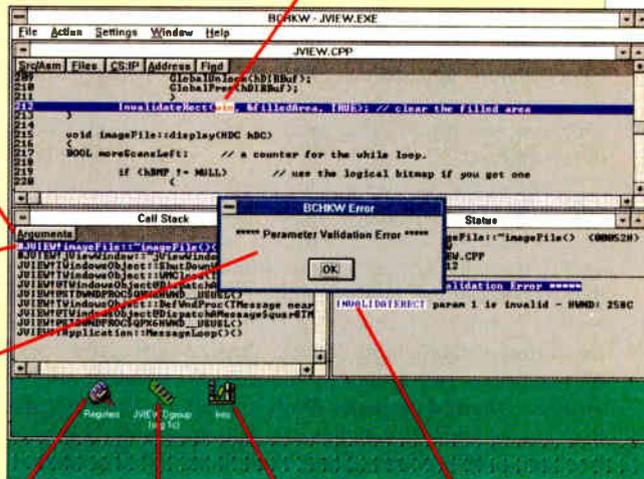
Bounds Checker for Windows pops up on invalid memory accesses, writes to NULL pointers, and several other events. In this case, the error is an invalid parameter passed to a Windows API function.

After your program terminates, Bounds Checker gives you a diagnostic log that lists memory use and memory and resource leaks. The log includes memory that is allocated but not freed by your program and by Windows DLLs on behalf of your program.

On program exit, Bounds Checker shows memory that has been allocated and not freed.

Allocated resources that haven't been freed. On this screen, Borland C++ and OWL load these resources.

The **Code window** shows the source line where the error occurred—you must have symbolic debugging information available.

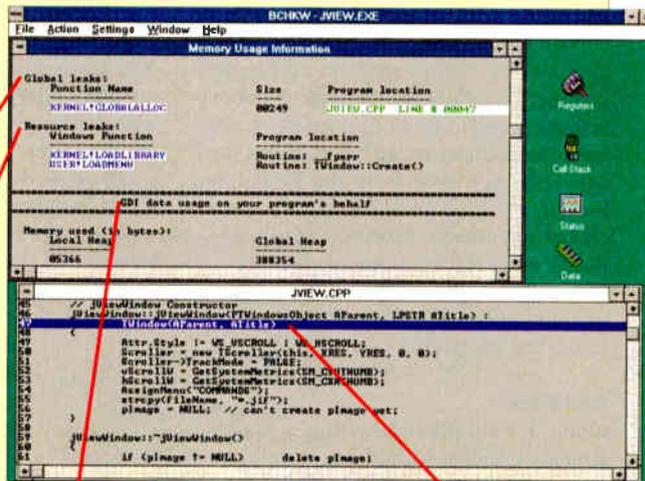


The **Registers** window shows 386 register information.

The **Data window** shows the state of memory when Bounds Checker pops up.

The **Info window** lets you track Windows heap and resource information.

The **Status window** shows a detailed description of the problem: a bad parameter passed to InvalidateRect().



Bounds Checker also reports GDI and USER allocations.

The line of code where the global memory leak occurred.

Reviews **Bounds Checker for Windows**

launch Bounds Checker under Windows and then use it to load the program you want to check. Once your program is loaded, Bounds Checker minimizes itself and waits in the background, monitoring your program's use of memory and other resources. Bounds Checker can also check the activities of DLLs that your program loads.

When the program under test does something wrong—and believe me, if you haven't run it under Bounds Checker already, it will—Bounds Checker pops up an error message, a description of the problem, and the offending code. Once Bounds Checker pops up, you can choose to log the error and continue, to terminate the program, or choose from among a few other options.

Bounds Checker 1.0 validates Windows API calls; in version 2.0, Bounds Checker flags actual API failures, which is more useful. Bounds Checker 1.0 also monitors the first part of the data segment to catch NULL pointer references in small- or medium-model programs. It tracks the size of structures and arrays to ensure that writes to these data items don't exceed their boundaries. It watches attempts to free unallocated pointers, and it monitors allocated memory to check for writes that go beyond allocated limits. Finally, it catches actual processor faults and handles them gracefully.

But Bounds Checker can't pop up on memory leaks. Instead, it monitors memory and resource usage to ensure that all calls to `malloc()` are paired with a call to `free()`, that all `LoadResource()` calls have a corresponding `FreeResource()`, and so on with all memory and resource allocation functions. Since problems in this class can't be found until the test program is done, Bounds Checker pops up a memory usage report on test program termination. The memory usage report shows stack use, memory used from the global and local heaps, global leaks (memory allocated but not freed), resource leaks, and GDI (Graphical Device Interface) and USER memory allocated on behalf of the test program.

Real Work

Once I had played with Bounds Checker to find out what it could do, I was anxious to try it out on a few programs. I first used it to check errors in JView, a relatively simple program; it ran fine.

Because of its simplicity, JView had few problems. Keep in mind, however, that this is a program that has been stable for quite some time without causing noticeable crashes—and it had bugs. It had a few minor resource and memory leaks, but these were mostly in code generated by OWL and the C compiler itself. JView's only serious problem was a parameter violation on a call made with an invalid window handle made from the destructor for one of my classes. Although Nu-Mega understandably touts Bounds Checker's unique ability to track out-of-range references ahead of the rest of its functions, I actually found some serious problems in JView and the large test program through Bounds Checker's Windows API validation. You could find these errors through the Windows debug kernel, but the collection of functions in Bounds Checker and its full-code and status displays makes finding these errors a more natural part of the debugging process.

Bounds Checker adds a lot of overhead, of course, but the slowdown during testing wasn't noticeable for JView. For example, it took about 2.5 seconds to open a dialog box under Bounds Checker versus half a second without Bounds Checker, and this was while using the most stringent checking options; certainly overhead I could live with. The large program was also slower under Bounds Checker (about 9.5 seconds versus 5 seconds to open a file), but eliminating some of the most time-consuming checks (e.g., checking all allocated blocks on every call to an allocation routine) reduced delays a tiny bit.

On the large test program, Bounds Checker caught many bad parameters sent to APIs, more than one attempt to use a NULL window handle, and a raft of memory leaks. Since the test program was built with the large data model, NULL pointer checks weren't as useful as they'd be in a small or medium model, as large-model NULL pointers tend to throw general-protection faults as soon as you touch them anyway.

Bounds Checker 1.0 had a few problems with the large file. It was subject to inexplicable system crashes sometime during each debugging session. After a few rounds of phone calls and after seeing a copy of some of the source code, Nu-Mega traced the problem to a bug in Bounds Checker 1.0. The large program used the Win-

dows `SwitchStackTo()` API to set up its own custom stack; however, it requested a stack size that was somewhat smaller than a full segment. Bounds Checker 1.0 expected, and assumed, that stacks set up in this manner would be a full 64 KB in length; thus, it failed on this program. The problem is exorcised from the latest beta of version 2.0.

The good news is that these were the only problems I had with Bounds Checker. Considering that the large test program was almost pathologically large for a single executable file—about 18 MB of symbol information before CVPACK—and that CodeView itself sometimes failed on this file, I was more than happy with Bounds Checker's stability.

Naturally, Bounds Checker will tell you only about errors in functions that you exercise, so if you have a large and complex program, it's best to use Bounds Checker while running whatever validation script or set of actions you use to test the complete functionality of your program.

Working with Soft-Ice/W 1.3

Even with Bounds Checker's complete reporting, you'll want to run a debugger alongside Bounds Checker to get the most secure handle on errors as they occur. Bounds Checker supports direct coordination with Soft-Ice/W 1.3, Nu-Mega's low-level Windows debugger. Getting the two to work together took some fiddling with configuration files, but it was well worth the effort.

Bounds Checker doesn't offer real debugging services to help you explore the source of errors. You can't single-step, trace, or view variables without looking at a memory dump. Bounds Checker works extremely well in concert with Soft-Ice/W as a "breakpoint generator," popping you directly into Soft-Ice/W whenever memory errors occur. With Soft-Ice/W, you can, of course, set breakpoints, and trace through your Windows code.

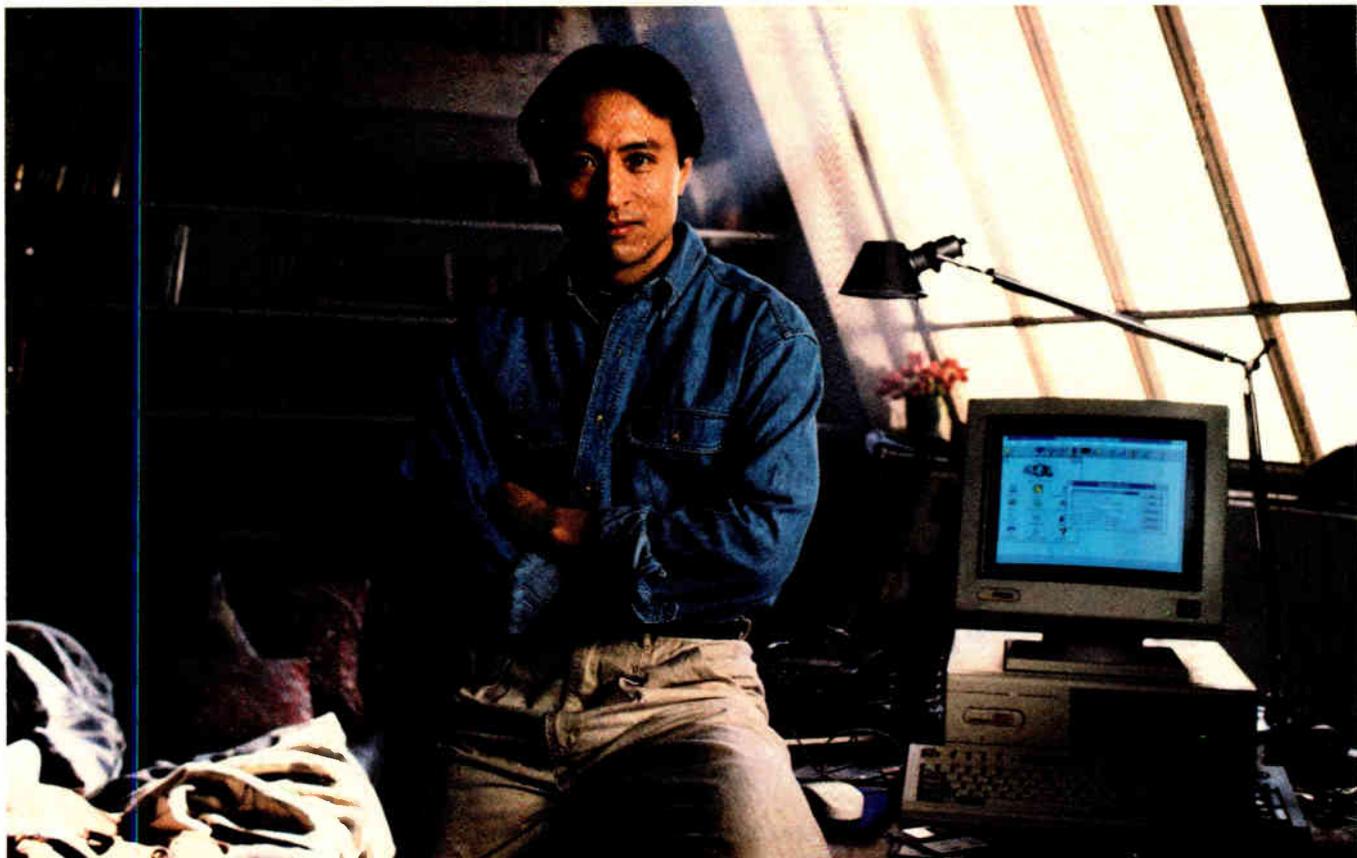
With or without Soft-Ice/W, Bounds Checker is a valuable tool, one that can help you find bugs that will elude even the best debuggers, bugs that could even go unnoticed through a good quality-assurance check. Unless you write perfect C code for Windows on the first try, Bounds Checker is an outstanding investment. ■

Steve Apiki is the director of the BYTE Lab. He has worked as a programmer and engineer and has a B.S.E.E. from Rensselaer Polytechnic Institute. You can reach him on BIX as "apiki" or on the Internet at apiki@byteph.byte.com.

About the Product

Bounds Checker for Windows 1.0.....\$199
Bounds Checker for Windows 2.0.....\$249

Bounds Checker and Soft-Ice/W 1.3\$499
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HANDS-ON TESTING

62 HIGH-POWER NOTEBOOKS

We choose the best 486-class notebooks and Macintosh PowerBooks for four important applications

RICHARD FOX AND STEPHEN PLATT

If you view travel time as wasted time, read on. We tested 62 of today's fastest PC and Macintosh notebooks and found a multitude of performance capabilities, color options, and price points to keep you working at full speed when you're away from your desk.

We put 486-class notebooks and 68030-based Mac PowerBooks through their paces with nine DOS/Windows and 13 Macintosh performance tests. We also evaluated the systems for screen quality, battery life, price, and ease of use.

Our test sample included color and monochrome DOS/Windows notebooks with CPUs from Cyrix, IBM, and Intel. Clock speeds ranged from 20 MHz to clock-doubled 66 MHz. The PowerBooks ran at 33 MHz. We chose this performance class because we believe it offers the best in price and speed.

We limited our scope to notebooks weighing 7 pounds or less, excluding battery and AC adapter. We required an internal floppy drive (this criterion excluded the Mac Duo line and the CompUSA 4SL/25.) Dell, DEC, Gateway 2000, and Packard-Bell were revamping their 486 notebook lines as we prepared this report and couldn't send new systems in time. All but Dell should announce new lines by the time you read this.

The fastest notebook was the DX2/66-based Amrel 486DX2/66 AC, which ran more than four times faster than our baseline 20-MHz 386SX notebook and performed on a par with high-end desktop systems.

At the other end of the scale was the SLC/25-based King-Tech KS-486C, with speed roughly equivalent to that of a slow 386SX machine. But top performance is expensive: The Amrel notebook lists for \$5249—over three times the \$1695 price of the KingTech system. Overall, we found that systems with Cyrix processors were consistently slower than Intel-based units, although the Cyrix-based systems were often less expensive.

How to use this guide

We selected notebooks by choosing the ones with the best mix of performance,

screen quality, battery life, price, features, and ease of use.

Scores are calculated from appropriate Windows and DOS tests. Higher numbers mean better performance.

Rating based on quality of keyboard design, pointing device, status lights, other considerations.

BEST OVERALL

Compaq LTE Lite 4/25E



This notebook lasts more than 7 hours—90 minutes longer than its nearest competitor. Further, its active-matrix monochrome screen's grayscale quality, clarity, and range of viewing angles made it the best monochrome screen we saw; its quality even rivaled that of some active-matrix color displays. A good screen like this is important for Windows: It avoids the muddy gray that can easily obscure visual details in a windowing environment. The trackball placement is unusual; it sits next to the screen rather than near the keyboard. The pointer is easy to use, although the small ball sometimes wobbled during use. Numerous security features, such as power-on and setup/utility password protection and a pop-up battery gauge on the LCD, round out the Compaq LTE Lite 4/25E's capabilities.

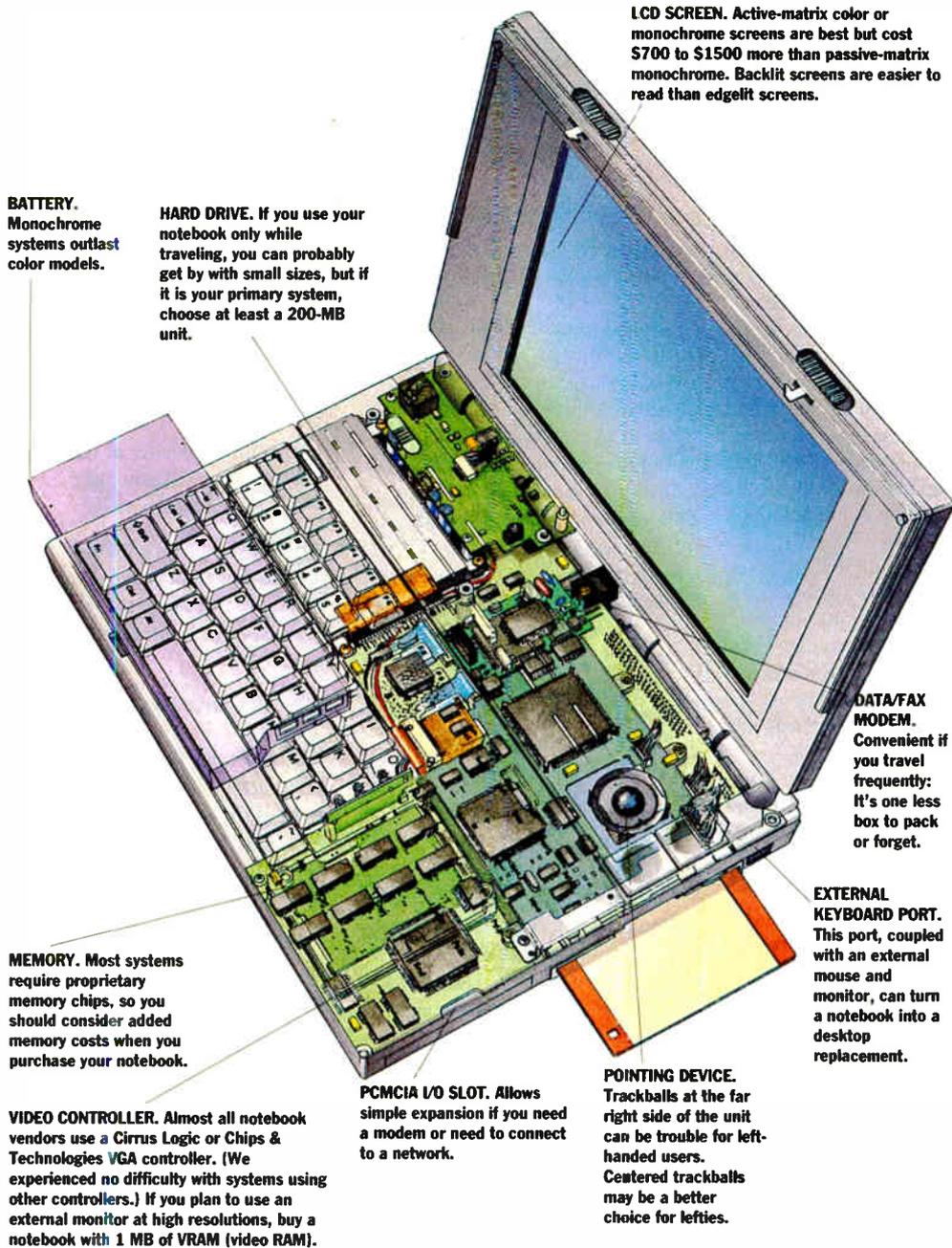


Rating clarity, reproduction of gray scales or color, and range of viewing angles.

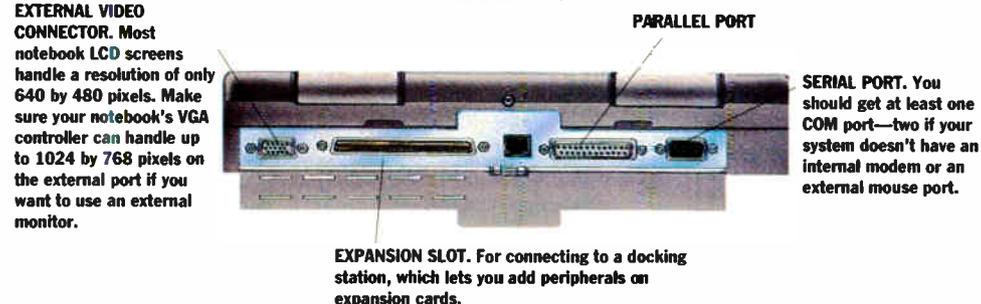
Battery discharge under real-world conditions.

NOTEBOOK	PRICE	CPU	WINDOWS SPEED	WINDOWS USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN USE (DL)
BEST Compaq LTE Lite 4/25E	\$4339	SL/25	2.61	Good	7:06	Excellent	8.4
WORST #205 2-Note 425Ln Model 130	\$2599	SL/25	2.89	Good	5:27	Fair	9.5

Anatomy of a Notebook



Back View



WINDOWS

Compaq LTE Lite 4/25E

This isn't the flat-out fastest notebook for Windows applications. However, the LTE Lite 4/25E's active-matrix display was the best monochrome display we evaluated. The notebook also placed first in our battery-life tests, running 90 minutes longer than its nearest competitor. **PAGE 165.**

COLOR

Sager NP843T

The NP843T's 10-inch, active-matrix color screen displayed colors, text, and graphics with a brilliance unsurpassed by any other notebook. The NP843T was also among the fastest notebooks we tested: It outperformed all but one of the 12 33-MHz color notebooks we tested for Windows and DOS speed, and it even outran one system with a higher clock rate. **PAGE 167.**

DOS

Compaq LTE Lite 4/25E

As in the Windows performance tests, the LTE Lite 4/25E didn't set the standard for DOS speed; its performance scores were in the middle of the pack. But its active-matrix monochrome screen had the highest quality of those we tested, and its 7-hour battery life was outstanding. **Page 181.**

DESKTOP

REPLACEMENT

NEC UltraLite Versa 33C

If you want one system to serve at the office and on the road, this is it. For travel, the Versa 33C's active-matrix color screen was among the best we tested. PCMCIA slots accommodate portable modems and network adapters, and a unique bay lets you plug in a floppy drive or a second battery. At the office, the Versa can drive a Super VGA monitor and achieves desktop-class video performance. The built-in keyboard has such a wonderful feel, you may not want an external keyboard. **PAGE 189.**

WINDOWS NOTEBOOKS

If Windows on the road is a necessity and you don't require a color display, the following 486 notebooks offer the best mix of price, performance, and features. (If you must have color, see our rankings for best color notebooks on page 167.)

We chose our Best Overall winners from among notebooks with processors rated at 33 MHz and slower. Our High-Performance category considered notebooks that had clock speeds of 40 MHz or faster. We made this separation because the faster systems fill a specific niche in the notebook market.

We received only 15 systems that fit into the high-performance category, and the average price of these machines is about \$1000 higher than the \$3100 average of the 33-MHz and slower systems. Furthermore, 80 percent of the faster systems had below-average battery runs—less than 3 hours. To be considered for Low Cost status, a notebook had to be priced at \$2750 or less.

Once we had made our initial cuts, we compared systems for performance when running our Windows performance test suite. This test suite consists of popular Windows business applications that provide real-world measurements of notebook performance. The suite also includes low-level tests that compare how well video subsystems execute Windows graphics calls. The resulting scores counted for 30 percent in our evaluation. Next, we factored in display quality (which was weighted at 20 percent), battery life (20 percent), ease of use (10 percent), features (5 percent), and price (15 percent).

The Compaq LTE Lite 4/25E won out as the Best Overall Windows system, even though its Windows performance was only average. Its display quality and battery-life scores were unsurpassed among monochrome Windows systems. For the best in Windows speed among the Best Overall finalists, the TI TravelMate 4000 WinDX/25 ranked first, running more than three times faster than the baseline 386SX notebook. The TravelMate 4000 WinDX/25 even out-scored the Twinhead Slimnote 4DX/33M, which runs at a faster clock speed.

For pure Windows performance, nothing matched the Micro-International HCP Model 65681M, which ran more than five times faster than the baseline notebook and became our High Performance winner. The HCP Model 65681M was the fastest monochrome system on the BYTE Windows low-level tests. In the Windows application tests, it was the fastest



Steps to Save Battery Power

1 Avoid excessive spinning up and spinning down of the hard drive. Once power management has been enabled, this can be achieved in several ways. A disk cache (e.g., SMARTDRV) buffers information in system memory, reducing the need to read from the hard drive. Storing your data on a RAM disk when operating on battery power eliminates the need for disk access at all. Be careful with this approach, however, because your data is not secure on the RAM disk and is lost once power is shut off. Finally, experiment with different time-out settings for the hard drive to find the one that works best for you.

2 Set the LCD shutdown interval to a short time. Backlighting can eat up a great deal of battery power, and when off, it simply requires a tap of a key when you are ready to resume working.

3 Most notebooks have controls for reducing the intensity of the LCD lighting. Backlighting requires less power at lower intensities.

4 Minimize the use of floppy drives, which also place a great strain on the battery.

5 Many systems let you adjust the processor speed. Set your system for the slowest speed that gives you reasonable performance.

6 If you are going to leave the notebook for a substantial length of time, place the notebook in its sleep mode. This shuts off most of the system's components but saves the contents of its memory so that you can pick up where you left off.

7 Choose a low-voltage CPU. Nine of the 14 longest battery times were produced by systems with 3.3-V processors.

monochrome notebook to run the Excel test and placed second (behind the TI TravelMate 4000 WinDX2/50) in the Word for Windows and Lotus 1-2-3 for Windows tests. The CompUSA 486DX2/66 Slimnote placed second overall, with a higher price tag and slower performance but 35 minutes more battery life.

All but two of the top-ranked Windows systems turned in above-average battery-life numbers, with half of the times topping 4 hours. Only the Twinhead Slimnote 4DX/33M and the HyperData HB 2300 DLC/40 had below-average battery endurance of under 3 hours. The HyperData system, which is based on a Cyrix 486DLC processor, was also the only ranked Windows system to employ a non-Intel CPU. Overall performance of this 40-MHz unit was comparable to Intel 33-MHz-based notebooks (except in the integer-math portion of the BYTE CPU test, where results placed it squarely between the 50-MHz and 66-MHz systems). Its \$2295 price also makes it the only notebook that qualified for both Low Cost and High Performance consideration.

A pointing device is crucial for Windows use. While most of today's notebooks include an integrated trackball with two

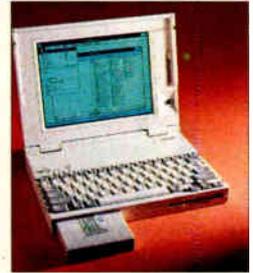
For the sharpest display and best battery...

BEST OVERALL

Compaq LTE Lite 4/25E



This notebook lasts more than 7 hours—90 minutes longer than its nearest competitor. Further, its active-matrix monochrome screen's gray-scale quality, clarity, and range of viewing angles made it the best monochrome screen we saw; its quality even rivaled that of some active-matrix color displays. A good screen like this is important for Windows: It avoids the muddy grays that can easily obscure visual details in a windowing environment. The trackball placement is unusual; it sits next to the screen rather than near the keyboard. The pointer is easy to use, although the small ball sometimes wobbled during use. Numerous security features, such as power-on and setup-utility password protection and a pop-up battery gauge on the LCD, round out the Compaq LTE Lite 4/25E's capabilities.



buttons, the location and design vary greatly from model to model. Micro-International's design is easy to use if you are right-handed: The trackball sits between the keyboard and the display on the far right side of the system, with the two input buttons on the right side of the case. Lefties may not be as pleased with the placement. By contrast, CompUSA places the trackball above the keyboard and slightly to the left of center, which makes it convenient for either left- or right-handers. The downside is that you're forced to hold your arm unnaturally elevated above the keyboard.

We found some keyboard designs to be unsuitable for long typing sessions. For example, the HyperData HB 2300 DLC/40's keyboard stands a full 1½ inches above the work surface; it's best to use an external keyboard or separate wrist rest when you're using this notebook for long typing periods. The Low Cost-winning Zenith Data Systems (ZDS) Z-Note had a much more comfortable keyboard that approximated the spaciousness and response of a desktop keyboard.

The \$1948 AST Bravo provided several unique hot-key features. You can use keys to toggle through several different gray-scale schemes to find the best color mapping for a particular application. This is especially helpful in determining the quick keys listed in an application menu or viewing the highlight bar. To conserve power on the Bravo, you can use keys to quickly enable or disable the LCD backlighting or enter a low-power mode that reduces both CPU speed and backlight intensity. The Bravo (as well as the Compaq LTE Lite) also includes a pop-up battery gauge that predicts the amount of remaining battery time based on the current usage pattern.

The Texas Instruments TravelMate 4000 WinDX/25 and WinDX2/50 map PageUp, PageDown, Home, and End keys via function-key/arrow-key combinations.

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	Compaq LTE Lite 4/25E	\$4339	SL/25	2.61	Good	7:06	Excellent	8.4
RUNNER-UP	ZDS Z-Note 425Ln Model 120	\$2599	SL/25	2.89	Good	5:27	Fair	9.5
RUNNER-UP	TI TravelMate 4000 WinDX/25	\$2678	DX/25	3.13	Good	4:46	Fair	10
RUNNER-UP	AST Bravo NB 4/25s	\$1948	SX/25	2.41	Good	3:16	Good	9.5
RUNNER-UP	Twinhead Slimnote 4DX/33M	\$2195	DX/33	2.96	Fair	2:51	Fair	10

Need the fastest Windows performer?

HIGH PERFORMANCE

Micro-International HCP Model 65681M



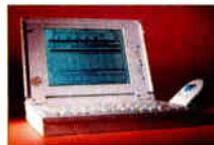
If you need a notebook with processing power for massive spreadsheets and databases, to perform gray-scale imaging, or for other demanding tasks, the HCP 65681M is for you. It ran our Windows performance tests twice as fast as the Compaq LTE Lite 4/25E, our Best Overall winner. In fact, this was the fastest monochrome notebook in our entire test sample. The HCP 65681M's monochrome screen quality is the best we saw from passive-matrix monochrome displays. In addition, it offers a reasonable battery life (3 hours, 32 minutes), two PCMCIA Type II slots, readable LED status indicators, and an excellent keyboard.

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	Micro-International HCP Model 65681M	\$2805	DX2/66	5.28	Good	3:32	Good	9.5
RUNNER-UP	CompUSA 486DX2/66 Slimnote	\$3228	DX2/66	4.40	Excellent	4:07	Fair	9.5
RUNNER-UP	TI TravelMate 4000 WinDX2/50	\$3499	DX2/50	4.75	Good	4:01	Fair	10
RUNNER-UP	HyperData HB 2300 DLC/40	\$2295	DLC/40	3.52	Excellent	2:52	Fair	8.8

Budget conscious?

LOW COST

Zenith Data Systems (ZDS) Z-Note 425Ln Model 120



This \$2599 notebook ran slightly faster than our Best Overall system. The Z-Note's display quality isn't in the same league as the Compaq LTE's, but the edgely passive screen was visually pleasing and well above average in our screen-quality tests; it beat the screens of numerous more expensive systems. The screen's wide viewing angle means you can move around while using the notebook and still see what you are doing. The keyboard is a pleasure to use. A built-in Ethernet adapter is standard.

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	ZDS Z-Note 425Ln Model 120	\$2599	SL/25	2.89	Good	5:27	Fair	9.5
RUNNER-UP	TI TravelMate 4000 WinDX/25	\$2678	DX/25	3.13	Good	4:46	Fair	10
RUNNER-UP	HyperData HB 2300 DLC/40	\$2295	DLC/40	3.52	Excellent	2:52	Fair	8.8
RUNNER-UP	AST Bravo NB 4/25s	\$1948	SX/25	2.41	Good	3:16	Good	9.5
RUNNER-UP	Twinhead Slimnote 4DX/33M	\$2195	DX/33	2.96	Fair	2:51	Fair	10

¹ Higher numbers indicate better performance (a 20-MHz 386SX Toshiba T2200SX = 1.0).

THE BEST

COLOR NOTEBOOKS

Color 486 notebooks are the easiest notebooks to use if you are running a GUI. But exceptional screen quality comes with a hefty price premium. Generally, an active-matrix color notebook will cost \$500 to \$1000 more than a similarly configured passive-matrix color system, and a passive-color product will cost \$500 to \$700 more than a passive-monochrome model. Micro-International's notebooks illustrate this: A monochrome unit lists for \$2805, an equivalent passive-matrix color notebook lists for \$3535, and the active-matrix color version lists for \$4305.

Screen quality counted for 20 percent in our evaluation when we chose the best color notebooks. We also factored in performance (30 percent). For all the categories, performance was an average of DOS and Windows test scores. We also considered battery life (20 percent), ease of use (10 percent), features (5 percent), and price (15 percent).

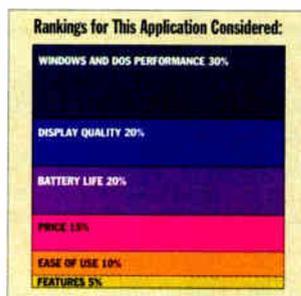
We chose our Best Overall winners from among notebooks with processors rated at 33 MHz and slower. Our High Performance choices considered notebooks with clock speeds of 40 MHz or faster.

To qualify for Low Cost status, a notebook had to be priced at \$2750 or less. Thus, it is not surprising that all the Low Cost systems came with passive-matrix displays. Moreover, 20 of the 21 most expensive notebooks that we tested contained active-matrix color displays. Active-matrix technology adds weight as well as cost—13 of the 20 heaviest models in our sample were active-matrix units.

All the systems considered for the Best Overall category had active-matrix screens; active matrix remains a clearly superior technology. These displays use three transistors to control each pixel's red, green, and blue values. By contrast, passive-matrix screens use three transistors to control an entire row or column of pixels.

Active-matrix displays deliver brilliant, fully saturated colors; deep contrasts; and wide viewing angles. Passive-matrix displays have slower refresh rates and narrower viewing angles, and they are prone to color streaking and pointer *submarining* (where the cursor seems to disappear when you are moving it across the screen). In our screen-quality testing, all the passive-matrix displays posted scores that were well below those achieved by the active-matrix products.

The \$3750 Sager NP843T ranked first among the Best Overall systems, in part for its winning performance in the Excel 4.0a portion of our applications tests. This benchmark, which displays many different multicolored bar, column, line, and pie charts, provides a good basis for comparing video performance, and the Sager NP843T repeatedly placed within the top five in several of these tasks. Runner-up NEC UltraLite Versa 33C outclassed the Sager NP843T in every aspect of our testing, but its steep list price of \$5538 was almost \$1800 higher than the Sager NP843T's—and the



Key Notebook Terms

Active matrix

Each pixel of an active-matrix display uses three transistors to control the red, green, and blue signals. This produces vibrant, fully saturated colors; deep contrasts; and wide viewing angles. However, due to manufacturing complexity, users must pay a price premium for active-matrix technology.

Docking station

An external expansion chassis that attaches to a notebook. A docking station can provide adapter slots, drive bays, and ports for attaching an external monitor, keyboard, and mouse. It provides the means for using the notebook as a desktop unit when you're not traveling.

Dual scan

An enhanced passive-matrix screen technology that divides the screen into two portions. Dual scan improves the refresh rate of the screen by updating two lines simultaneously. This technology is twice as fast as standard passive screens that update one line at a time.

Hot swap

The ability to swap batteries while using the notebook, without shutting off the power.

LCD

Liquid crystal display; a common display technology used in portable computers that uses a liquid between two transparent electrodes. When an electric current passes through the electrodes, the molecules in the liquid form a crystalline pattern that polarizes the light passing through it.

Nickel cadmium, NiMH

Two battery chemistries prevalent in mobile computers. Nickel-cadmium batteries are prone to the *memory effect*: When they are recharged before they are completely drained, subsequent charges tend to run out at about the point where they were last recharged. Nickel-cadmium batteries are being replaced by more expensive NiMH (nickel-metal-hydride) batteries, which offer more power per pound than nickel-cadmium batteries and do not exhibit the memory effect.

Passive-matrix

Each column or row of pixels in a passive-matrix display uses three transistors to control the red, green, and blue signals. Passive-matrix units produce slower refresh rates and narrower viewing angles than active-matrix displays (see Active matrix, above). This technology is also subject to color streaking and pointer submarining (where the cursor seems to disappear when being moved across the screen).

PCMCIA

An acronym for Personal Computer Memory Card International Association, as well as the name of the standard established by that association. PCMCIA is a hardware and software specification for memory, I/O, storage, and communications (e.g., fax, modem, and network adapter) devices. All these devices can be inserted into a credit-card-size slot (the slots range from 3.3 millimeters to 10.5 mm in height) in the notebook without any need for configuration by the user. The standard has yet to achieve plug-and-play compatibility, however.

Power management

A common feature in portable computers that conserves battery life by shutting down system components such as the hard drive and the display. Some systems slow down the CPU's clock speed as well.

Need the best color at an affordable price?

BEST OVERALL

Sager NP843T



The Sager NP843T's 10-inch, backlit, active-matrix display scored top honors for quality in the color purity section of our screen-quality test. Overall, this screen was in the top three for clarity and brilliance in displaying color text and graphics. The NP843T's speed score was the second fastest of the 12 33-MHz color notebooks we tested and was

faster than one system with a higher clock rate. The keyboard is well built, with a nice, crisp response; most of the keys are full-size, making it easy to use. The Sager's trackball is located on the upper right edge of the keyboard.



second highest among all 62 tested notebooks. (The price of the Versa 33C is partly owing to this unit's having 12 MB of RAM; most of the reviewed notebooks included only 8 MB.)

Most color notebooks require more power to operate than monochrome units do. Monochrome notebooks averaged 3 hours, 19 minutes of battery life, while the average battery life of the color models was only 2 hours, 48 minutes. Eight out of the 10 best battery times were produced by monochrome products.

However, this is merely an overall trend in our testing; there are plenty of exceptions. Six color notebooks achieved battery-life numbers that were higher than the monochrome average. The Acer Note 750C, the winning Best DOS Color notebook, lasted 4.5 hours, which places it within the top five models for battery endurance.

The median battery life for an active-matrix color system was 2.9 hours, outlasting the median time of 2.5 hours for the passive-matrix models. Once again, we saw exceptions. Our low-cost leader, the Toshiba Satellite T1900C, outlasted more than two-thirds of all the notebooks tested, with 3 hours, 17 minutes of staying time.

All the notebooks in this review offer a maximum internal resolution of 640 by 480 pixels. However, nearly all support higher resolutions, either 800 by 600 or 1024 by 768 pixels, on external monitors. This is especially important if you want your notebook to serve as your desktop system. Among top color systems, only the Toshiba Satellite does not support 1024 by 768 pixels externally: It supports only 640 by 480 pixels.

Simulscan support, which is the ability to simultaneously display on both the internal LCD and the external monitor, is another important consideration. Only nine of the tested notebooks—including the Toshiba Satellite—did not support this feature.

	PRICE	CPU	OVERALL SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)	SCREEN TECHNOLOGY
BEST Sager NP843T	\$3750	DX/33	2.99	Good	2:52	Excellent	10	Active
RUNNER-UP NEC UltraLite Versa 33C	\$5538	SL/33	3.06	Excellent	2:55	Excellent	9.5	Active
RUNNER-UP AST Power Exec 4/25SL ColorPlus	\$4758	SL/25	2.18	Excellent	3:49	Excellent	9.5	Active
RUNNER-UP Acer Note 750C	\$3988	SL/25	2.22	Excellent	4:28	Good	9.5	Active
RUNNER-UP NEC UltraLite Versa 25C	\$4888	SL/25	2.52	Excellent	2:40	Excellent	9.5	Active

Need speed and color?

HIGH PERFORMANCE

Micro-International HCP Model 65681C



This passive-matrix color notebook was the third-fastest system in our entire sample. It repeatedly placed within the top three slots in our video-intensive application tests and flew through tests like our WordPerfect 5.1 for DOS print preview, charting portions of the 1-2-3 for DOS and Windows benchmarks, and the font-change section of the Word 2.0 for Windows test. Color detail was good, with crisply defined text in all modes. The display's viewing angle was above average, but the colors themselves were washed out.

The keyboard was well arranged and had an excellent feel: All the keys were large, were placed where a touch-typist would expect to find them, and had nice travel.

	PRICE	CPU	OVERALL SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)	SCREEN TECHNOLOGY
BEST Micro-International HCP Model 65681C	\$3535	DX2/66	3.92	Good	2:33	Fair	9.5	Passive
RUNNER-UP AMS TravelPro 5366A	\$3895	DX2/66	3.39	Good	2:52	Good	9.5	Active
RUNNER-UP TI TravelMate 4000 E WinDX2/50	\$5278	DX2/50	3.62	Good	2:36	Excellent	8.5	Active
RUNNER-UP Twinhead Slimnote 4DX2/66T	\$4399	DX2/66	3.41	Fair	2:38	Good	8.5	Active
RUNNER-UP Amrel 486DX2/66 AC	\$5249	DX2/66	4.13	Fair	1:30	Good	8.5	Active

Need economical color?

LOW COST

Toshiba Satellite T1900C



Toshiba's new Satellite presents a good set of features in a low-cost package. The passive-color screen did well on our quality tests, providing crisp text and good graphics, but it offered limited left/right visibility. This means that you'll be able to read the screen easily, but only from head on. The notebook is based on the SXA/20 chip and provides more than enough performance for day-to-day activities: Its performance was faster than that of 19 of the 27 systems with clock speeds less than 33 MHz, and

faster than two 33-MHz systems. It uses a QuickPort mouse, which simplifies the process of attaching and detaching the external mouse. Sliding port-covers slip inside the case so they won't easily break or get lost. A Type III PCMCIA slot further distinguishes the Satellite: Only nine other systems support the larger Type III slots.

	PRICE	CPU	OVERALL SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)	SCREEN TECHNOLOGY
BEST Toshiba Satellite T1900C	\$2700	SXA/20	2.03	Excellent	3:17	Fair	9.5	Passive
RUNNER-UP AST Bravo 4/25s Color Model	\$2748	SX/25	2.14	Good	2:15	Fair	9.5	Passive
RUNNER-UP AMS TravelPro 4533 PAS	\$2495	DX/33	2.66	Good	2:11	Poor	7.75	Passive

¹ Higher numbers indicate better performance (a 20-MHz 386SX Toshiba T2200SX = 1).

The ZEOS[®] Contenda That Great Things Co

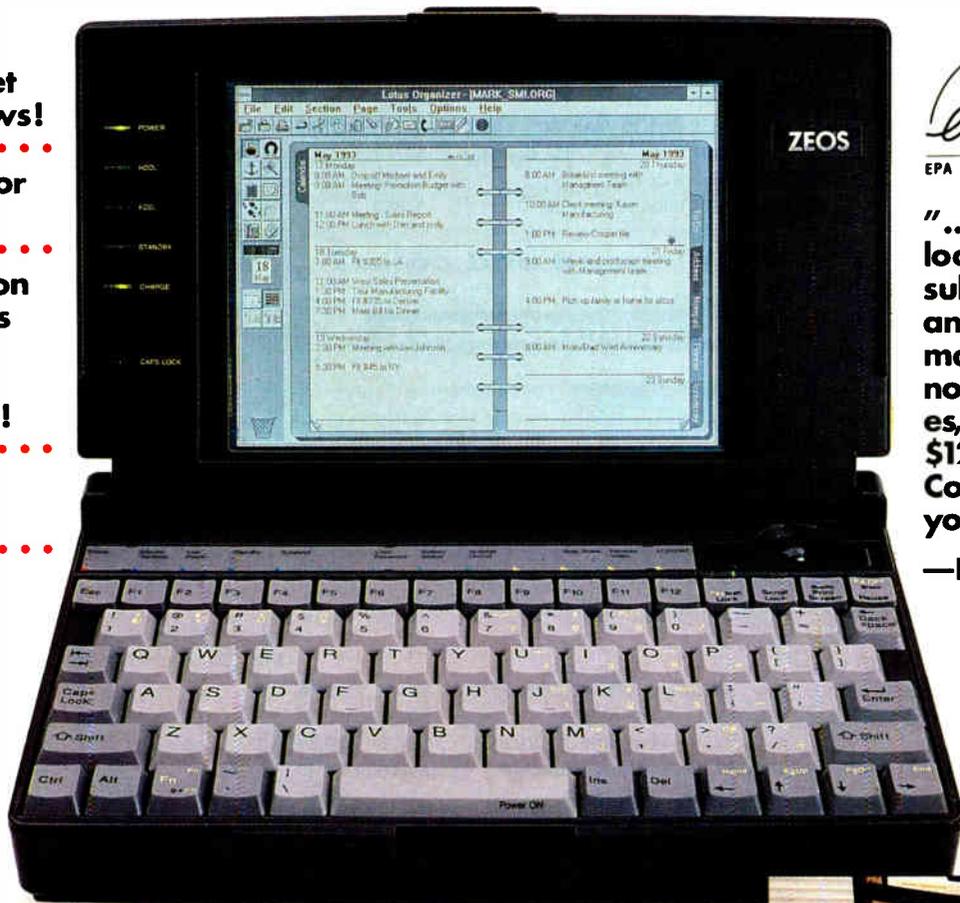
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—PC Week

Smaller than a notebook. Lighter than your briefcase. The ZEOS Contenda subnotebook is proof that great things come in small packages...including plenty of power to run Windows wherever you go!

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What's more, the Contenda's features make it a pleasure to use. Features such as a high-resolution backlit screen that's crisp and vibrant. A built-in trackball so you won't have to tote a mouse around. And with a standard 80MB hard drive, memory up to 10MB and weight of less than four pounds, it's one powerful, portable Windows workhorse!



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486SL Contenda: \$1795

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- 4MB RAM
- 80MB IDE hard drive

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386SL Contenda: \$1595

Lease: \$62/month

- 4MB RAM
- 80MB IDE hard drive
- External 3.5" floppy disk drive
- MS-DOS 6.0
- Microsoft Windows 3.1
- Lotus Organizer

486SL Contenda: \$1995

Lease: \$73/month

- 4MB RAM
- 80MB IDE hard drive
- External 3.5" floppy disk drive
- MS-DOS 6.0
- Microsoft Windows 3.1
- Lotus Organizer

FAVORITE OPTIONS

ACCESSORIES

- External 3.5" floppy disk drive \$99
- Extra battery \$99
- External charging stand \$79
- Custom leather carrying case \$129
- Custom nylon carrying case \$79
- DC-DC adapter \$49

MEMORY UPGRADES

- 386SL: 2MB to 4MB upgrade \$99
- 386SL: 4MB to 10MB upgrade \$561
- 486SL: 4MB to 8MB upgrade \$198

COMMUNICATION

- FastLynx File transfer software \$79
- Internal 2400 bps modem with 9600 bps send fax and 4800 bps receive fax \$99
- Xircom Ethernet adapter (10BT or Coax) \$349

PACKAGE 3

386SL Contenda: \$1795

Lease: \$69/month

- 4MB RAM
- 80MB IDE hard drive
- External 3.5" floppy disk drive
- Custom leather carrying case
- Extra battery
- Internal 2400 bps modem with 9600 bps send fax and 4800 bps receive fax
- MS-DOS 6.0
- Microsoft Windows 3.1
- Lotus Organizer

486SL Contenda: \$2395

Lease: \$87/month

- 8MB RAM
- 80MB IDE hard drive
- External 3.5" floppy disk drive
- Custom leather carrying case
- Extra battery
- Internal 2400 bps modem with 9600 bps send fax and 4800 bps receive fax
- MS-DOS 6.0
- Microsoft Windows 3.1
- Lotus Organizer

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- 25MHz 80386SL or 80486SL microprocessor.
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- IDE hard drive.
- Display: 640 x 480 VGA backlit, .23 dot pitch, Sharp 7.4" diagonal, up to 64 shades.
- 256K (386SL version) or 512K (486SL version) video RAM.
- 486SL version includes 3.3v technology for added battery life, PI local bus for Windows acceleration, high-speed floppy drive controller, built-in math coprocessor.
- Supports simultaneous display with an external SVGA color monitor.
- Replaceable and rechargeable NiMH battery.
- 80-key keyboard with embedded numeric keypad and easy-to-use built-in trackball.
- One serial port, one parallel port, one video port, and ports for optional internal fax/modem and external floppy drive.
- AC adapter with full range from AC110-240V to DC.
- Power Management: Fully featured, including De-turbo, programmable Standby features and Suspend to disk.
- Password feature built-in ROM.
- 9.7" x 6.1"; 3.9 lbs.
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World Radio History

How We Tested

PERFORMANCE

We tested each 486-class notebook with a performance suite of combined BYTE low-level DOS and Windows benchmarks, along with Windows application tests developed by NSTL. Mac PowerBooks ran BYTE's Macintosh Performance Benchmarks version 2.0.

The BYTE DOS low-level tests measure performance of specific system components, including CPU, FPU, memory, video, and hard drive. The Windows low-level tests exercise the Windows GDI (Graphical Device Interface). These determine how well a system can execute basic graphics calls within Windows, including calls that display pixels, lines, rectangles, polygons, and ellipses. Text and BitBlt operations are also executed. Windows-based performance tests (both low-level and application) were executed in 640-by-480-pixel resolution at 16 colors.

The NSTL application tests use popular business applications that give a real-world representation of notebook performance. For DOS tests, we use WordPerfect 5.1, Lotus 1-2-3 release 2.4, FoxPro 2.0, and Autodesk Animator Pro 1.0. Our Windows application tests include Microsoft Excel 4.0a, Microsoft Word 2.0b, and Lotus 1-2-3 for Windows 1.1.

All applications execute macros that exercise common areas of each application. For instance, the Word for Windows test includes many subtests that measure a variety of activities, including common file I/O, search and replace functions, changing fonts, page and line scrolling, spelling checking, print preview, and print to file.

For comparisons, we scaled all test scores against a 20-MHz 386SX Toshiba T2200SX, whose performance equaled 1.0 in our index. Thus, a system with an overall performance index of 3.0 executed our tests three times faster than the baseline T2200SX.

The Macintosh performance suite is a sequence of 13 tests. Four are low-level performance tests, concentrating on the CPU, FPU, disk, and video. Two others are the industry-standard LINPACK and Dhystone tests. Finally, the suite includes seven application tests, including word processing, desktop publishing, database, program development, graphics, mathematical, and spreadsheet.



Testing team (clockwise): Richard Fox, Siva Kumar, Stephen Platt, Alan Joch, and Anthony Lennon

All test scores are scaled relative to the baseline Mac Classic II.

EASE OF USE

To gauge usability, we evaluated several factors. Keyboard quality was important, and we considered whether non-character keys were located in more-or-less standard positions, how comfortable the typing angle was, and the crispness of key response.

We judged pointing devices by considering whether the design accommodated both left- and right-handed users and whether the pointer's location was within convenient reach from the keyboard. We considered status indicators: Were the common conditions (e.g., battery low and hard disk access) represented? Was the indicator's meaning obvious or obscure? Were indicators easy to see?

We also looked at the less-frequently-used areas of battery installation, setup utility, memory expansion, ports, and overall construction. Finally, we considered the completeness and clarity of the technical documentation.

SCREEN QUALITY

We evaluated three aspects of display quality: crispness, intensity/color range, and viewing-angle range. Crispness measures how detailed the line- and character-drawing abilities of the screen are. We ran numerous tests to examine text clarity in both color and monochrome environments; horizontal and vertical line placement; color and grayscale displays; LCD streaking; and solid color and black, gray, and white regions.

We used DisplayMate Professional 1.0 from Sonera Technologies, which provides a wide range of monitor tests.

All the tests were run in a darkened room and examined by a panel of testers. Many of the tests were rerun at different times to ensure that our results remained consistent throughout the testing cycle.

To determine color quality, we displayed a color bar on each of

the color systems and segregated displays into five categories, ranging from those with bleached and barely distinguishable colors up through the best



Color bars helped our panel of testers rate displays for color purity and depth.

Windows at Your Fingertips



"Scoring high in overall value and design, the Micro Electronics WinBook gives you a lot for your money, including an outstanding integral trackball."

PC MAGAZINE, August 1993, Cover Story: Portable Computing

The WinBook by Micro Electronics™ gives you all the power to run Windows, and a unique, ergonomic design to make it easier to use.

It features a built-in, centered trackball which allows you to control cursor movements effortlessly with either thumb without having to lift a single finger off the keyboard. Full-size keys and the WinBook's exclusive sloping hand rest let you work in total comfort.

The WinBook comes with the power and speed needed to run Windows effectively. You get 4MB memory, the new ultrafast 486 SLC/E processor and

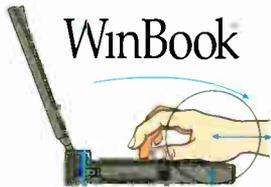


Dual-button trackball centered under the keyboard

the Motorola chipset which provides eight power-saving features, even while running Windows. Plus, we have fine-tuned the WinBook's screen. In monochrome and now in dual-scan STN color—you get sharper and clearer images with less cursor loss.

The WinBook was engineered for Micro Electronics, a division of MEI/Micro Center, Inc. MEI is America's leading direct source for computer accessories. Micro Center has been selling PCs for more than 14 years—longer than IBM or Compaq—with over 736,000 units sold. With over 2.2 million satisfied customers nationwide, we have developed a superior support staff, including top engineers and technical specialists. So you always get the highest quality product at the lowest possible price.

Before you choose a notebook computer, look at the WinBook—the first notebook computer designed specifically for Windows.



WinBook

The 5.4lb. WinBook, designed by award-winning Palo Alto Design

- Includes a 9600 baud send/4800 baud receive fax/2400 baud modem.
- Fast-acting, LCD screen for less cursor loss.
- Industry-standard PCMCIA 2.0 slot for future expandability.
- 512k video RAM.

Longer battery life

The WinBook features NiMH 2200 MA batteries with gold-plated contacts. This allows it to run much longer than units with traditional NiCAD batteries—and there's no memory effect.

Clean, sharp color display

The WinBook's advanced, dual-scan color display gives you 99% shadow-free performance compared to other single-scan passive matrix displays. You get near active matrix quality at a passive matrix price!

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- Size/Weight**
- 11" X 8 3/4" X 1 3/4"
 - 5.4 lbs. with battery (monochrome)
 - 5.9 lbs. with battery (dual-scan color)
- Pointing Device**
- 16mm Alps dual-action, Microsoft-compatible trackball
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- Up to 3 hours with power management (less 30 minutes for color)
 - NiMH (no memory effect)
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- Eight power-saving features
- Processor and Memory**
- 486 SLC/E-25MHz CPU
 - 4MB RAM
 - 1MB ROM for AMI BIOS
 - Motorola chipset
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Drives

- One built-in 1.44MB 3.5" floppy drive
- Monochrome: Internal 120MB (15MB) hard drive
- Color: Internal 250MB (16MB) hard drive

Software

- Comes load-4 with MS-DOS 6.0 and

Microsoft Windows 3.1

- Display**
- Super-twisted 64 gray-scale, 10" LCE and 1024 x 768 for external monitor with 512k video RAM
 - Optional dual-scan STN color display
 - Adjustable contrast and brightness
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- Keyboard**
- Full-sized on keyboard with 85 keys a d4 inverted-T cursor control keys 3 Chm keyboard spacing

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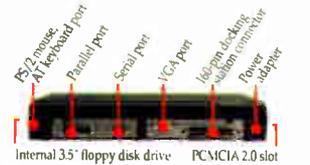
- Fax 9600 baud send/4000 baud receive/2400 baud modem

I/O Ports

- PS/2 mouse interface/A keyboard interface

- PCMCIA 2.0 slot
 - Serial 9-pin connector
 - Parallel port
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 - 160 pin docking station
- Options**
- Capless
 - Docking station

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How We Tested *(continued)*

screens with solid, pure colors. A similar test was performed for monochrome systems using a 16-level gray scale. For monochrome systems, we looked for level gradation, evidence of *banding* (i.e., groupings of gray levels in the middle of the display), and the intensity of the white and black bands.

We measured the viewing-angle range of each display using a rotating platform that allowed us to move the test unit left and right until we detected visible distortion in the display. Distortion includes loss of text, color changes, or glare caused by the design of the backlighting or edgelighting. After testing the left/right range, we tilted the screen to measure the vertical viewing range.

After we computed a display's viewing range, we compared it to the range of the best system we tested; in this way, we determined ratings for each screen. Screens tended to cluster at viewing ranges of 55 to 60 degrees, 35 degrees, 20 degrees, and 10 degrees, providing



Thumper 2 rates notebook battery life by mimicking a word processing session and working with each notebook's power management capabilities.

four categories: excellent, good, fair, and poor.

Our final screen evaluation combined all three factors—clarity, quality, and range. Monochrome systems were evaluated separately from color displays; however, we grouped active and passive screens together.

We measured PowerBook screen quality using a modified version of our notebook screen methodology that included our viewing-angle measurements. DisplayMate doesn't run on the Power-

Books, so we substituted similar Mac screens on a test-by-test basis.

BATTERY LIFE

We measured battery performance using BYTE's Thumper 2 battery-life tester. Thumper mimics real-world use by running a program that replicates a typical word processing session. It uses robotic arms and an optical sensor to detect and control each notebook's power management functions.

We configured each notebook's power management features to let the hard drive spin down and the screen's backlighting shut off after a set period of inactivity. The notebook is also allowed to enter a standby mode during the test cycle. Each notebook is put through the test cycle repeatedly until the battery is dead. Note that results from any battery-life test, including Thumper 2, are meant as a guideline. Your usage patterns will affect your system's battery life.

CONFIGURATION

Our testing was open to all 486-class notebooks. We specified that the system must have a minimum of 8 MB of RAM and at least a 120-MB hard drive (the AMS TravelPro 4533 PAS and TravelPro 5366A that we received contained only 80-MB hard drives and so were evaluated with that configuration). Each notebook had to have an internal floppy drive and a VGA display. The products all weighed less than 7 pounds without a battery or AC adapter.

OUR TEST TEAM

Richard Fox, Senior Testing Engineer/NSTL, has spent the last two years testing compatibility and performance of notebooks, systems, and applications software.

Alan Joch, Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.

Siva Kumar, Technical Analyst/NSTL, specializes in hardware and network operating-system testing.

Anthony Lennon, Technical Editor/NSTL, conducts evaluations of notebooks, systems, and peripherals.

Stephen Platt, Manager of Unix Development/NSTL, directs testing of Unix hardware and software, Windows NT, and network operating systems.

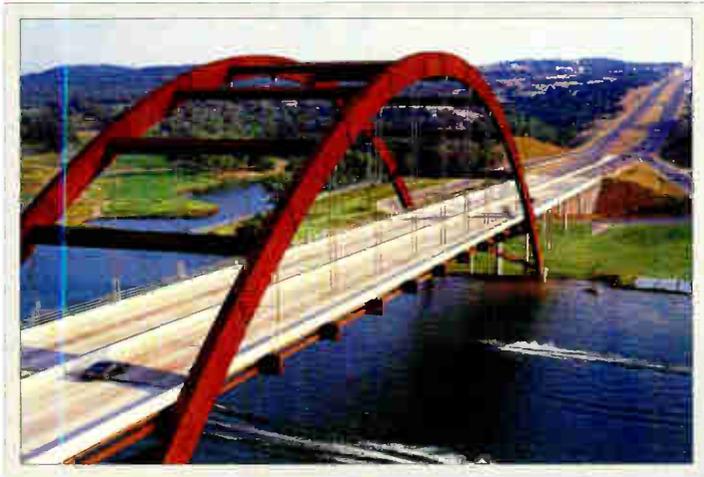
The Lab Report is an ongoing collaborative project between BYTE Magazine and National Software Testing Laboratories (NSTL). BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.

KEY NOTEBOOK FEATURES

We considered the following features most important for 486 notebooks:

FLASH ROM BIOS	Allows you to upgrade the BIOS without taking the notebook apart to replace chips
SUPER VGA SUPPORT	Important for connecting to an external monitor when you're not traveling
ENHANCED OR BIDIRECTIONAL PARALLEL PORTS	Improved performance with network adapters and printers
INTEGRATED POINTING DEVICE	Eliminates extraneous parts and cables
PCMCIA SLOTS	Needed for future generations of modems, network adapters, and storage devices
PASSWORD PROTECTION	For added data security on the road
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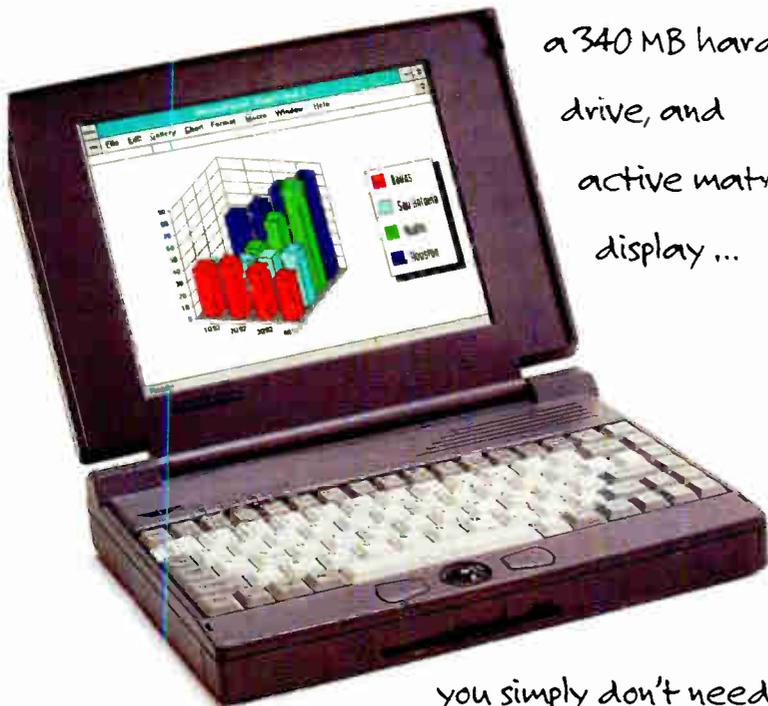
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Macintosh PowerBooks

Apple has come a long way since the days of the PowerBook 100. The current PowerBook line boasts performance levels and features that rival those of many leading PC notebooks. We focused our evaluations on the PowerBook 165c, 180, and 180c, all of which use the Motorola 68030 CPU. We omitted DuoDocks because they don't contain internal floppy drives. The three tested PowerBooks are virtually identical except for their displays: 9-inch passive-matrix color in the 165c, 10-inch active-matrix monochrome in the 180, and 8.4-inch active-matrix color in the 180c.

All the PowerBooks have the same physical keyboard: a standard chassis topped with a set of full-size keys in the standard Mac layout. All have the same trackball, which is large and comfortable to use, with buttons both above and below the ball. It's the best mouse replacement we've seen for right-handed, left-handed, and ambidextrous people. The wrist rest is large, with no obstructing features.

SCSI, LocalTalk, external monitor, sound I/O, and two serial ports are all standard. The PowerBook external video monitor can either mirror the display (showing the same information) or act as a dual display (providing a second desktop, giving you more surface area for applications).

Internally, the three PowerBooks are all based on the same 68030 CPU and 68882 FPU (both at 33 MHz), with the same memory expansion capabilities (4 to 14 MB). The 165c and 180 come with either 80-MB or 120-MB hard drives,

while the 180c offers 160-MB drives.

Since they are based on the same processor technology, you would expect the PowerBooks to provide the same level of performance (see the table). In processor-intensive tasks, we found this to be true. However, we saw wide differences in video-processing tests, such

as excellent screens. We found that the Compaq's smaller screen (8.4 by 10 inches) produced slightly better gray scales and had a wider viewing angle. Both had left/right viewing angles of approximately 55 to 60 degrees in each direction, but the Compaq's screen could be tilted back twice as far (30 degrees versus 15 degrees) before it became difficult to read.

The active-matrix color screen of the PowerBook 180c was beautiful. Clear, crisp, and with good saturated colors, it was equivalent to the best of the PC color screens in both quality and viewing angle. It had a viewing angle equivalent to the NEC UltraLite Versa 33C's—you could twist it left, right, and back until it was practically flat and still read text. Likewise, the colors were as solid as those of the AST Power Exec 4/25SL Color-Plus, which had the best PC screen. In some senses, the 180's was the best color screen we saw; our only complaint was that it was small (8.4 inches versus the Power Exec's 9.5 inches).

In the end, we can recommend two PowerBooks: the PowerBook 165c and the PowerBook 180c. If your budget is limited, the \$2339 PowerBook 165c is a solid choice. Its screen quality is acceptable, and the price compares well with PC passive-matrix color systems. If your pockets are deeper, choose the PowerBook 180c. For only an additional \$330 over the cost of the monochrome 180 (\$4079 vs. \$3749), you gain a top-quality color screen. Denying yourself one of the best active-matrix color screens for a savings of less than 10 percent is a decision you may regret later.



From left to right: The PowerBook 180c, with an active-matrix color display; the monochrome-version 180; and the 165c, a passive-matrix color PowerBook.

as the spreadsheet (charts and diagrams) and database (full-screen redraw of displayed data). The monochrome 180 showed a 4-to-1 advantage in screen speed over its two color cousins.

Battery life for all the PowerBooks was similar to that of comparably equipped PCs. PowerBook screen quality was generally better than that of DOS/Windows notebooks. The passive-color screen of the PowerBook 165c, which was the worst PowerBook screen, was equivalent to a mid-quality PC passive-color screen. It had clear text and one of the widest viewing-angle ranges among passive-matrix color displays, but its colors were washed out.

The active-monochrome PowerBook 180 has only one rival in the PC group—the Compaq LTE Lite 4/25E. Both had

RESULTS OF THE BYTE MACINTOSH BENCHMARKS VERSION 2.0

Figures shown are summary index figures and represent how many times faster the notebook is than a Mac Classic II, with an index of 1. The exception is the Overall App Index (the sum of all the application indexes, for which the Mac Classic II scores 7.0).

	LOW-LEVEL				APPLICATION							Overall App Index
	CPU Index	FPU Index	Disk Index	Video Index	Word Processing Index	DTP Index	Database Index	Development Index	Graph App Index	Scientific Index	Spreadsheet Index	
PowerBook 165c	2.59	10.49	1.71	0.57	2.73	1.72	1.98	1.89	1.98	4.16	4.92	19.39
PowerBook 180	2.60	10.68	1.72	2.00	2.76	1.81	2.50	2.19	2.63	4.46	5.54	21.91
PowerBook 180c	2.59	10.64	1.70	0.55	2.74	1.68	2.10	2.13	1.44	4.16	5.10	19.35

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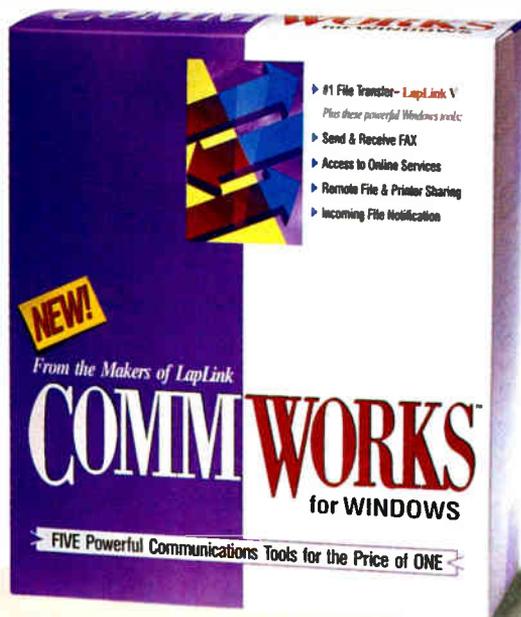
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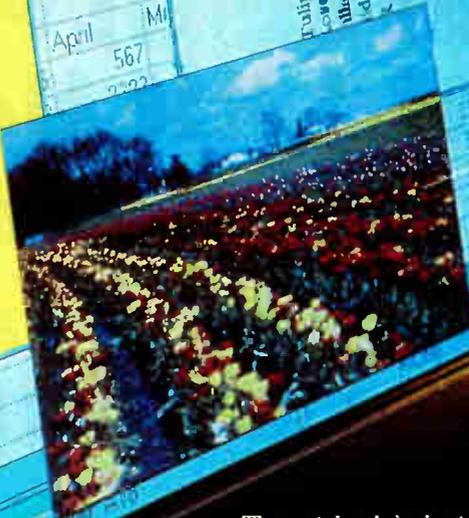
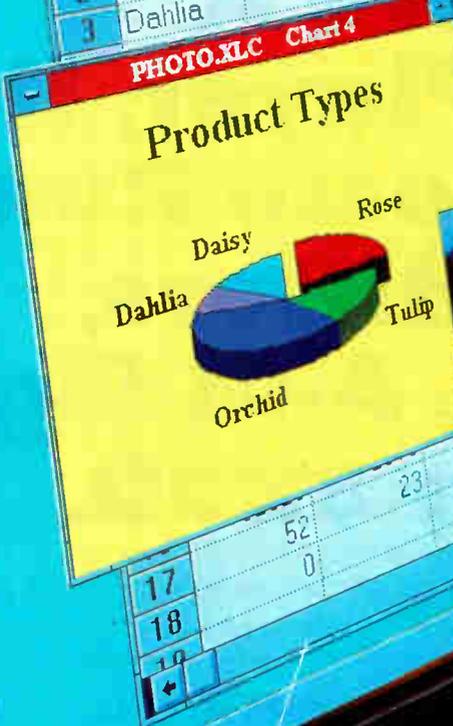
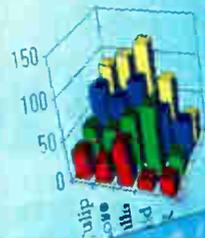
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	A	B	C	D	E	F
1	Tulip	35	45	76		
2	Rose	26	45	65		
3	Dahlia	55	65	89		

Flowers by Product



The notebook industry's first 4mm, full-travel keyboard with the look and feel of a desktop system.

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

Texas Instruments offers over 10 models of 486 notebooks for you to choose from.

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Notebook CPUs

Many chips now carry the 486 label, making the user's choice of CPU even more difficult. We received

notebooks with 486 processors from Intel, IBM, and Cyrix. The table lists the important attributes of each CPU.

The graphs compare the overall system performance of each CPU class at each clock speed. Manufacturers typically design a system around comparable components; that is, a low-cost unit will be constructed with inexpensive components, like a lower-quality screen, a slower hard drive, and a less expensive CPU. Look at the total notebook performance (including video, hard drive, and memory subsystems) for insight into typical notebook designs for each CPU. All ratings in the figures are indexed; a Toshiba T2200SX, a 20-MHz 386SX notebook, equals 1.0.

At the low end of the performance scale are the Cyrix 486SLC chips at 25 and 33 MHz. Units running at 25 MHz were only 41 percent better than the baseline Toshiba T2200SX; however, these notebooks were also the cheapest, averaging little more than \$2000. The \$1580 Xinetron X/LAN Book was the lowest-priced notebook tested and the second-fastest SLC/25 unit. All the 486SLC/25 units employed passive-matrix monochrome displays that were ranked "fair" in our screen-quality tests. Many of the 486SLC notebooks supported a maximum of only 8 MB of RAM. On average, notebooks with the 33-MHz Cyrix 486SLC—with an index score of 1.82—outperformed those with the 25-MHz Cyrix model but still lagged behind the slowest Intel-based notebook.

Although IBM's 486SLC2/50 chip (used in the ThinkPad 720C) operates internally at 50 MHz, its overall performance was comparable to that of notebooks containing Intel 486DX/33 and 486SL/33 chips. The 486SLC2/50 has only a 16-bit external data path, as opposed to the Intel's 32-bit path, and it does not contain a math coprocessor.

Generally, more powerful CPUs are used in more expensive systems. At the left of the graph (the low end), SLC/25 systems are exclusively monochrome. At the SX/25 level, there is an even mix

	CYRIX	CYRIX	INTEL	INTEL	INTEL	INTEL	IBM
Model	486SLC	486DLC	486SX	486DX	486SL	486DX2	486SLC2
External data path (bits)	16	32	32	32	32	32	16
Internal cache (KB)	1	1	8	8	8	8	16
FPU	No	Yes	No	Yes	Yes	Yes	No

of screen technologies. By the time you reach the DX2/66 class, six of the nine units are active-matrix color notebooks. You pay a pretty penny for DX2/66

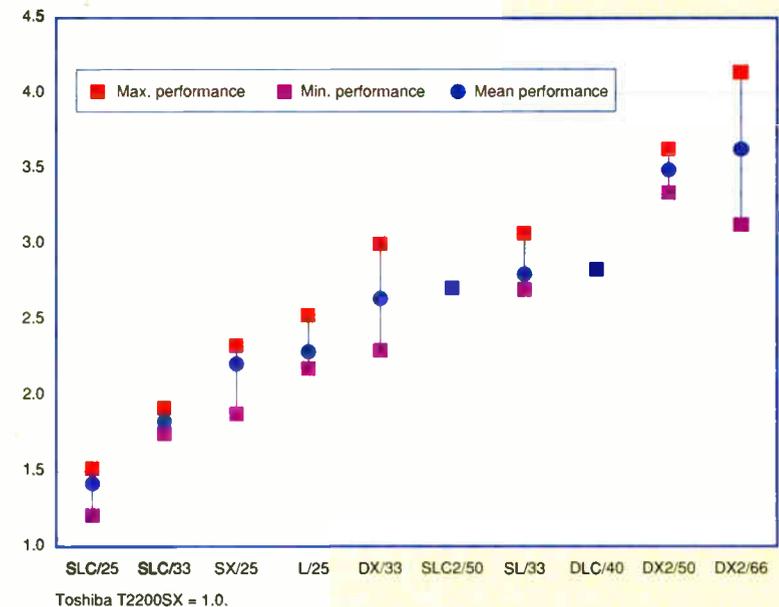
notebooks: Average cost is \$3737, while the most expensive model, the Amrel 486DX2/66 AC, is \$5249.

A good deal of this trend analysis uses averages, so there are exceptions: The fastest SX/25-based notebook, the CompuAdd 425TXT, had a better index than the CAF AquaLite-486DX3/C, the slowest DX/33 notebook.

System Price Comparison by Chip Class

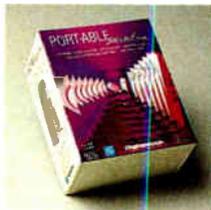


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PORT-ABLE Sound Plus is the first portable external sound peripheral to deliver 16 Bit CD quality music with stereo audio capabilities. And, since you just plug into your IBM PC or compatible, desktop or laptop parallel port, you do not need an engineering degree or even a screwdriver.

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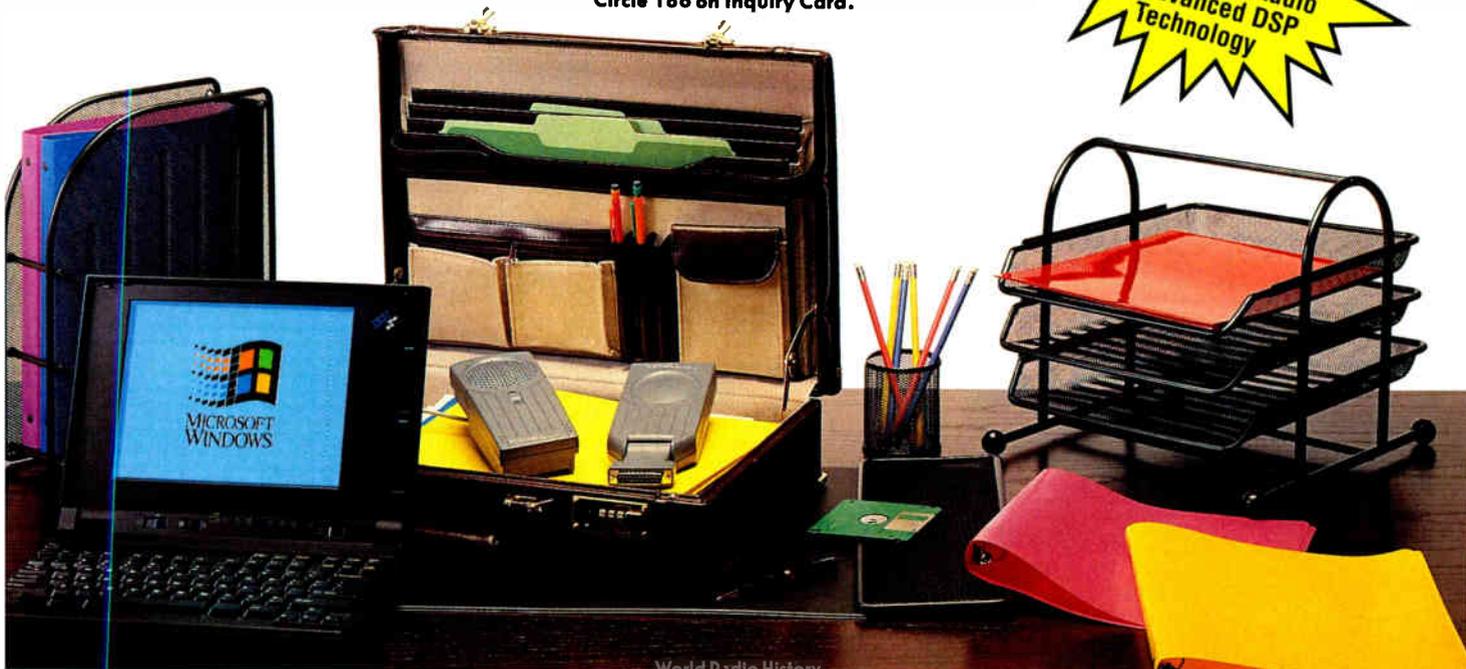
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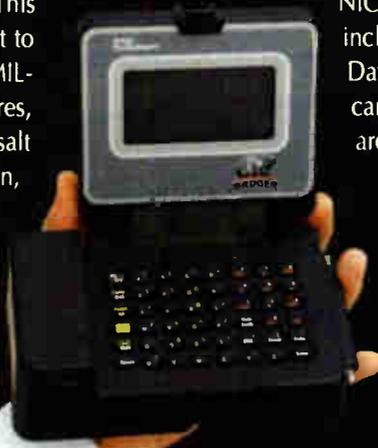




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Today's DOS applications are increasingly robust, and a 486-class processor can eliminate the time that you need to spend waiting for screens to redraw or for sales projections to recalculate. All the notebooks ranked in this section offer performance that is more than double the speed of the baseline Toshiba 386SX system.

For all the DOS categories, we compared systems for performance in running our DOS test suite. Within the DOS application tests, we placed the most emphasis on the WordPerfect 5.1 and Lotus 1-2-3 release 2.4 results. The combined performance score accounted for 30 percent of our evaluation. Next, we factored in display quality (weighted at 5 percent), battery life (25 percent), ease of use (10 percent), features (10 percent), and price (20 percent).

For the Best Overall category, we ranked only systems rated at 33 MHz or slower. The High Performance category considered systems with internal clock speeds of 40 MHz or faster. To be considered for Low Cost status, a notebook had to be priced at \$2750 or less.

All the notebooks rated for DOS Best Overall or Low Cost used 25-MHz Intel CPUs. Two of these five systems used Intel 486SL chips that combine the performance of a 486DX/33 with power-saving features that prolong battery life.

The \$2678 Texas Instruments



DOS

Is screen quality important?

BEST OVERALL **Compaq LTE Lite 4/25E**



An excellent active-monochrome screen and a long battery life (over 7 hours) make the Compaq LTE Lite 4/25E our choice for the best monochrome DOS notebook. The spectacular screen was far above and beyond that of any other monochrome system we tested in both viewing angle and quality. Further recommending it are small details like the well-constructed port covers and clear, comprehensive, and complete manuals.



		PRICE	CPU	DOS SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	Compaq LTE Lite 4/25E	\$4339	SL/25	2.15	Good	7:06	Excellent	8.4
RUNNER-UP	ZDS Z-Note 425Ln Model 120	\$2599	SL/25	2.22	Good	5:27	Fair	9.5
RUNNER-UP	TI TravelMate 4000 WinDX/25	\$2678	DX/25	2.32	Good	4:46	Fair	10
RUNNER-UP	CompuAdd 425TX	\$2090	SX/25	2.22	Excellent	4:10	Fair	9.5
RUNNER-UP	AST Bravo NB 4/25s	\$1948	SX/25	2.19	Good	3:16	Good	9.5

Tired of waiting for recalculations?

HIGH PERFORMANCE **CompUSA 486DX2/66 Slimnote**



If you need the fastest notebook for DOS applications, consider the CompUSA 486DX2/66 Slimnote. Internal niceties such as a 128-KB hard disk cache (most systems have from 0 to 32 KB) helped it achieve the second-best monochrome DOS performance score. A battery life of 3 1/2 hours was longer than the average. The trackball is nearly centered above the keyboard, making it easy to use with either hand.

		PRICE	CPU	DOS SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	CompUSA 486DX2/66 Slimnote	\$3228	DX2/66	3.14	Excellent	4:07	Fair	9.5
RUNNER-UP	Micro-International HCP Model 65681M	\$2805	DX2/66	3.66	Good	3:32	Good	9.5
RUNNER-UP	TI TravelMate 4000 WinDX/50	\$3478	DX2/50	3.27	Good	4:04	Fair	10
RUNNER-UP	HyperData HB 2300 DLC/40	\$2295	DLC/40	2.74	Excellent	2:52	Fair	8.8

Want the best for DOS on a budget?

LOW COST **Zenith Data Systems (ZDS) Z-Note 425Ln Model 120**



For simple DOS computing on a budget, the Z-Note 425Ln Model 120 is the best system we tested. The edge-lit passive screen was easy to read from a wide range of angles. Its 3.3-V processor (this was one of the 15 systems with low-voltage processors) gave the Z-Note a long battery life of almost 5 1/2 hours. Nine manuals detailed DOS, networking, start-up, the trackball, and other topics. Like the Compaq LTE, the Z-Note uses a processor with middle-of-the-road speed. At a price of \$2599, that's an acceptable trade-off.

	MODEL	PRICE	CPU	DOS SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	ZDS Z-Note 425Ln Model 120	\$2599	SL/25	2.22	Good	5:27	Fair	9.5
RUNNER-UP	TI TravelMate 4000 WinDX/25	\$2678	DX/25	2.32	Good	4:46	Fair	10
RUNNER-UP	CompuAdd 425TX	\$2090	SX/25	2.22	Excellent	4:10	Fair	9.5
RUNNER-UP	AST Bravo NB 4/25s	\$1948	SX/25	2.19	Good	3:16	Good	9.5

¹ Higher numbers indicate better performance (a 20-MHz 386SX Toshiba T2200SX = 1).

TravelMate 4000 WinDX/25 turned in the best performance of all the 25-MHz systems for the DOS WordPerfect and 1-2-3 application tests, with scores that

averaged more than three times faster than those of the baseline Toshiba system. Although we tested several 33-MHz monochrome systems that produced

better performance results than the 25-MHz units, each of these notebooks had shorter battery-life times and inferior ease-of-use ratings.

How to Buy a Notebook

1 Do you really need a cordless machine, or just a portable? If you plan to work while traveling, battery life is a high priority. If you plan to take your keyboard from site to site and expect to always have a power outlet handy, other features may be more important.

2 Are you left-handed? Many of the pointing devices are designed for right-handed use. Look for a system with a centered mouse or one that's mountable on the left side.

3 Are you concerned about stress-related injuries? A notebook with a wrist rest may be easier and healthier to use.

4 Are you using your notebook as your primary system? If so, you will need external ports for keyboard, video, and mouse. Additionally, you may need a docking station to access network interface cards, CD-ROM, and sound cards. Some systems, such as the Mac PowerBooks and Zenith Data Systems' notebooks, have many of these features built in.

5 How important is color? If your system is used primarily for document preparation, you probably don't need color. If you do extensive chart preparation on the road, however, color may be a must.

6 Are you using a windowing operating environment? The Mac OS, Microsoft Windows, and X Window System all use more processor power and place greater emphasis on screen quality. Plan to buy a 33-MHz or faster system.

7 What's your comfort level? Make sure that the notebook you buy has acceptable keyboard and pointing-device designs. If you are purchasing from a mail-order company, make sure you can return the notebook without incurring any restocking fees.

8 Do you plan to do extensive traveling? Monochrome notebooks lasted longer on our battery-life tests than color notebooks.

Portable Pointers



KEYBOARD-BASED

IBM's TrackPoint II places a small, pressure-sensitive, eraser-like protrusion between the G and H keys. Its two buttons are located just below the space bar, within easy reach of thumbs. This design makes it extremely easy to use and does not require your hands to leave the keyboard. However, damp or sweaty fingers slide right off the smooth rubber tip, which has no grooves or raised portions for extra grip.



RETRACTABLE

The slide-out trackball on the Amrel 486DX2/66 AC makes for easy storage when traveling. Due to the trackball's central placement on the front of the unit, it can be used by either left- or right-handed users.



FRONT AND CENTER

This trackball is located on the front of the Noteable N425. It's designed for thumb movement, with buttons located on each side. The range of thumb movement is greatly limited, however, because the trackball is so close to your work surface. Moreover, its left mouse button is dangerously close to the suspend/resume switch, and the buttons are unresponsive.



WRIST-REST TRACKBALL

A very large trackball is located on the PowerBook's wrist rest below the keyboard, with two surrounding oversize buttons. It's an extremely good design that several PC vendors have tried to imitate.



SIDE-MOUNT

Several vendors have begun using a QuickPort implementation that is an altered Microsoft BallPoint Mouse that attaches to the unit via pins, eliminating the need for a dangling cable. This mouse connects to a specialized port on the right side, prohibiting left-handed operation. Since the mouse is not integrated into the unit, you have to carry it separately when you're traveling.



CLIP-ON

Usually a Microsoft BallPoint Mouse or Logitech TrackMan Portable that provides more flexibility than the QuickPort interface, since this model can be attached to either side of the unit. On some notebook designs, the clip-on mouse can obstruct the floppy drive when attached to the right side of the case.



UPPER-RIGHT

Many pointing-device implementations arrange the trackball and buttons above the keyboard. This design offers a compromise between comfort and convenience. It usually offers left- or right-handed operation that is not too far from the keyboard, and there are extra parts to carry while on the road.

**YOU CAN'T CONTROL
YOUR BOSS,
YOUR WORKLOAD,
YOUR WEIGHT,
YOUR BACKHAND,
YOUR WEEDS,
YOUR DOG, YOUR LIFE.
AT LEAST NOW
YOU CAN CONTROL
YOUR CURSOR.**



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And which is why, in independent tests, people worked 35% faster with the BallPoint mouse than with other leading portable and built-in pointing devices.

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And have one aspect of your life firmly, and comfortably, in the palm of your hand.

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Unix on a Notebook

What does it take to run Unix on the road? To find out, we installed The Santa Cruz Operation's Unix System V release 3 version 2.4 on five notebooks. This version of SCO Unix is a full, non-graphical Unix, a multitasking operating system that is capable of supporting networking and compilers. We also installed SCO's Open Desktop 2.0. ODT 2.0 is a full-blown system based on SCO's System V product. It includes the X Window System (a fully networked windowing system), network software, a shared file system, and a DOS subsystem (which allows you to run DOS and Windows in an X window).

For comparison, we looked at a SparcBook 2 from Tadpole Technology. The SparcBook is based on Sun Microsystems' SPARC processor and came with X, the OpenWindows display manager,



Unix on the road: The SparcBook 2 (left), a RISC-based notebook; and Amrel's 486DX2/66 AC, the fastest 486-class system.

networking software, and a development system. A DOS emulator capable of running Microsoft Windows is also available for the SparcBook.

The SparcBook 2 is the only RISC-based Unix system that we tested. The test system had an active-matrix color screen; 32 MB of RAM; a 250-MB drive; an external monitor port; a SCSI port; an Ethernet port; and microphone,

mouse, serial, keyboard, and fax modem connections; but it had no floppy drive. The test configuration, including software, costs \$13,350. Using an Ether-

net transceiver, it took us less than 5 minutes to connect to our in-house TCP/IP network.

Although the display is only 640 by 480 pixels and 256 colors, the video system supports a virtual screen with six times the total area of the visible portion. You can slide windows from section to section and choose which of the six virtual pieces of the desktop you want displayed.

The SparcBook has a true sleep state: The system is turned off, and all memory is written to disk, to be automatically restored at start-up.

But this nifty feature is not without cost: Of the 250 MB on the hard disk, 32 MB is used for a swap space, and another 32 MB is used for a resume partition to hold the saved memory image.

PERFORMANCE

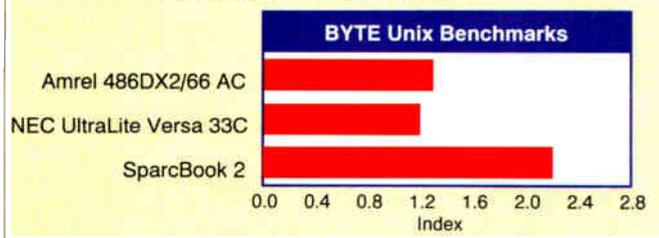
We ran the SPEC89 suite of application-level benchmarks on the five notebooks running SCO Unix SVR3 2.4. This implementation of SPEC is an unaudited implementation; as such, it should be used only to compare these notebooks with other systems running our implementation. We also ran the BYTE Unix Benchmarks version 3.0. The results are summarized in the graph.

The graph shows the fastest and slowest in each of the DX2/50 and DX2/66 categories for the June Lab Report on systems. Note that SPEC89 figures are indexed with respect to a DEC VAX

11/780 and that the BYTE Unix Benchmarks are indexed with respect to a Sun 3/50.

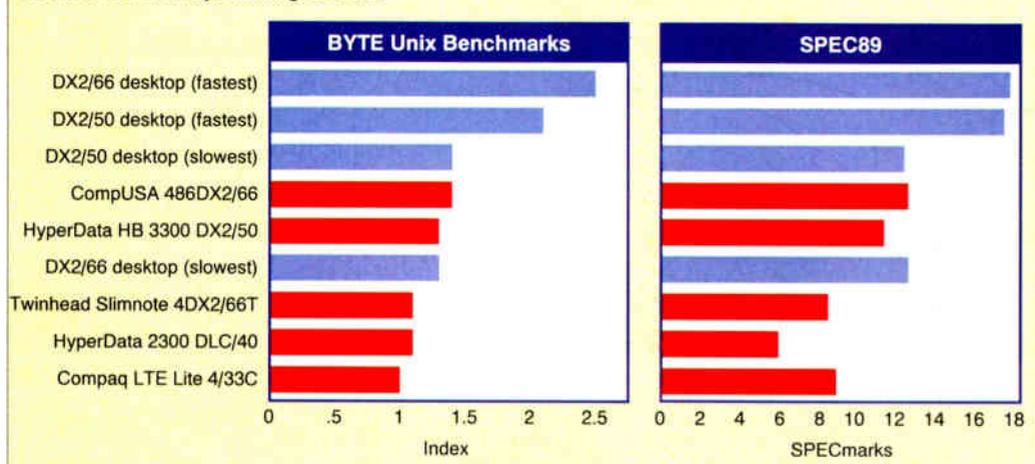
These results can be summarized in three words: Notebooks are slow. They are built with power conservation in mind, not raw performance. For example, practically every desktop system will have a secondary processor cache, but of the Unix notebooks we tested, only the HyperData's had one.

Notebook Performance Under SCO Open Desktop



The SPARC-based SparcBook 2 had performance nearly double that of two Intel 486-based notebooks.

Notebook vs. Desktops Running SCO Unix

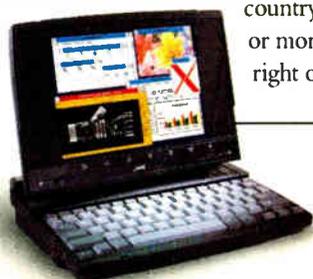


Although adequate for some Unix applications, 486-based notebooks lag in Unix performance compared to desktop 486-based systems.

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Circle 147 on Inquiry Card.

World Radio History

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Satellite 486

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- 6.5 lbs.

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T1950CT

- 8.4" color active matrix TFT-LCD screen
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ALL MODELS

- Intel 486™ DX2/40MHz, 3.3v
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- 14.5mm PCMCIA 2.01 slot
- BallPoint® Mouse 2.0 with QuickPort™
- NiMH battery with Toshiba MaxTime™ Power Management



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Don't copy that floppy.

DESKTOP REPLACEMENT

Need one system for office and travel?

BEST OVERALL

NEC UltraLite Versa 33C



The UltraLite Versa 33C was the fastest mainstream notebook in this category. In addition, this notebook's 9 1/2-inch screen received the second-best quality score in our entire sample (AST's PowerExec ranked first). A special bay lets you slide in a floppy drive or an additional battery, which can extend battery life to almost 6 hours. The \$5538 test model came with 12 MB of RAM, two Type II PCMCIA slots, a removable hard drive, and a clip-on mouse.



The processing power of 486-class notebooks means many people can justify buying a single system for use on the road or at the office rather than a separate system for each environment. A single system ends the hassle of transferring data between two different computers to keep duplicate sets of data files current. And depending on your hardware choices, the cost of a single 486 notebook may be far less than the combined price of a notebook and a desktop system.

To qualify as a desktop replacement, a notebook had to support an external Super VGA monitor at a minimum of 1024 by 768 pixels, an external keyboard and external PS/2-style mouse, and a docking unit. The latter is essential for expansion options for network or SCSI adapters, and bays for a second hard drive or tape or CD-ROM drives. Only 14 of the reviewed notebooks met these requirements. Because the prices for this subset of notebooks were so similar, we were unable to choose low-cost winners for this category.

We ranked these systems based on their performance in our DOS and Windows tests (weighted at 45 percent), screen quality (15 percent), battery life (15 percent), ease of use (10 percent), features (10 percent), and price (5 percent).

As in our other application categories, the Best Overall

		PRICE	CPU	OVERALL SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN TYPE	DOCKING STATION
BEST	NEC UltraLite Versa 33C	\$5538	SL/33	3.06	Excellent	2:55	Excellent	Color	\$699
RUNNER-UP	NEC UltraLite Versa 25C	\$4888	SL/25	2.52	Excellent	2:40	Excellent	Color	\$699
RUNNER-UP	Toshiba T4600C	\$4699	SL/33	2.69	Excellent	3:52	Fair	Color	\$849
RUNNER-UP	Twinhead Slimnote 4DX/33T	\$3895	DX/33	2.74	Fair	2:54	Good	Color	\$499

Do you need portability without compromise?

HIGH PERFORMANCE

TI TravelMate 4000 E WinDX2/50



The TravelMate 4000 E was the fastest notebook in this class, and within the top five notebooks in our entire sample. In addition, its active-matrix color screen is crisp and clear, with a very good viewing angle. The keyboard has a nice feel and can be used for hours without hand or wrist exhaustion.

		PRICE	CPU	OVERALL SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN TYPE	DOCKING STATION
BEST	TI TravelMate 4000 E WinDX2/50	\$5278	DX2/50	3.62	Good	2:36	Excellent	Color	\$929
RUNNER-UP	TI TravelMate 4000 WinDX2/50	\$3499	DX2/50	3.50	Good	4:01	Fair	Mono	\$929
RUNNER-UP	Twinhead Slimnote 4DX2/66T	\$4399	DX2/66	3.41	Fair	2:38	Good	Color	\$499

When color isn't required...

MONOCHROME

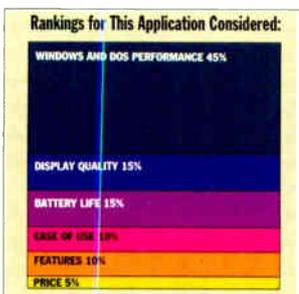
TI TravelMate 4000 WinDX2/50



The TI TravelMate 4000 WinDX2/50 is the fraternal twin of the 4000 E color notebook and, as such, the top monochrome system for both office and travel. This monochrome version may offer the best of both worlds. You get 4 hours of battery life for work on the road (the color 4000 E is limited to 2 1/2 hours), and when you're back at the office, the notebook can drive a full-color Super VGA monitor.

		PRICE	CPU	OVERALL SPEED ¹	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN TYPE	DOCKING STATION
BEST	TI TravelMate 4000 WinDX2/50	\$3478	DX2/50	3.50	Good	4:01	Fair	Mono	\$929
RUNNER-UP	TI TravelMate 4000 WinDX/25	\$2678	DX/25	2.48	Good	4:46	Fair	Mono	\$929

¹Higher numbers indicate better performance (a 20-MHz 386SX Toshiba T2200SX = 1).



notebooks here are those with clock speeds of 33 MHz or slower, while the High Performance models had CPUs ranging from 40 MHz up to the clock doublers.

The top notebooks in our Best Overall, High Performance, and Best Monochrome categories were among the fastest

systems in our entire test sample. The NEC UltraLite Versa 33C performed especially well in our graphics tests, thanks to its implementation of local-bus video. The Versa 33C even outperformed some of the clock-doubled systems on some of the tests.

Texas Instruments swept the

remaining categories with the TravelMate 4000 E WinDX2/50 and the TravelMate 4000 WinDX2/50. These two systems turned in the top two results in our hard disk-intensive FoxPro 2.0 application test, as well as the best scores for three of the five memory-move tests in the low-level benchmarks.

HONORABLE MENTIONS

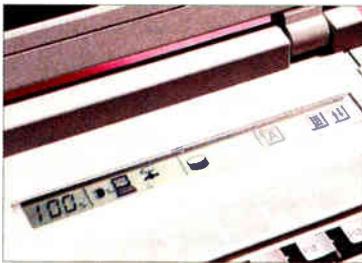
You can extend battery

life by removing the floppy drive from the NEC UltraLite Versa notebooks. After you pull out the floppy drive, you pop in a second battery, doubling the effective battery life to more than 6 hours.



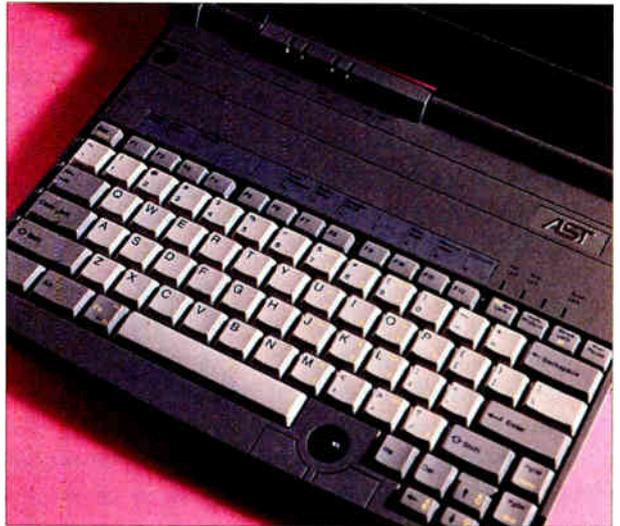
External ports on the Toshiba Satellite T1900C are covered with sliding doors. Most other systems use hinged panels, which are subject to snapped hinge pins.

The Toshiba T4600C status indicators consist of clever battery and water-faucet icons that make it easy to see how much battery power remains (either in percentage of full power or in time remaining) and what level of power management you've set.



Other icons show typical items such as Caps-Lock, floppy drive and hard drive access, and whether the power is on or off.

The AST Bravo 4/25s Color Model supported an extensive collection of well-labeled hot keys. These keys (activated by pressing Fn-F1 through Fn-F10) allow you to quickly adjust a variety of system management functions, such as system setup, gray-scale schemes, external monitor control, and checking the expected battery life. Other systems had similar hot-key features, but none were as extensive, convenient, or well labeled as the AST Bravo's.

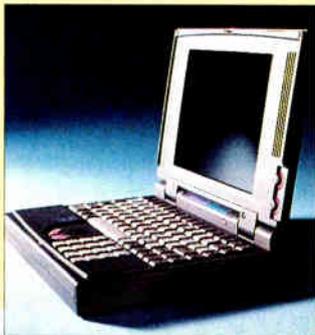


Dubious Achievements



Snap! Flimsy hinge pins on the Compaq Contura's port-cover plate break off with the slightest provocation. Thicker pins proved sturdier, but the best solution was the Toshiba Satellite's, with sliding doors covering its ports. Note that this problem is not restricted to Compaq; other vendors, including Twinhead and Texas Instruments, are equally guilty.

We expect occasional typographical errors, but the manual of the KingTech KS-486C went far beyond the norm. We had trouble finding a page without spelling or grammatical errors. Worse, some pages, like this one, contained incomprehensible crucial warnings.



Better keep your HyperData HB 3220 SLC/33 plugged in. Once its battery gets low, it starts playing Beethoven's *Für Elise*. Over and over. Until the system finally dies, leaving you (and whoever is sitting in the plane seat next to you) in blessed silence once again.

1865X1/486SI 1
Notebook Computer
User's Manual

• Avoid using washes such as fleon and trichloroethane on the LCD. They can seep into the resin sections of the connecting pins and melt the transparent electrodes, causing disconnection.

Two Thumbs Up For ALR's EVOLUTION V



"Best of Show, Spring Comdex, 1993"

BYTE Magazine - May, 1993

Winner

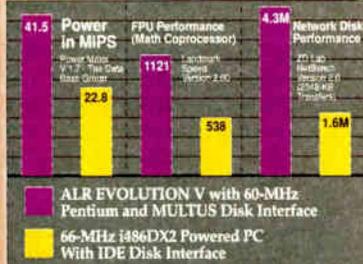
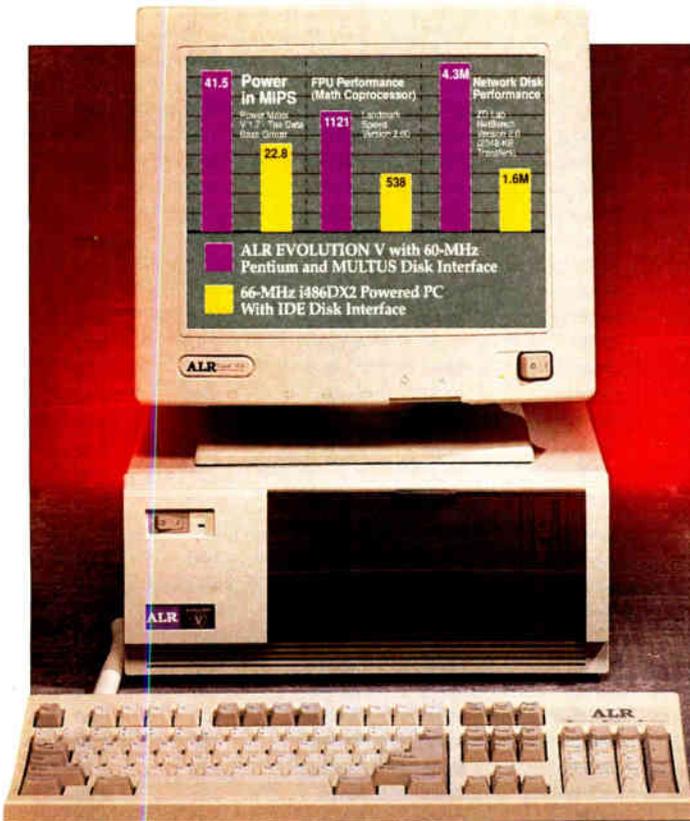
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The ALR EVOLUTION V



EVOLUTION V System Board Technology

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- System Also Includes: Six Drive Bays & 200Watt Power Supply

Model 170DWM

MODEL 1

Powerful Pentium Processing plus the Advanced Features shown at left -- amazing power for such a low price

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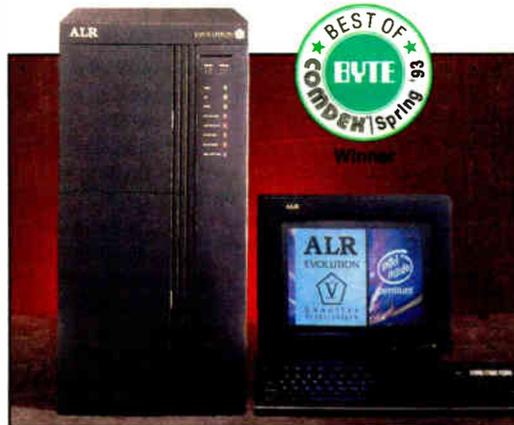
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Amrel Technology, Inc.	486DX2/66 AC	DX2/66	Color	Active	4.13	1:30
AMS, Inc.	TravelPro 4533 PAS	DX/33	Color	Passive	2.66	2:11
AMS, Inc.	TravelPro 5366A	DX2/66	Color	Active	3.39	2:52
AMS, Inc.	TravelPro 7525A	SL/25	Color	Active	2.20	2:58
Aspen Computer, Inc.	Aura 33	DX/33	Color	Passive	2.88	1:39
AST Research, Inc.	Bravo 4/25s Color Model 123W	SX/25	Color	Passive	2.14	2:15
AST Research, Inc.	Bravo NB 4/25s Model 123W	SX/25	Mono	Passive	2.15	3:16
AST Research, Inc.	Power Exec 4/25SL ColorPlus	SL/25	Color	Active	2.18	3:49
CAF Technology, Inc.	AquaLite-486DX3	DX/33	Mono	Passive	2.80	4:34
CAF Technology, Inc.	AquaLite-486DX3/C	DX/33	Color	Passive	2.29	3:04
CAF Technology, Inc.	AquaLite-486DX3/T	DX/33	Color	Active	2.80	3:16
CAF Technology, Inc.	AquaLite-486SLC	SLC/33	Mono	Passive	1.74	2:47
Chaplet Systems, Inc.	NBD 486SX-25	SX/25	Mono	Passive	2.30	2:39
Chaplet Systems, Inc.	NBD 486SX-25TFT	SX/25	Color	Active	2.29	1:55
Compaq Computer Corp.	Contura 4/25	SL/25	Mono	Passive	2.21	3:55
UNIT Compaq Computer Corp.	LTE Lite 4/25E	SL/25	Mono	Active	2.21	7:06
Compaq Computer Corp.	LTE Lite 4/33C	SL/33	Color	Active	2.71	2:20
CompuAdd Computer Corp.	425TX	SX/25	Mono	Passive	2.29	4:10
CompuAdd Computer Corp.	425TXT	SX/25	Color	Active	2.32	3:24
CompUSA Direct	486DX/33 Slimnote	DX/33	Mono	Passive	2.51	2:30
CompUSA Direct	486DX2/66 Active TFT Color	DX2/66	Color	Active	3.50	2:17
CompUSA Direct	486DX2/66 Slimnote	DX2/66	Mono	Passive	3.31	4:07
Epson America, Inc.	ActionNote 4SLC/25	SLC/25	Mono	Passive	1.40	2:32
Ergo Computing, Inc.	486 Marathon NoteBrick	SL/25	Mono	Passive	2.17	3:16
Ergo Computing, Inc.	PowerBrick 66	DX2/66	Color	Active	3.12	2:39
HyperData Tech Corp.	HB 2300 DLC/40	DLC/40	Mono	Passive	2.82	2:52
HyperData Tech Corp.	HB 3220 SLC/33	SLC/33	Color	Passive	1.83	2:04
HyperData Tech Corp.	HB 3300 DX2/50	DX2/50	Color	Active	3.33	1:19
IBM Corp.	ThinkPad 350C	SL/25	Color	Passive	2.41	3:07
IBM Corp.	ThinkPad 720C	SLC/250	Color	Active	2.70	4:00
Jetta International, Inc.	JetBook 486DX-33	DX/33	Mono	Passive	2.34	2:55
KingTech USA Corp.	KS-486C	SLC/25	Mono	Passive	1.20	1:30
Micro Electronics	WinBook 486 SLC/E	SLC/E/25	Mono	Passive	1.91	2:20
Micro-International, Inc.	HCP Model 65681C	DX2/66	Color	Passive	3.92	2:33
Micro-International, Inc.	HCP Model 65681M	DX2/66	Mono	Passive	3.84	3:32
Micro-International, Inc.	HCP Model 65681T	DX2/66	Color	Active	3.96	2:38
Mitsuba Corp.	486SX-AC	SX/25	Color	Active	1.87	2:33
NEC Technologies, Inc.	UltraLite Versa 25C	SL/25	Color	Active	2.52	2:40
UNIT NEC Technologies, Inc.	UltraLite Versa 33C	SL/33	Color	Active	3.06	2:55
Noteable Computers, Inc.	N425	SLC/25	Mono	Passive	1.47	2:16
Panasonic Communications & Systems Co.	CF-580 ¹	SLC/25	Mono	Passive	N/A	N/A
Primax Data Products	MediaNote 450V	DX2/50	Mono	Passive	2.15	2:01
UNIT Sager Midern Computer, Inc.	NP843T	DX/33	Color	Active	2.99	2:52
Samsung Electronics America, Inc.	S3800	SLC/25	Mono	Passive	1.48	2:30
Texas Instruments	TravelMate 4000 E WinDX2/50	DX2/50	Color	Active	3.62	2:36
Texas Instruments	TravelMate 4000 WinDX/25	DX/25	Mono	Passive	2.48	4:46
Texas Instruments	TravelMate 4000 WinDX2/50	DX2/50	Mono	Passive	3.50	4:01
Texas Instruments	TravelMate 4000 WinSX/25	SX/25	Color	Passive	2.28	2:23
Toshiba America Information Systems, Inc.	T4600C	SL/33	Color	Active	2.69	3:52
Toshiba America Information Systems, Inc.	Satellite T1900C	SXA/20	Color	Passive	2.03	3:17
Twinhead Corp.	Slimnote 4DX/33M	DX/33	Mono	Passive	2.51	2:52
Twinhead Corp.	Slimnote 4DX/33T	DX/33	Color	Active	2.74	2:54
Twinhead Corp.	Slimnote 4DX2/66T	DX2/66	Color	Active	3.41	2:38
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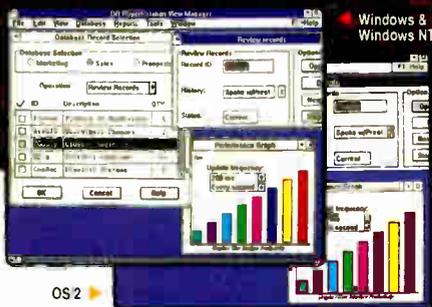
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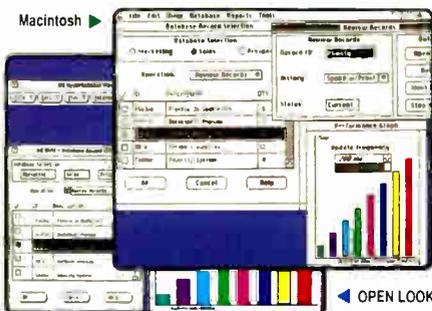
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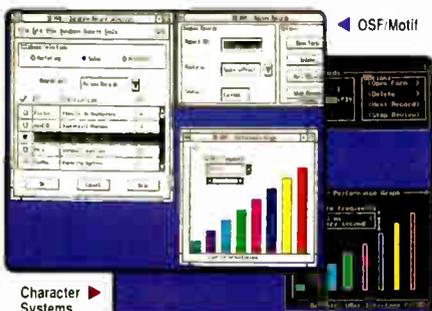
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Fractal Image Compression

Fractal-based compression techniques offer distinct advantages over JPEG image-compression techniques



LOUISA F. ANSON

For several years, many people in the personal computing world have been chasing the Holy Grail of mass-market computing: multimedia. Two obstacles to reaching that goal have been overcome: 16- and 24-bit color printers and scanners are now readily available, and true-color graphics adapters display stunning pictures. But the large size of the image files required for these beautiful images is a huge problem. A single 800- by 600-pixel true-color image requires 1.44 MB of disk space; an uncompressed 10-second video clip with 30 frames per second at 320 by 200 pixels in true color requires an enormous 57.6 MB of disk space.

Clearly, compression is necessary. JPEG is one commonly used compression technique. But you may not be aware of fractal image compression, which combines high compression ratios with fast decompression times.

Compression technologies can be divided into *lossless* and *lossy* methods. A lossless method always produces a decompressed image that is identical, pixel-for-pixel, to the original image. The problem with lossless methods, such as the one used in PKWare's PKZip, is that the attainable compression ratios on images are very small—typically 2 to 1. Lossy compression methods designed for image data can achieve much higher compression ratios. Both the DCT (Discrete Cosine Transform) and fractal-transform image-compression methods are lossy, but in other respects they are very different.

JPEG Compression

To understand the value of fractal image compression, you must first understand the status quo. In the world of image compression, that means JPEG. This standard, defined by the Joint Photographic Experts Group, describes ways of taking bit-mapped data for color or grayscale continuous-tone images and storing it in a smaller number of bytes.

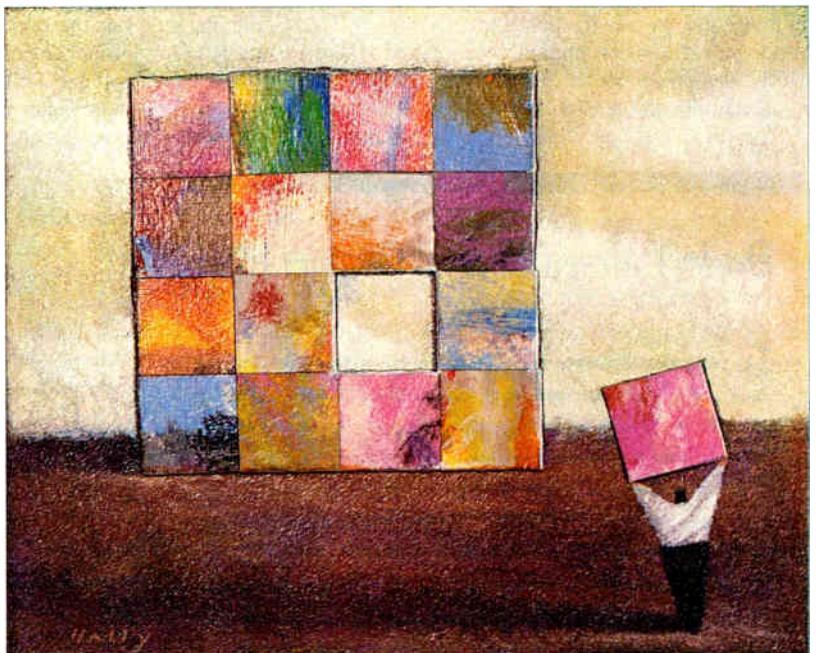
The JPEG assembly was first convened in 1986. Its goal was to find the best method for image compression and to get it adopted as an international standard. At press time, many worker-years had resulted in the JPEG recommendations' being formally adopted by the CCITT;

acceptance by the ISO was expected shortly.

The image-compression technology at the heart of the JPEG standard is DCT. Numerous publications provide an in-depth explanation of DCT and how it is used within the JPEG standard. Here I will provide just enough description to highlight the significant differences between DCT and fractal image compression.

DCT Explained

DCT breaks an image into 8- by 8-pixel blocks and then uses mathematical tricks to decide what image information can be thrown away without damaging the appearance of the image too much. DCT transforms the image data in the 8-by-8 block mathematically from x, y space into frequency space. Instead of viewing the data as an array of 64 values arranged in an 8-by-8 grid, DCT views



GREG HALLEY © 1993

it as a varying signal that can be approximated by a collection of 64 cosine functions with appropriate amplitudes. Each cosine that DCT uses as a basis function is associated with a value called its *DCT coefficient*, which determines each cosine function's amplitude.

Most of the important visual information for typical continuous-tone images is concentrated in the cosine functions with lower frequencies. Thus, by giving less weight to higher-frequency cosines and approximating



Compare the difference: The left image is from a 640- by 400-pixel, 24-bit color scan that resulted in a 768-KB file. Compressing this image at a ratio of 100 to 1 using JPEG/DCT creates a 7365-byte file (center), versus a 7316-byte file for the fractal transform compression (right). Both fractal and JPEG/DCT compression are lossy, but notice how the JPEG/DCT image exhibits distinct blockiness at this relatively high compression ratio.

small DCT coefficients to zero, compression can be achieved without too much image degradation. Further space savings are possible if you quantize the remaining DCT coefficients to a pre-defined set of values. With JPEG/DCT, the algorithm is symmetrical: Compression and decompression take roughly the same amount of time.

JPEG/DCT Limitations

Although the DCT method in the JPEG standard is effective at low compression ratios—up to about 25 to 1—it suffers from serious problems at higher compression ratios. Since the first step in JPEG/DCT is to break the image into 8- by 8-pixel blocks, the compressed file size is roughly proportional to the number of these blocks. Hence, as uncompressed files increase in resolution, JPEG/DCT compressed files either increase in size or decrease in image quality (see the parrot images above). The middle image of the parrot was compressed by a ratio of 100 to 1 using JPEG/DCT. The blocky nature of the image is typical of JPEG/DCT images at high compression ratios.

The JPEG/DCT assumption that higher frequencies are unim-

portant does not hold if you have sharp edges in your picture. Attenuating the higher-frequency DCT-basis functions results in artifacts that look like ripples spreading out from the edges. This effect, called *Gibb's phenomenon*, is most noticeable around edges and textures, and it is an unavoidable aspect of DCT.

The most serious problem caused by the long-term use of JPEG/DCT compressed images is that they are resolution dependent. Any attempt to display the decompressed image at a higher resolution than the original will result in the blockiness that results from pixel replication. Since graphics cards and printers have increased in resolution every year, resolution dependence results in this year's images needing to be re-scanned and recompressed next year to take full advantage of the latest technology.

Fractals Defined

For the purposes of this article, a *fractal* is an infinitely magnifiable picture that can be produced by a small set of instructions and data. With a fractal, the more you zoom in on an image, the more detail you see. If you zoom in on a bit-mapped image, however, eventually all you will see is big blocks of the same color.

The word *fractal* was coined by Benoit Mandelbrot to mean a fractured structure possessing similar-looking forms at many different sizes. For example, a tree in winter has large branches, small branches, and tiny twigs, all branching off in the same way at different scales. Traditional, abstract fractals, such as the Mandelbrot set, have become very popular. They tend to be harmonious, delicate, balanced, and pleasing to the eye because they have low information content (in the mathematical sense), which follows from the fact that the program that produces them is finite, even though the picture appears to be infinite. The eye is drawn toward them, and the mind senses their hidden order. Mandelbrot created some of the first pictures of abstract fractals, and he observed that similar mathematical structures lay behind the geometry of such things as clouds, mountains, and forests.

Affine Transformations

The concept of an affine transformation is central to fractal image compression. An *affine transformation* is a mathematical function made up from some combination of a rotation, a scaling, a skew, and a translation in n -dimensional space. A simple example in two dimensions would be

$$W(x,y) = (ax + by + e, cx + dy + f).$$

This can be written in matrix notation as the following:

$$W \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} e \\ f \end{pmatrix} = \begin{pmatrix} ax + by + e \\ cx + dy + f \end{pmatrix}$$

Do-It-Yourself Fractal Compression

The fundamental mathematics behind the fractal transform are very deep and can be implemented in various ways. To help you better understand the material in this article, I've made the source and executable code for a simple version of the gray-scale fractal transform available on-line as the file `fractal.zip` (see editor's note).

In these sample programs, various choices have already been made: The domain regions are simple 4- by 4-pixel squares, and the only affine transformations considered are simple translations, rotations, and flips. This program was written for clarity rather than speed or image quality, but it can achieve quite good results. Enclosed in `fractal.zip` you'll find `compress.exe`, `decompress.exe`, and two sample image files on which to run the program. See the `readme` file for details on using the program.

Note that computer implementations of the fractal transform are covered by various U.S. and worldwide patents and that the demonstration code is for sample purposes only. Use of this code for other purposes requires a licensing agreement from Iterated Systems.

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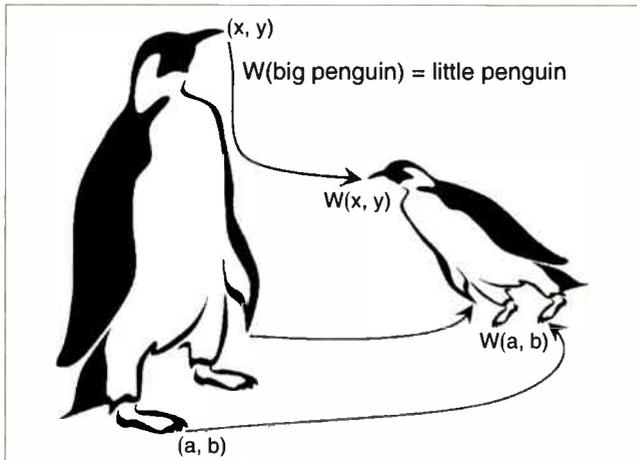
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A contractive affine transformation has a distinct effect on this penguin. The transformed big penguin (right) is smaller, and its feet are closer together. Such affine transformations are central to fractal image compression.

The matrix

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

determines the rotation, skew, and scaling, and

$$\begin{pmatrix} e \\ f \end{pmatrix}$$

determines the translation. This transformation moves the point $(0,0)$ to (e,f) , the point $(1,0)$ to $(a+e, c+f)$, the point $(0,1)$ to $(b+e, d+f)$, and the point $(1,1)$ to $(a+b+e, c+d+f)$. The values $a, b, c, d, e,$ and f are the affine coefficients for this transformation.

Consider the effect of an affine transformation W on a picture of a penguin in the x, y plane (see the figure above). Notice how applying W to the big penguin on the left results in the smaller penguin on the right. An affine transformation with this property is said to be *contractive*. Such affine transformations are important to the theory and practice of fractal image compression.

Given a two-dimensional image such as the penguin and its

affine transformation W , you can solve the six simultaneous equations determined by the x, y location of three points on the big penguin and the corresponding three points on $W(\text{big penguin})$ to find the values of the six coefficients ($a, b, c, d, e,$ and f) that define the affine transformation W .

Affine transformations are not restricted to two dimensions. A gray-scale image can be considered to be a 3-D entity with two spatial dimensions and one intensity dimension (see the figure below). If you apply a 3-D contractive affine transformation to a gray-scale image, then it will become smaller spatially, the brightness will change, and the contrast will decrease.

A collage of an image S is a finite set of N contractive affine transformations W_i with the property that

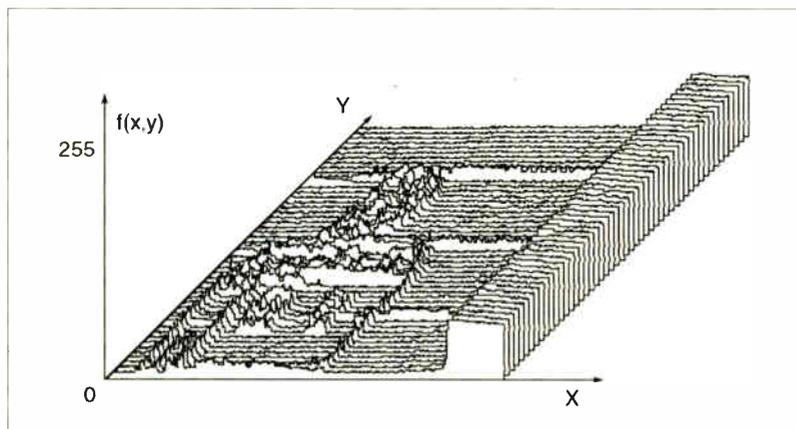
$$W_1(S) \cup W_2(S) \cup \dots \cup W_N(S)$$

is approximately the same as S , where \cup denotes the union of the images.

Study the series of images on page 202, and you will see that image A can be constructed from a combination of the two affine transformations of the leaf. To visualize these transformations, consider the three points labeled O, X, and Y, which make up three of the four corners of the rectangle in image A.

The affine transformation W_1 takes the origin O to $W_1(O)$, the point X to $W_1(X)$, and the point Y to $W_1(Y)$. The result appears as image B. Rectangle A has been shrunk, rotated, slightly twisted, and translated. The affine transformation W_2 takes origin O to $W_2(O)$, X to $W_2(X)$, and Y to $W_2(Y)$. The result appears as image C. Note that W_2 not only shrinks, rotates, and translates rectangle A, it also flips it relative to the y axis.

You can re-create the leaf by combining images B and C, so these images and their affine transformations form a perfect collage for the leaf. In "A Better Way to Compress Images" (January 1988 BYTE), Iterated Systems' founder Michael F. Barnsley and Alan D. Sloan show in detail how a collection of affine transformations can be used to re-create a fractal replica of a leaf by using an algorithm called the Chaos Game. In this way, the 12 numbers that define the two transformations can generate an intricate picture of a leaf with infinite detail. The Collage Theorem states that "the more accurately the union of the transformed images approximates the target image, the more accurately the set of transformations provides an encoding of that target image."



A 2-D gray-scale image actually has three dimensions: height, width, and intensity. This is evident in the above graph.

Fractal Image Compression

The Collage Theorem and the Chaos Game were breakthroughs for pictures of ferns, but arbitrary real-world images could still be encoded only by the tedious process of modeling the image as a collection of fractal segments and finding the right set of affine transformations for each. Before fractal image compression could be used commercially, a method was needed that could be carried out automatically by a computer in a reasonable amount of time and with predictable and accurate results.

While considering this problem, Barnsley made the observation that all real-world images are rich in *affine redundancy*; that is, under suitable affine transformations, large bits of real-world images look like smaller bits of the same real-world image. This observation, together with the mathematics of the Collage Theorem, led him to the invention of

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the fractal-transform process for automatic image compression.

The first step in the fractal-transform compression process is to partition the image into nonoverlapping domain regions (see the figure "The Fractal Image Compression Process"). Taken together, the set of domain regions must cover the entire image, but they can be any size or shape. Next, the program defines a collection of possible range regions, which must be larger than the domain regions, can overlap, and need not cover the entire image.

For each domain region, the program must choose the range region that, after an appropriate 3-D affine transformation is applied, most closely matches the domain region. The affine transformations not only shrink and deform the image within the range region, they also decrease contrast and change brightness in the intensity dimension. Each 3-D affine transformation can be described by its affine coefficients.

A FIF (Fractal Image Format) file is then written. It consists of a header with information about the specific choice of domain regions, followed by the packed list of affine coefficients chosen for each domain region. This process generates a file that is independent of the resolution of the original image; you have found an equation for the picture. Consider a straight line: It can be represented by the equation $y = ax + b$. If you know the values of the coefficients a and b , then you can draw the line at any resolution. In an analogous way, given the affine coefficients in the

FIF file, the decompression process can create a fractal replica that looks like the original at any resolution.

Commercial implementations of the fractal transform face some complex trade-offs when choosing domain regions, range regions, and allowed transformations. The larger the domain regions, the fewer the number of transformations that are needed to model the image, and the smaller the fractal file. However, if a reasonably close match is not found between each of the domain regions and a transformed range region, the quality of the decompressed image is reduced.

The compressor considers domain regions of various sizes, finds the best range region for each in the time available, and uses a mathematical procedure to assess the optimum set of domain regions for the desired file size. On a region of blue sky, for example, it may be possible to use a large domain region that matches well with an even larger patch of sky. But in another part of the picture, you might have to use a smaller domain region to find a good-enough range region within the available search time.

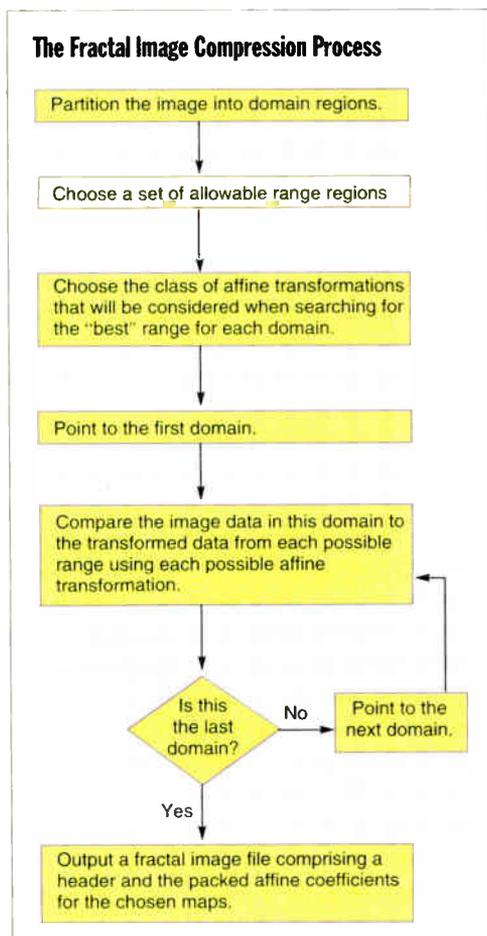
To keep compression time reasonable, practical limits must be put on the collection of possible range regions and the allowed transformations. In Iterated Systems' Poem ColorBox, for example, the compressor has four possible modes that control the time allowed for searching out the best range region for each domain. In the higher-quality modes, which take the most time,

it is possible to extend the class of transformations and the set of possible range regions to achieve better image quality in the same compressed file size.

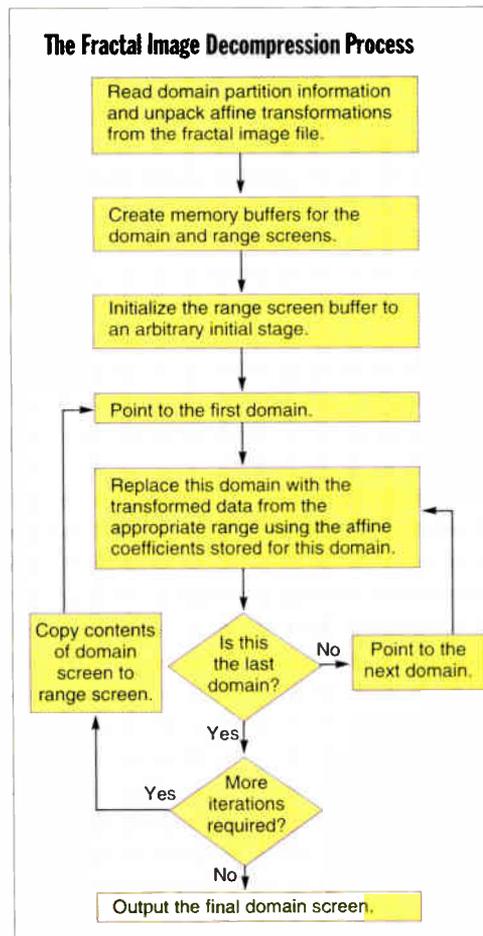
Fractal-Transform Decompression

The decompression process starts when you assign memory for two equal-size images A and B. The size of these images can be smaller or larger than that of the original image before compression, and the initial content is unimportant. It can be data, a picture of your dog—anything.

For the first iteration of the decompression process, I refer to image A as the *range image* and image B as the *domain image* (see the figure "The Fractal Image Decompression Process"). I partition the domain image into domain regions specified in the FIF file header. For each domain region in the domain image, I read the affine coefficients for this domain from the FIF file, locate the range region specified by this affine transformation in the range image, and map the contents of this range region from the range image



The algorithm for fractal-transform compression of image data.

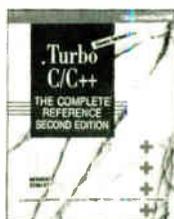


The algorithm to decompress an image stored as fractal-transform data.

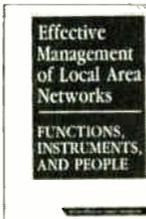
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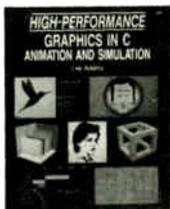
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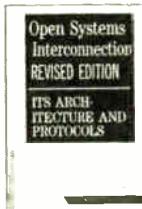
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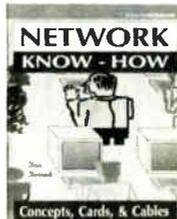
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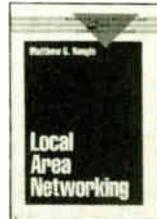
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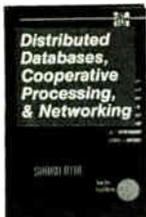
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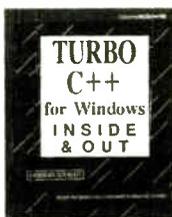
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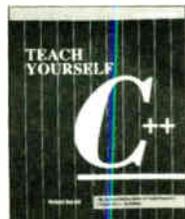
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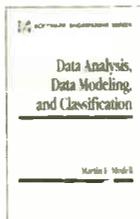
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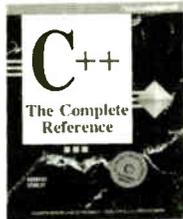
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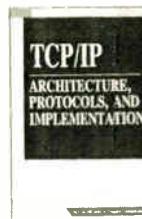
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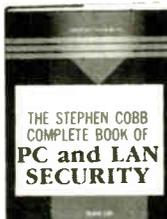
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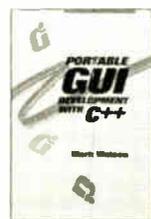
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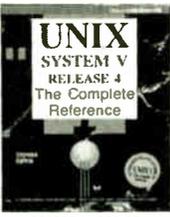
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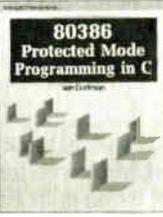
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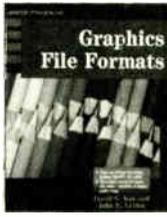
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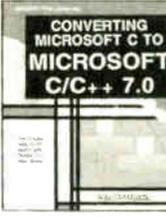
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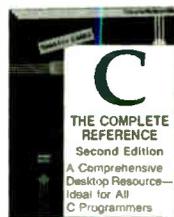
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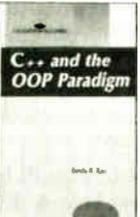
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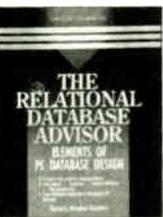
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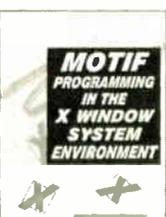
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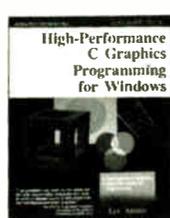
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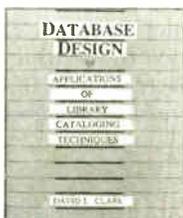
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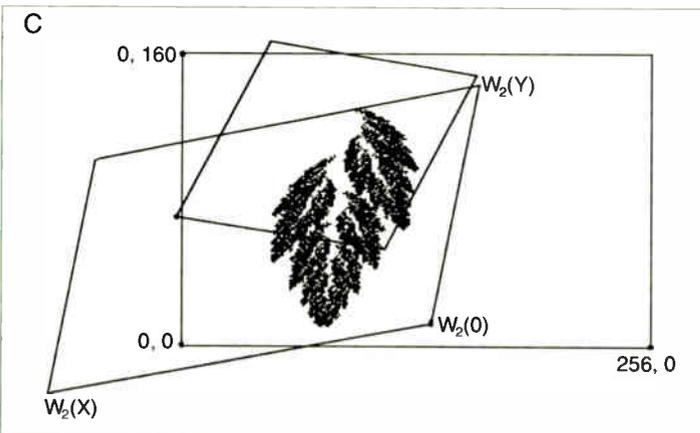
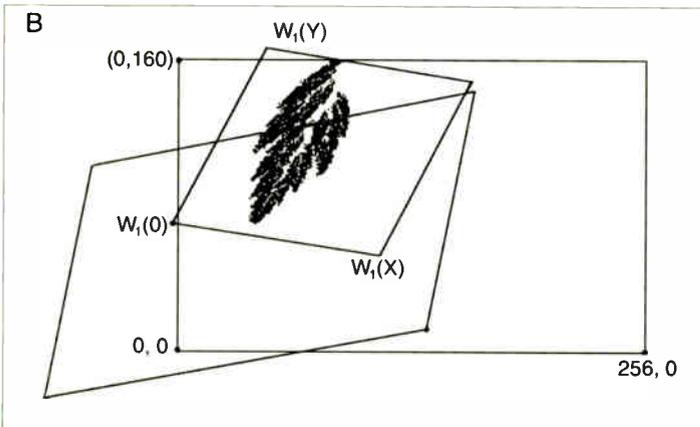
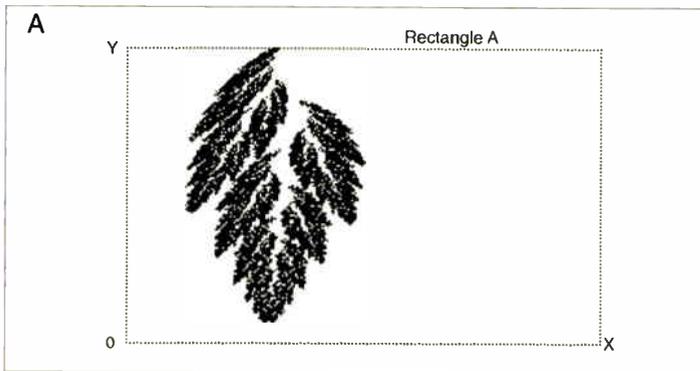
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The leaf in A has been transformed by affine transformation W_1 to get leaf B, and by affine transformation W_2 to get leaf C. If you combine the transformed images in B and C, the resulting image looks like the leaf in image A.

to the appropriate domain region in the domain image.

Note that the transformation from the range to the domain is contractive, since I require the range regions to be larger than the domain regions. When this is done for each domain region, a new image B is created from transformed bits of image A.

For the second iteration, I make the new image B the range image and image A the domain image, and I repeat the process for each domain region. After two iterations, the arbitrary starting data has been mapped from A to B and then from B to A. I repeat this process until the differences between images A and B are indiscernible, and I then display image A.

This simple process creates an image. How closely the decompressed image matches the original depends on how accurately the chosen range regions match the domain regions during the compression process. For a mathematical explanation of why the fractal transform works, see the book *Fractal Image Compression* (see bibliography).

Fractal vs. JPEG/DCT

Fractal-transform image compression overcomes many of JPEG/DCT's problems. The fractal-transform process can use much larger and more complex regions when dealing with high-resolution images, so the size of a compressed FIF file does not have to increase in proportion to the number of pixels in the image. Instead of suppressing the higher-frequency data associated with sharp edges, fractal compression predicts edges at higher resolutions from the fractal model determined during compression.

The fractal-transform process is inherently asymmetric—more computation is required for compression than for decompression, so fractal-transform compression is relatively slow, while decompression is fast. Also, compression ratios can be improved by taking more time during compression without any increase in decompression time or decrease in image quality.

For example, in the JPEG version of the parrot in the photo, JPEG software compression and reading/decompression require 41 seconds each on a 386/33. By contrast, the fractal image compressed in 8 minutes, but it was read and decompressed in 7 seconds. Reading the original, uncompressed image required 14 seconds. Fractal compression time can be reduced by using fractal accelerator compression boards or by using a smaller compression ratio.

Decompression speed, resolution independence, and high compression ratios distinguish fractal image compression from JPEG/DCT. Many applications developers may find fractal image compression preferable for multimedia applications where quick access to high-quality images is essential. Microsoft, for example, currently uses fractal image compression in its Encarta multimedia encyclopedia. ■

Editor's note: The listings for programs mentioned in this article are available electronically. See page 5 for details.

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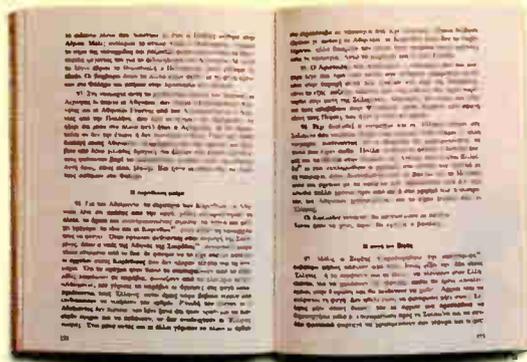


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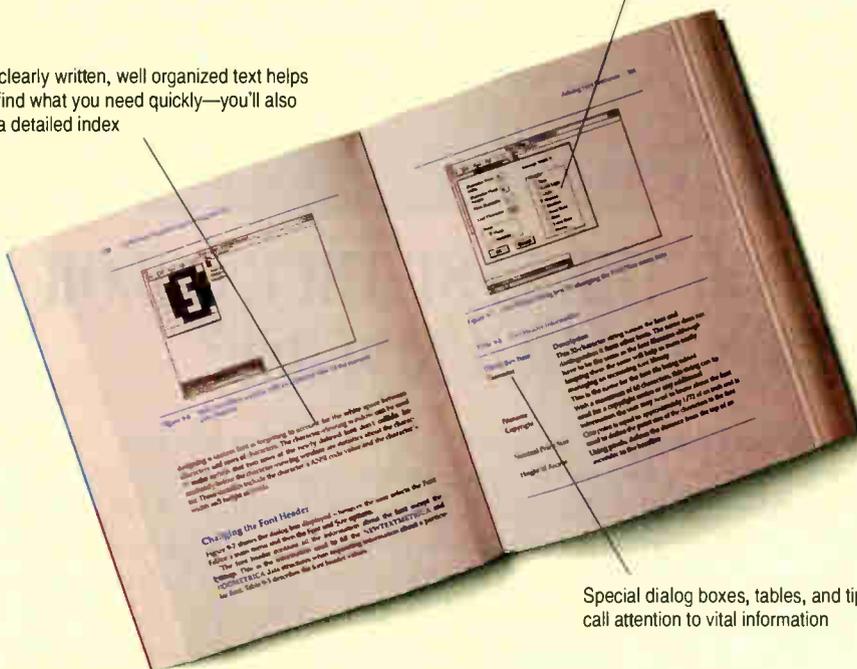
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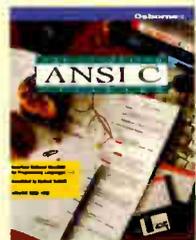
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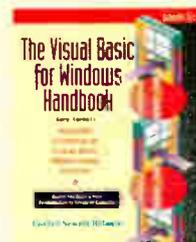
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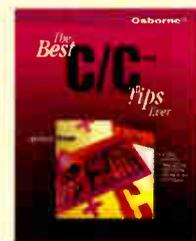
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Visual programming tools make quick work of simple OS/2 programming jobs



MARK J. MINASI

This month, I'd like to let you in on a little secret of mine: a quick way to build small OS/2 GUI applications. Now and then, a client needs a quick-and-dirty routine to "GUI-ize" something. They might want me to tie together several existing applications, put a GUI front end on something, or perhaps create a small stand-alone GUI application. Pulling out the C compiler can result in long hours of coding—something I know the client is not willing to pay for. That's when I reach for my visual toolbox.

You've probably heard of visual development systems like ObjectVision and Visual Basic for Windows. Borland even offers ObjectVision for OS/2, which is a great product for projects like putting a front end on a database. But for simpler tasks, a product like Visual Basic has been lacking.

For years, DOS users have turned to simple tools like QuickBasic to grind out simple character-based routines. But what do OS/2 users have to accomplish this? Since version 1.3, OS/2 has had something that has about the same level of power as BASIC, and it's built in: the REXX procedural language.

REXX is actually a more powerful language than BASIC when it comes to controlling the underlying operating system. It's integrated into OS/2 more closely than BASIC ever was with DOS. REXX isn't as well known or well documented as BASIC, but it's quite good nonetheless. As a simple command-line-oriented procedural language, however, it has been no good for controlling the Workplace Shell GUI. That has now changed. Recently, HockWare and Watcom introduced VisPro/REXX and VX-REXX, two similar products that add significantly to REXX.

VisPro/REXX vs. VX-REXX

I've had more experience working with VisPro/REXX than with VX-REXX, but I've put together applications with both. These products let you build Workplace Shell applications using just REXX and a few extra DLLs. You can build some nifty applications.

Visual Basic reworked the whole idea of BASIC, meld-

ing together a traditional BASIC interpreter with a screen-painting program to create a run-time environment. In contrast, VisPro/REXX is simply a bunch of new REXX functions.

For example, to put a window on the Workplace Shell, you just call the REXX function `VOpenWindow`, which takes as input parameters the dimensions of the window, the window's title, and the border color. `VOpenWindow`, if successful, returns a window ID, or *handle*, which you can use with `VForeColor` to set the foreground color, `VSetFont` to control the text font used in the window, or `VSay` to put text into the window. `VMsgBox` displays a simple text message box with programmer-selectable feedback buttons such as OK and Cancel.

In contrast, VX-REXX uses a slightly more object-oriented approach that relies, according to Watcom, on the



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SOM (System Object Model) support in OS/2. VX-REXX lets you define characteristics for different objects and change them with a `VRSet` command. For example, to change a button's background color to blue, you'd use the command `Call VRSet "PB_4", "BackColor", "Blue"`. Here, `PB_4` is the name of the push-button object.

Creating dialog boxes is a snap in VisPro/REXX as well, and it even comes with some predefined dialog

boxes. To display a dialog box that looks like the standard OS/2 File Choose dialog box, for example, you just add the following line to your program: `button = VFile-Box('Pick a file...', 'c:\os2*.exe', 'file')`. The result is indistinguishable from when you click on File/Open from inside the system editor. (VX-REXX has a function like that as well: `VR-FileDialog`.) If you don't like the prebuilt dialog-box functions, you can build your own dialog boxes with functions to display command buttons, radio buttons, checkboxes, and the usual GUI tools.

Most VisPro/REXX programmers will never have to worry about these built-in functions, however. It has an integrated form painter (*form* is VisPro/REXX talk for window) that lets you drag and drop controls from a toolbar to your program, building entire applications with clicks and drags. Want a button in the middle of your program that says "Exit"? Just drag a button from the toolbar to wherever you want it, drop it, and edit its Settings notebook to specify the Exit text. To tell the system what to do when a button gets pushed, just click on the button, choose the When option on the Form menu, and code to your heart's content.

VX-REXX uses something like that, but with a look and feel more like Visual Basic's toolbar. I prefer its screen painter to VisPro/REXX's only because I've never found dragging and dropping a comfortable action.

Additionally, the defaults on colors and shading under VX-REXX produce somewhat more professional-looking programs. Those things can be accomplished by VisPro/REXX as well, but at the cost of a bit more programming. You get the feeling with VX-REXX that the designers thought a lot about what the programs that it produces look like.

VisPro/REXX knows graphics as well. You can draw objects with the `VDraw` and `VArc` functions. `VDraw` is very powerful, incorporating the ability to control line styles, endings, and colors. A demonstration program that HockWare ships with VisPro/REXX shows how to draw splines with `VDraw`. I found it quite simple to throw together a basic drawing package using largely `VDraw` commands. VX-REXX, in contrast, doesn't support any drawing tools, or at least none that I was able to find.

Missing Pieces

These visual tools are not without flaws. VisPro/REXX and VX-REXX are interpreted, which means that you won't use them to do your Mandelbrot calculations—at least not in this lifetime. For speed-critical applications, these are *not* the tools of choice.

VisPro/REXX includes a sample calculator application, and I found it easy to click on the number buttons too quickly for the calculator to catch on. When I entered the number 6542, it often registered as 64 on the display. In contrast, VX-REXX's calculator had no trouble following the keystrokes. VX-REXX's built-in objects made it possible to put together a better-looking calculator, as well.

VisPro/REXX is a good tool for building GUI

batch files and light-duty programs, although the user interface is a little clumsy. For example, if you put a control into your new program and then change your mind about using the control, you can't just click on it and press the Delete key, as you do with VX-REXX. You've got to click on Edit/Cut.

Event-driven programming can be tough to get used to, but if you're willing to do some more work, you can avoid much of the

event-driven stuff with VisPro/REXX and VX-REXX. Because they still incorporate the familiar input-processing-output paradigm of common procedural languages, you can choose to write the familiar interactive program that you'd write without any GUI in mind. Instead of PARSE, PULL, and SAY (REXX for INPUT and PRINT), you use the special GUI-ized functions incorporated in VisPro/REXX.

That design springs mainly from the fact that, again, this is not a whole new language—it's just a library you add to the already-existing REXX interpreter

that's built into OS/2. As a result, you can opt not to completely rewrite REXX programs into VisPro/REXX or VX-REXX; you just modify the existing I/O sections.

That points to another potential problem for someone wanting to get started with one of these tools: They assume you know REXX. At some point, the clicking and dragging ends and the coding starts. I recommend getting a firm foundation in REXX before tackling these development tools. REXX is, however, simple to pick up, as it looks a lot like Pascal or QuickBasic.

Price Is the Object

VX-REXX is quite attractively priced at \$99. VisPro/REXX, unfortunately, costs \$299, and that's the so-called introductory price. It's hard to justify an interpreted tool for \$299; \$99, on the other hand, goes down smoothly. There are no royalties for distributing applications built with either tool, however. HockWare's Bronze Edition of VisPro/REXX sells for \$99, but it does not include the business graphics, container control, notebook control, and slider control features.

If I have a major wish for these tools, it is that they let me make OS/2 API calls. Neither can do this, but VX-REXX can create and manage threads, a pretty nifty capability for a macro programming tool. Of course, both of these packages may be put to shame by a product that IBM is rumored to be working on, another visual tool that may be incorporated into a future version of OS/2.

If you want a good tool for prototyping OS/2 GUI programs, or a tool to quickly put a GUI front end on an existing OS/2 application, pick up one of these packages. Of the two, I prefer VX-REXX. But both are good examples of a new breed of visual development tools that will improve the general lot of GUI programs and simplify GUI programming. ■

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For speed-critical applications, these visual tools are *not* the tools of choice.

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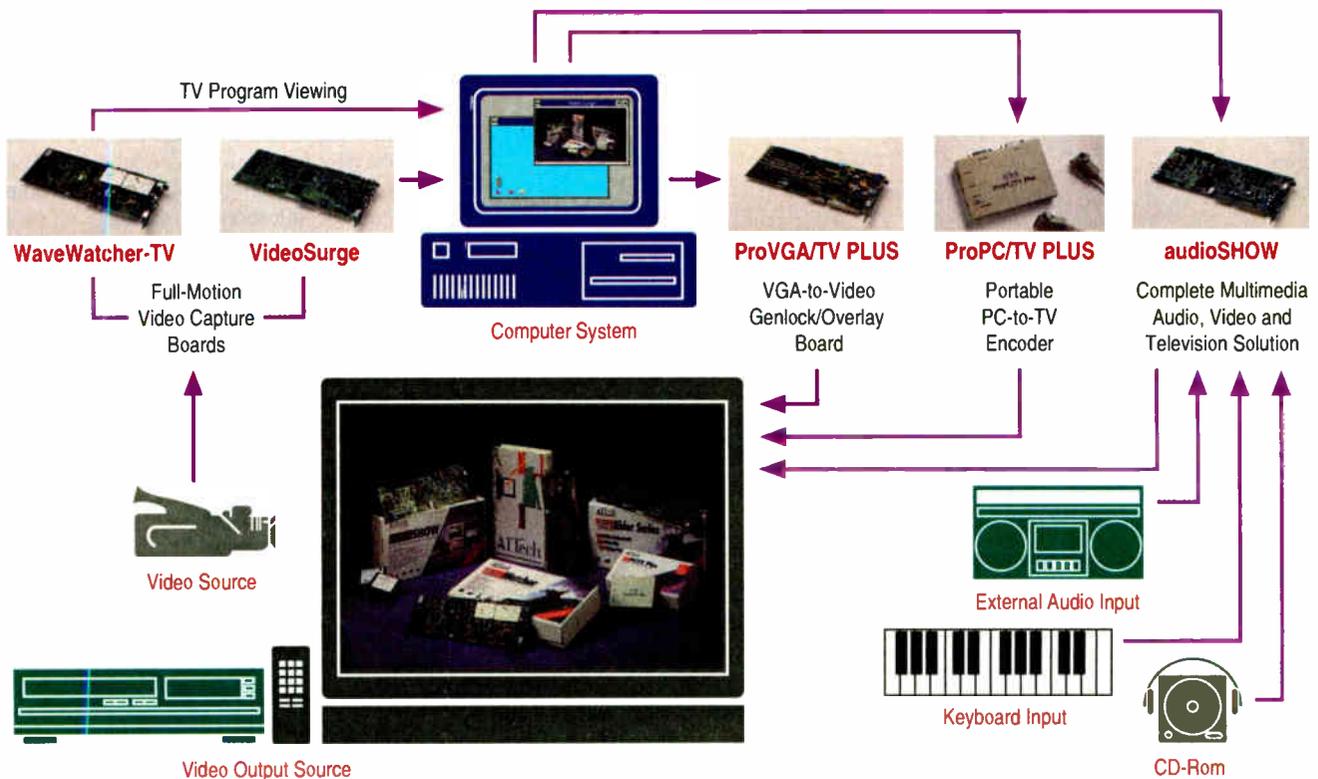
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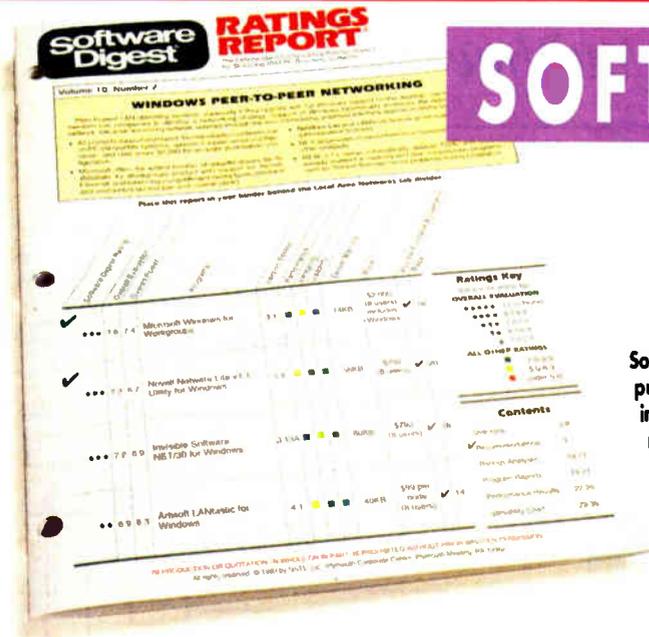
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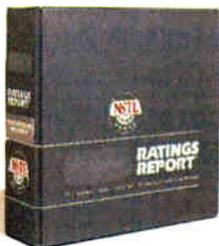
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Windows NT, OS/2, and Debuggers

A developer of programming tools looks at the power of debugging APIs in Windows NT and OS/2



MATT PIETREK

Last month I reviewed the fundamental services that operating systems must provide to a debugger. I showed the services that Microsoft Windows 3.1 provides and how a Windows debugger would use them. This month, I focus on debugger support under OS/2 2.1 and Windows NT on Intel-based systems.

Understanding debugger support in an operating system is important for any programmer—not just those who write debuggers. It's an essential part of writing many classes of tools and applications. For example, a program that wanted to monitor window messages and API calls would need to use the facilities designed primarily for debuggers.

The OS/2 2.1 Environment

Unlike that of Windows 3.1, the OS/2 2.1 memory model provides for each application to have its own address space. Whenever the operating system switches to a new task, it changes the CPU's page tables so that memory used by one process is not accessible to another. DLLs, however, are a special case; they can have code or data that's visible in the address space of two or more processes.

In addition to address-space considerations, an OS/2 debugger also must contend with multithreaded processes. The debugger must track the comings and goings of threads in the child process. When displaying the call stack or registers, the debugger needs to be aware of and display the thread to which the stack or registers pertain.

In OS/2, your sole connection to the process that is being debugged is through the `DosDebug()` API. To use it, you create a command by filling in various fields of a `DBGBUF` structure. You then pass the structure to `DosDebug()`, which acts on it. When `DosDebug()` returns, it has filled in the structure with notification information. The notification may be a simple success code (`DBG_N_Success`), or it may be something complex, such as a notification of a DLL load occurring (`DBG_N_ModuleLoad`).

A short sequence of `DosDebug()` commands and

notifications might resemble the following scenario: The debugger issues a `DBG_C_Go` command. When `DosDebug()` returns, the `DBGBUF` structure has fields specifying information about a module load (`DBG_N_ModuleLoad`). The debugger then does whatever housekeeping it needs to do for a module load and issues another `DBG_C_Go` command. This time, `DosDebug()` returns a `DBG_N_Exception` command, with one of the `DBGBUF` fields indicating that the exception was a breakpoint. At this point, the debugger could issue `DBG_C_ReadReg` and `DBG_C_ReadMemBuf` commands to get the current register and memory values to update the display.

If you were to believe the badly written `DosDebug()` documentation, you might think it's possible to get any `DBG_N_xxx` notification after giving any `DBG_C_xxx`



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command. In reality, the `DosDebug()` commands can be broken into two categories: commands that return immediately and commands that block until something happens in the child process.

The commands that return immediately are information commands, such as `DBG_C_ReadReg` and `DBG_C_ReadMemBuf`. The commands that do not return immediately are the execution control commands, such as `DBG_C_Go` and `DBG_C_SStep`. The presence of

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commands that block until something takes place in the child process has a dramatic impact on the design of an OS/2 GUI debugger.

In OS/2, as in Windows, a GUI program that isn't pumping messages is a quick ticket to a deadlocked input system. Consider what would happen if an unsuspecting debugger were to call `DBG_C_Go` for a child program that was just about to enter into a 2-hour database sort. Until the child process stops for some reason (e.g., by hitting a breakpoint), the debugger user interface thread is blocked, waiting for the `DosDebug()` call to return. Since the single debugger thread is blocked in the `DosDebug()` call, the debugger isn't calling `WinGetMessage()` and `WinDispatchMessage()`, so the mouse and keyboard are useless. But OS/2 has preemptive multitasking, so it shouldn't matter if the debugger thread is blocked, right? While that's true, the design of the Presentation Manager input system still requires that applications call `WinGetMessage()` on a regular basis.

The solution to this problem is to start a second thread whose job is to perform `DosDebug()` calls. In this scenario, the primary user-interface thread tells the second thread to issue `DosDebug()` commands (think of the second thread as a `DosDebug()` server thread). When the second thread calls `DosDebug()`, it blocks with no ill effect on the user-interface thread. When the `DosDebug()` call finally returns, the `DosDebug()` thread indicates to the user-interface thread that there's new information available on the child process. A posted message is ideal for this.

Loading a New Process

Loading a process for debugging under OS/2 is a two-step procedure. First, you go through the laborious process of setting up a `STARTDATA` structure that you'll pass to `DosStartSession()`. To debug a program, it's essential that you specify the `SSF_TRACEOPT_TRACE` and `SSF_RELATED_CHILD` flags in the `STARTDATA` structure. You also need to specify what type of application you're debugging: PM, Windowable VIO (video input/output), or VIO.

After the process has been loaded and the new session started, you then call `DosDebug()` with the `DBG_C_Connect` command. When you return from this call, you are connected to the child process, but you're positioned in some OS/2 system DLL instead of at the first instruction. To get to your program's entry point, you need to set a breakpoint at the entry point and run the child process until it hits the breakpoint.

The only way I know to determine the starting EIP register is to parse the executable file directly. Once the breakpoint is set, you issue `DBG_C_Go` commands until you receive a `DBG_N_Exception` notification for the breakpoint. Between issuing the first `DBG_C_Go` command and finally hitting the breakpoint, you'll receive a slew of `DBG_N_ModuleLoad` notifications for all DLLs to which the program implicitly links. Unlike with Windows, you will receive a module load notification even if the DLL was already present in memory when the child process loaded. You can also receive more than one module load notification per DLL—for example, if a DLL is also using a DLL that your program is using.

Execution Control

Execution control over a child process boils down to letting you know about the process's exceptions and interrupts. In Windows, a debugger actually sees interrupts for the child task because it installs an interrupt handler for all tasks in the system. While this is good in some respects, it's not secure. A buggy debugger can bring the whole system down. OS/2, on the other hand, has "crash protection." While OS/2 users often get a laugh out of this name, it does at least mean that OS/2 attempts to isolate processes from one another.

Among other things, an OS/2 process is unable to handle the interrupts and exceptions of other processes. Since a debugger needs to handle these very things for the child process, some sort of compromise is necessary.

OS/2 provides for this case by putting a layer on top of the interrupt handler. Instead of the debugger handling interrupts directly, the OS/2 kernel handles all interrupts. If the interrupt is for a process that is being debugged, the kernel interrupt handler passes the debugger a sanitized report of the relevant information in the form of a `DosDebug()` `DBG_N_Exception` notification.

One of the nice features of `DosDebug()` is that it attempts to handle some of the housekeeping chores for you. For instance, it takes care of setting the trap flag to indicate whether the child process will single-step or run. To make the child process run, you'd use `DBG_C_Go`. To make it single-step, you would use `DBG_C_SStep`. Without these commands, you would need to read in the child process's register set, modify the trap flag image, and write the registers back out.

When the child process encounters an exception of some kind (an INT 1 single-step, an INT 3 breakpoint, or something like an exception 13 general protection fault), the debugger needs to issue a `DBG_C_Continue` command eventually. When it does, a separate field in the `DBGBUF` structure indicates to OS/2 how the exception should be handled. The debugger has three possible choices of action.

For normal single-step and breakpoint exceptions, the debugger specifies `XCPT_CONTINUE_STOP`. This tells the OS/2 kernel that the debugger has handled the exception and wants the child process to stop (usually so that it can update its display and receive a new command from the user). In this case, the child process will not see the exception.

The second possibility is that the debugger specifies `XCPT_CONTINUE_EXECUTION`, which tells the operating system that the child process should resume execution and not see the exception. A debugger uses `XCPT_CONTINUE_EXECUTION` if it wants the child process not to see signal exceptions, such as Control-C.

The final option for handling an exception is to specify `XCPT_CONTINUE_SEARCH`, telling OS/2 that it should search for exception handlers installed by the child process. If the kernel finds an exception handler, it passes control to it. If the child process hasn't installed an exception handler, the kernel invokes

A GUI program that isn't pumping messages is a ticket to a deadlocked input system.





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the default operating-system handler, which typically terminates the process.

Memory Access

The most obvious way to read and write child-process memory in OS/2 is with `DBG_C_ReadMemBuf` and `DBG_C_WriteMemBuf`, but I've found that these commands can be relatively slow. If you need to access the child process's memory space frequently, consider using `DBG_C_MapROAlias` and `DBG_C_MapRWAlias`. These commands let you specify a range of memory in the child process's address space that is also accessible in the debugger's address space. This can be done through the magic of page tables.

One of the joys of writing an OS/2 debugger is having to contend with 16-bit segments. The `DBG_C_ReadMemBuf` and `DBG_C_WriteMemBuf` commands deal only with 32-bit linear addresses, so a debugger needs to convert any segment:offset address into its linear equivalent. The `DBG_C_SelToLin` `DosDebug()` command is useful for this.

Register Access

Since OS/2 supports multiple threads, it's important for the debugger to remember the thread for which it's manipulating the registers. The `DBG_C_ReadReg` and `DBG_C_WriteReg` commands force you to specify the thread for which the register set should be retrieved. Often, though, when `DosDebug()` returns with a notification, it has filled in `DBGBUF` with the register set of the current thread.

The `DBG_C_ReadCoRegs` and `DBG_C_WriteCoRegs` commands access the 387 floating-point registers. To save space, the `DBGBUF` structure doesn't contain fields for the floating-point registers. Instead, you include a pointer to a buffer in the `DBGBUF` structure that's passed to `DosDebug()`. `DosDebug()` fills in this buffer in the format that the `FSAVE` and `FRSTOR` instructions use.

Event Notification and Address Mapping

As with interrupts, the OS/2 kernel has a layer that keeps the debugger from direct contact with the operating-system notifications. The kernel packages just the notifications that a debugger needs to know about and sends them to the debugger. The debugger sees these notifications as `DBG_N_xxx` values in the `DBGBUF` structure upon returning from `DosDebug()`.

To convert an OS/2 logical object number to its starting linear address, a debugger can use the `DBG_C_NumToAddr` command. For the purpose of address mapping, each segment in a 16-bit EXE or DLL file is considered to be an object. To convert from a linear address to a logical address, `DosDebug()` has the `DBG_C_AddrToObject` command. `DBG_C_AddrToObject` accepts a linear address and returns a module handle and logical object number.

Isolating a Child Process

As with Windows, the OS/2 input system doesn't deal well with a process that doesn't handle messages in a timely manner. The problems are essentially the same as with Windows (described last month), but the solutions are different.

In OS/2, each message queue is associated with a particular thread, and only that thread can retrieve messages from the queue. As a result, when the child process is stopped, an OS/2 debugger can't simply subclass the child process's windows and read mes-

sages intended for the child process. Instead, it has to call `WinThreadAssocQueue()` to reassign ownership of the queue to a debugger thread.

Once you get past the nuisance of reassigning the message queue, another problem arises. When a program calls `WinDispatchMessage()`, PM happily maps the message's `HWND` value to the address of the window procedure to be called. Unfortunately, the window procedure address is valid only in the context of the child process, not the debugger. When PM calls an address in the wrong context, the result is almost assuredly a general protection violation.

To make things even more complicated, an OS/2 process can have more than one thread/queue combination. When entering soft mode, therefore, an OS/2 debugger needs to set up a unique *message pump* thread for each child-process thread that owns a message queue. (Note that *soft mode* is a state in which the debugger has taken over message processing for the child process. All applications other than the child process continue to run normally. By contrast, *hard mode* is a special mode of the windowing system. Only one process—the debugger—receives messages; all other tasks are suspended. See last month's column for details.)

Mercifully, like Windows, OS/2 has a hard mode that is substantially easier to use than soft mode. You enter hard mode in OS/2 by calling `WinLockInput()`. To make the debugger writer's life interesting, only the thread that will be the sole active message thread can call `WinLockInput()`. Since the thread doing the `DosDebug()` calls is usually not the user-interface thread, some complicated gyrations are necessary. The debugger needs to somehow perform a synchronized thread switch so that the user-interface thread is the one that calls `WinLockInput()`.

In keeping with the spirit of isolating the debugger from the lowest level of system access, an OS/2 debugger cannot set hardware breakpoints by reading or writing the debug registers. Instead, a debugger uses the `DBG_C_SetWatch` and `DBG_C_ClearWatch` commands.

Windows NT

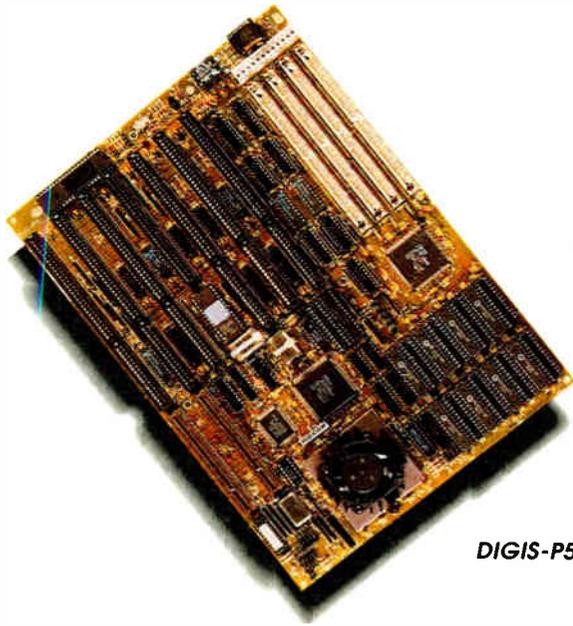
The debugging support in Windows NT is a hybrid of the OS/2 2.1 and Windows 3.1 models. The replacement for OS/2's `DosDebug()` is the `WaitForDebugEvent()/ContinueDebugEvent()` combination, along with a handful of other APIs. In the main process loop of an NT debugger, you pass a pointer to a `DEBUG_EVENT` to `WaitForDebugEvent()`. When the function returns, some sort of notification information appears in the `DEBUG_EVENT` buffer. Unlike OS/2, NT doesn't have different commands for stepping, running, and continuing after an exception. Instead, all this functionality is wrapped up in the `ContinueDebugEvent()` API.

As for retrieving information about the child process, NT provides individual API calls for each area of consideration. This is in contrast to OS/2, which forces all requests for information through the `DosDebug()` API. Of the two models (OS/2 versus Windows NT), the NT model is far easier to work with.

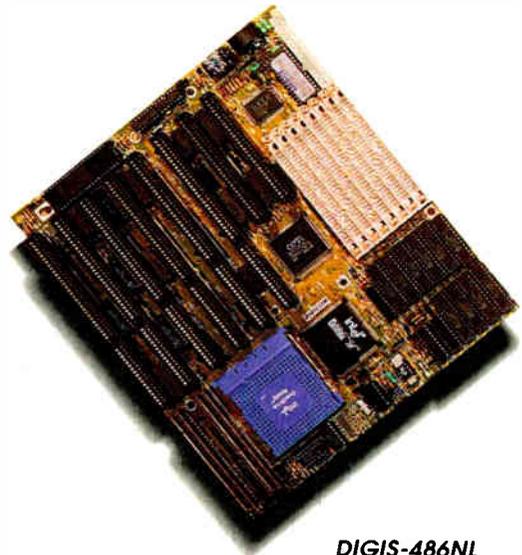
Loading a New Process

Loading a process for debugging under NT is as simple as adding the `DEBUG_PROCESS` flag to the `fdwCreate` creation flags parameter of `CreateProcess()`. Unlike with OS/2, there's no need to connect to the child process.

continued



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Hands On Some Assembly Required

Once the child process has been created, the debugger can immediately go into its `WaitForDebugEvent()` loop. If the debugger wants the child process not to start execution until the debugger has a chance to set breakpoints, it can also specify the `CREATE_SUSPENDED` flag to `CreateProcess()`.

Execution Control

There's no explicit support for single-stepping an instruction or setting breakpoints in NT. An NT debugger is in the same boat as its Windows 3.1 siblings in that it needs to set or clear the trap flag, write breakpoint op codes (0xCC) to memory, and watch for INT 1 and INT 3. On the other hand, as in OS/2, an NT debugger doesn't have to install an interrupt/exception handler. Rather, NT tells the debugger about interrupts in the child process via `EXCEPTION_DEBUG_EVENT` events returned by `WaitForDebugEvent()`.

An NT debugger gets two chances to handle an exception. The first time it sees the exception, NT sets the `dwFirstChance` flag in the `EXCEPTION_DEBUG_INFO` structure returned by `WaitForDebugEvent()`. When the debugger starts up the child process again after receiving a child-process exception, it specifies one of two possible flags. The `DBG_CONTINUE` flag tells the NT kernel to start the child process running again and not to invoke any structured exception handlers in that process. If the debugger specifies the `DBG_EXCEPTION_NOT_HANDLED` flag, the NT kernel invokes any structured exception handlers that the child process may have set up.

If the NT debugger specified `DBG_EXCEPTION_NOT_HANDLED` and the child process doesn't have any exception handlers, the NT kernel tells the debugger of the exception again. This time, if the debugger specifies `DBG_EXCEPTION_NOT_HANDLED` to `ContinueDebugEvent()`, the operating system terminates the child process.

Memory and Register Access

The `ReadProcessMemory()` and `WriteProcessMemory()` APIs are the ticket for accessing the memory of the program being debugged. These APIs are similar to the `MemoryRead()` and `MemoryWrite()` APIs in Windows 3.1. The key difference with NT is that you have to specify a handle for the process whose memory you'll be accessing (separate address spaces, remember?).

The keys to accessing the registers of the process being debugged are the `GetThreadContext()` and `SetThreadContext()` APIs. Both take a thread handle and pointer to a `CONTEXT` structure.

The `CONTEXT` structure has space for holding practically all the registers of the CPU, including the 387 floating-point registers and the debug registers. Because some of the flags in the `CONTEXT` register (e.g., the protected-mode flag) have system-wide ramifications, `SetThreadContext()` won't allow you to alter those flags.

Event Notification

Events such as DLL loads and thread creations are returned in a `DEBUG_EVENT` structure by `WaitForDebugEvent()`. The list of events under NT is small compared to the collection of possible OS/2 events.

Like OS/2, Windows NT tells the debugger about DLL loads and unloads for each process. Under Windows 3.1, a debugger knows about DLL loads and unloads only when the DLL is ac-

tually loaded into memory or freed. If the DLL was already in memory when the Windows 3.1 debugger spawned the child process, the debugger won't receive any notifications for the DLL. In NT, by contrast, each DLL that a process uses is shown as loaded or unloaded, even if another program has already loaded it. In a sense, loading and unloading a DLL under NT is more like attaching and detaching.

Address Mapping

It took a long time to figure out how to go from a logical section number in the EXE/DLL file to a linear address in memory. Unlike Windows 3.1 or OS/2, NT has no explicit APIs to do this.

It appears that the only way to convert between logical and physical addresses is to watch the process creation and DLL load notifications. Both of these notifications give you the base address where the EXE or DLL file is loaded in memory. By reading the section table of the PE (portable executable) file, you can convert the relative virtual addresses stored there into actual linear addresses in memory.

Isolating a Child Process

In NT, a process that's not pumping messages doesn't affect other processes. Instead, a special thread is devoted solely to placing messages in the appropriate queues of each process. As a result, all these horrible contortions with hard and soft modes go away in Windows NT.

Although NT debuggers are free of the tyranny of hard and soft modes, they're still likely to have separate threads for handling user input and waiting for debug events. In NT, you don't *have* to pump messages in order for the system to remain usable; if you don't, however, your user interface won't respond. An NT debugger that calls `WaitForDebugEvent()` in its user-interface thread won't respond to the mouse or keyboard until the child process stops for some reason. An unresponsive debugger won't win you any awards for user-interface design. If you look at the DEB sample application in the `\MSTOOLS\SAMPLES` directory of the March 1993 NT Preliminary SDK (Software Development Kit), you'll see that it has a multithreaded design to avoid this problem.

Miscellaneous Support

Other miscellaneous support includes the ability to use the `CONTEXT` record to set and read the values of the debug registers. This capability lets you add hardware breakpoints to an NT debugger.

There doesn't appear to be any explicit support for walking the heaps, listing the modules and tasks, and so on. However, the collection of tools that comes with the March 1993 SDK shows that it is possible to do these things. For instance, `PVIEW` uses the `VirtualQueryEx()` API to walk the heap of a process.

System-Level Debuggers

Application-level debuggers focus on application programs and perhaps an occasional device driver. Because these debuggers are themselves applications, they are subject to the restraints and design flaws of the underlying operating system. The primary problem is that, since they're applications themselves, these debuggers affect the very system that they're trying to debug (a computer science equivalent of the Heisenberg Uncertainty Principle).

For example, these debuggers use the operating system's task-switching mechanisms to switch between themselves and the



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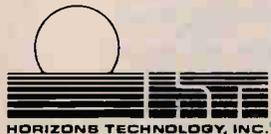
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Hands On Some Assembly Required

child process. This makes them unsuitable for stepping through the operating system's task-switching code.

The places where normal application-level debuggers fear to tread are the domain of the system-level debuggers. These special debuggers use few, if any, of the operating-system services. Instead, they perform all their input and output themselves, talking directly to the hardware so as not to alter the state of the operating system. As a result, the user interfaces of these debuggers are typically much cruder than the interfaces you'll find in application-level debuggers, but the user gains the ability to step through just about any piece of code in the machine. Additionally, system-level debuggers can display the operating system's internal data structures.

Because they can go anywhere and see anything, these debuggers are the tool of choice for operating-system writers and other low-level programmers. You can bet that the operating-system developers at Microsoft and IBM aren't tracing through their bootstrap code in, say, Microsoft's CodeView.

Under Windows 3.1, there are two primary system-level debuggers. WDEB386 comes with the Windows 3.1 DDK (Device Driver Kit) and requires a second machine or terminal. It is a command-line debugger, and as such, it requires that you type in text commands and read scrolling output.

Another system-level debugger for Windows 3.1 is Nu-Mega Technology's SoftIce/W. The user interface is command-line driven, but more commonly used information is shown in windows; less often used information is shown in a scrolling command buffer. SoftIce/W understands the debugging information that Borland's Turbo Debugger and CodeView use, so it's also usable as an application-level debugger. You start both WDEB386 and SoftIce/W after you boot DOS but before you start Windows.

In OS/2 2.1, the system-level debugger is integrated into the operating-system kernel. IBM supplies a special version of the OS2KRNL file that replaces the original. The debug OS2KRNL communicates to the user via a serial connection, in a fashion similar to WDEB386. The basic command set for the debug OS2KRNL is very close to WDEB386's, so it's relatively painless to switch between the two environments.

For Windows NT, Microsoft provides I386KD. This debugger requires two NT machines and is similar to WDEB386 and the OS/2 kernel debugger.

API Power Tools

Despite all the complexity you've just waded through, there are a lot of common concepts in writing a debugger for Windows 3.1, OS/2, and Windows NT. Once you get past the initial hurdle of learning one debugging API, learning the others is easy.

In a sense, the debugging facilities are a chink in the operating system's armor. The operating system needs to allow a debugger special powers that ordinary applications don't have. However, nothing prevents applications that aren't debuggers from using these same facilities. With this newfound knowledge of the debugging APIs, you have a whole new bag of tricks to apply to those nasty problems that don't seem to have a solution. ■

Editor's note: *Some Assembly Required* has no listings this month.

Matt Pietrek specializes in debugging tools at Nu-Mega Technologies (Nashua, NH). He is the author of *Windows Internals* (Addison-Wesley, 1993). You can reach him on BIX c/o "editors," or on CompuServe at 71774.362.

JERRY POURNELLE

The State of Multimedia

I can remember when going to the National Computer Conference and the West Coast Computer Faire was enough to keep me up-to-date on the computer revolution. Then came Comdex, which rapidly cloned into Fall and Spring shows. After that, there was an explosion of conferences, some general and some specialized, and no one could possibly get to all of them.

One I do try to make is Jonathan Seybold's Digital World. It's held in Beverly Hills in early summer, and it brings together venture capitalists, journalists, educators, Hollywood, the record industry, Silicon Valley, and nearly everyone who's interested in the rather indefinable phenomenon known as multimedia. There aren't too many exhibits, but the hall conversations are wonderful, and it has the best sessions of any conference I attend.

This year, the most interesting session was on education. Ron Rescigno, district superintendent of the Hueneme School District, is interested in what his students learn, not how they feel about things. He showed ways to use multimedia in education and demonstrated the kind of equipment setup a good school district can put together at reasonable costs.

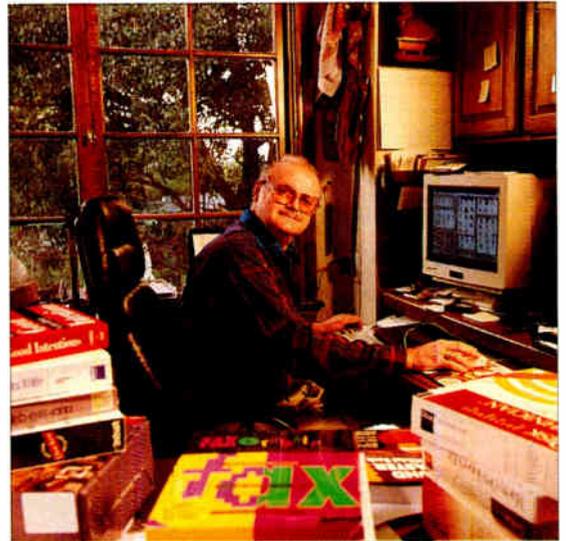
The district's CD-ROM on the Lewis and Clark Expedition uses photos, text excerpts from the expedition's journal, full-motion video clips, and sound recording to build a hypertext account that integrates geography, history, and natural science. The project is still in development, but it was already fascinating. They're presenting real history and useful information in new ways.

There was also the usual twaddle from an Ohio State professor of education, who "isn't interested" in standardized tests or the "usual definition of literacy." He's interested in "how well kids do things differently." I used to be in operations research (see my June column), and I recognize what he's doing: if you can't solve the real problem, change the definitions and criteria so that you can work on something else. It's called "dazzling them with footwork." The result isn't very useful to the customer, but it gets you off the hook.

In this case, he was redefining literacy as reacting to TV, and of course the students are "successful" in doing that. Students will always be successful if you redefine success. Anyone can hit a target glued to the end of a rifle.

He also showed one of the usual gosh-wow contentless multimedia films that abound in our schools now. It took several minutes to convey perhaps three English sentences' worth of information, and it was a dramatic contrast to the excellent Lewis and Clark film.

There's an odd myth making the rounds of the education establishment: skill doesn't exist, and you can't learn by study. This is best illustrated by Chaplin's film *City Lights*, in which a thoroughly inept character is suddenly transformed into the world's greatest political satirist. He never studies or works at developing any skill: it just happens, presumably by osmosis. The osmotic theory of learning appears to be increasingly popular in education: if the school

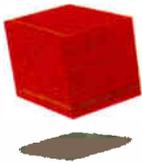


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uses computers just right, skills will appear. The practical result is to assure a continued supply of clients for the social work establishment and exacerbate the already-too-large gap between the productive and the needy.

In the real world, the freedom to study is the real key to liberation. Moreover, the secret of learning to study is like the secret of learning to be a writer: you have to do it. You can't just think about it, talk about it, get in touch with your feelings, or absorb it by osmosis. It doesn't even much matter *what* you study, as long as you master something. Once you have learned to do one thing well, you're a long way down the path to knowing how to do anything well.

Programmers discover this after they've learned one programming language. Not only is the next one easier, but so are a lot of unrelated subjects. Moreover, most humans find learning a skill—any skill—highly rewarding. You don't have to motivate people who have really begun to learn. They'll learn *something* no matter what you do.

This is obvious on 10 minutes' thought, which is why it's surprising when you meet professors of education who don't realize it. I'm reminded of George Orwell's remark at a party: "You must be an intellectual. An ordinary person would never have said a thing like that."

Computers in general and multimedia in particular can be useful in developing study skills. But if we think they're going to negate the need for study and hard work, we're in for a big shock.

Multimedia is nearly all potential at the moment, with few programs to make use of it. However, Kaleida Labs introduced the first public demonstration of the PC version of ScriptX at Digital World. This is a device-independent multimedia programming language that's supposed to make it easy to author multimedia applications. Kaleida is a joint venture of Apple and IBM; they hope to create a standard authoring system that will work on any computer, and I wish them well.

Kaleida is taking applications from developers. Joining up isn't cheap, but if you're planning on doing multimedia applications for Windows, System 7.1, or OS/2, you should be aware of what Kaleida is doing.

Until ScriptX comes out, the best way to play with multimedia is to use a Mac, System 7.1, and QuickTime. QuickTime 1.6 has incremental improvements over previous versions, and it works fairly well. As was true in previous years, most of the

exhibits at Digital World were either big workstations or Macs, although this year there were a significant number of high-end desktop PCs.

If you want to do multimedia in Windows right now, your best bet is Asymetrix's Multimedia ToolBook. This has built-in macro recorders, a run-time package you can freely distribute with your program, and a whole bunch of object-oriented programming tools. You can build very complex multimedia projects with this, and while they won't be machine-in-

dependent, it's surprising how easy it is to do complex stuff for Windows.

Mrs. Roberta Pournelle has spent the past several months converting her reading-instruction program to the Mac. She's using SuperCard and learning more about managing programmers than she really wanted to know. When she's done with it—version 1 is in beta testing now, and the schools and parents who have seen it love it—I'll use Multimedia ToolBook to convert the new version to Windows.

The current versions of her program—



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PC and Mac—require a tutor to read the screens to the student. The tutor needn't be trained. Any literate person—parent, older sibling, classmate who can read, or teacher's aide—will do. But it does require the tutor's constant presence.

Roberta is now playing with a beta version of the PlainTalk TTS (a text-to-speech engine that is Apple's successor to Mac-inTalk) to turn her program into a nearly stand-alone package. Sit the student down at the computer, go away, and 75 lessons later, you've got someone who can read. By read, incidentally, we mean read anything, not just controlled-vocabulary grade-level stuff.

Like regular Tool-Book, the multimedia version is a bit slower than I'd like, but it does the job, and there are plenty of examples to work from. If you're interested in multimedia, this is a good way to get started, and you won't regret the time you spend learning this, no matter where multimedia programming goes.



The Mac world continues to improve, and they haven't neglected the low end. The Mac Classic II has a street price well under a grand, and that's complete: keyboard, small screen, 68030 chip, and System 7.1. It's one heck of a bargain. Sure, you can do a lot more with your guru-friendly Windows machine, but for beginners, it's good enough to get going. There's a lot of Mac in there. Tom Clancy did his first two novels on no better machine, and, like my partner Larry Niven, Tom steadfastly refuses to learn much about computers. (Larry uses a Windows machine, but he doesn't mind that his system sometimes needs a guru: he's got my home phone number.)

My son Richard got through two years at UCLA with a Mac Classic. Eventually he converted to an AT&T Safari laptop with Windows, but if we'd just handed him that in the first place, he might still be using pen and paper.

Last month, I talked about the Tandy

Sensation as a beginner's machine, and I haven't changed my mind; if you want to learn Windows from scratch, there's nothing better. However, it costs over \$900 more than the Mac Classic II.

If you'd asked me five years ago, I'd have said that given the number of computers appearing in classrooms across the country, it wouldn't be long before everyone left school exposed to the little beasts; but I would have been wrong. We still have computer-illiterate kids graduating from high school. Alas, about a quarter of them leave the school system book- and newspaper-illiterate, too, so I suppose I was overly optimistic.

Anyway, the Mac Classic II is a good start, and it won't be long before Roberta's reading program will be available for it. She operates the Educational Roundtable on GENIE and probably hears from more teachers on a regular basis than anyone in the country. Roberta reports that the Mac Classic II is what most schools are buying now.

If you tried System 7.0 and got fed up, try 7.1, which is a genuine improvement, not just a maintenance release. For example, it now puts your fonts into a fonts

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problems with the Pioneer drive.

Alex installed our Chinon drive without the CD-ROM Toolkit and then added it later for comparison. A CD-ROM drive is not inherently designed to be optimum for random access—it's a continuous spiral rather than a series of concentric tracks—but as Alex puts it, FWB's CD-ROM Toolkit speeds up searches something fierce. Recommended.

The big news at Chaos Manor is that I'm becoming fond of OS/2; so much so that if I were starting over on hardware, I'd be careful to make sure everything I bought was OS/2-compatible.

OS/2 isn't for unaided beginners. Setting it up won't be difficult for most BYTE readers. It's not simple; but neither is Windows. Once you have OS/2 set up properly, you can give it to new users with some confidence, particularly if the programs they'll be running are written for DOS and OS/2. I've less experience running Windows programs under OS/2, but I've tried the Windows

programs I use frequently—Ami Pro, Microsoft Word, and Ascend—and those do just fine.

I've known for a couple of years that OS/2 is a better DOS than DOS, and it multitasks much better than Windows. It's not necessarily a better Windows than Windows, but it seems to be good enough; and I'm seriously considering converting to OS/2 for all my operations once I get proper networking.

Longtime readers will know this has been no snap decision, and I've still got some reservations. One concern isn't new: I'm still not sure IBM knows how to market software. On the other hand, they sure know how to support it, as I've learned in the past few days. More on this in a moment.

I've been meaning to get to OS/2 for some time now, but the immediate motivation was a new version of Norton

Commander for DOS. I've long been in the habit of using Commander as an automated way to deal with my MCI Mail.

This doesn't work as well as MCI's

Mail Express. For one thing, MCI gives rather minimal support to the only phone line Commander can use (only 2400 bps and not enough lines; thus, you often get a ring but no answer, or worse, an answer but you can't get into MCI).

Worse, though, Commander 3.0 has some serious design defects. You can't sort the address book, and when you add too many entries to your address book, weird things start to happen to them. On the other hand, I haven't had time to install and learn MCI Mail Express, and warts and all, Commander 3.0 got the job done.

Commander 4.0 has taken care of almost every objection I ever had to its mail handler. It automatically adds names to the address book, and you can have more than one of them. It sorts the addresses. There's good mouse support. The mail viewer is better, and you can incorporate the received message into the reply. There are significant nonmail improvements, too. In a word, if you use Commander 3.0, you will want the upgrade; and if you use MCI Mail, you'll really like Commander as a mail-retrieval tool.

Unfortunately, the Commander 4.0 mail



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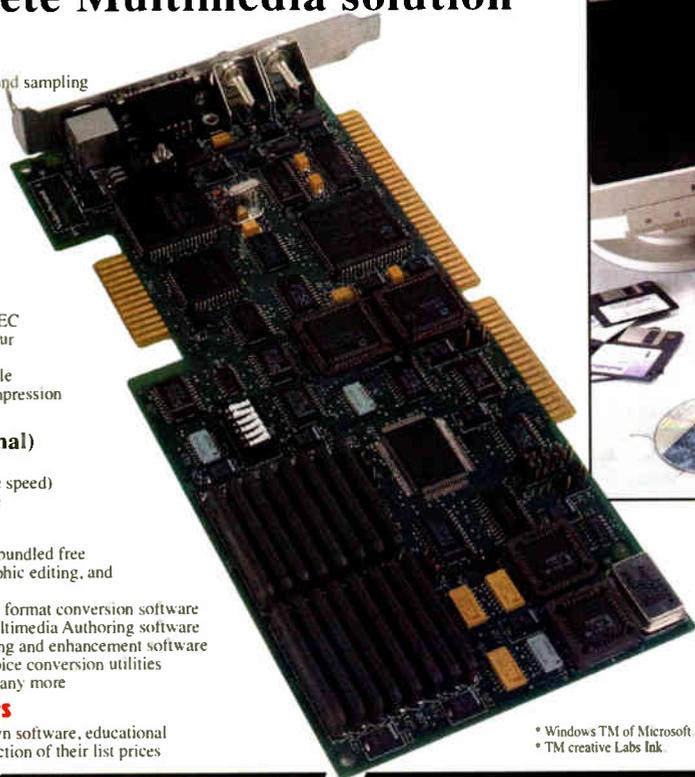
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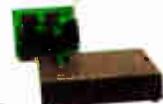
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Pournelle

handler wouldn't work properly on my 486/66 running Windows for Workgroups. For a while I thought this was MCI's wretched line support, but that wasn't it. I could try several times with Commander 4.0 and get nowhere, and then switch back to Commander 3.0 and get access to MCI first try. Also, I could drop out of Windows and use Commander 4.0 under DOS, and that worked; but when I returned to Windows for Workgroups, it would generally fail again.

When it did work, it was slow, really slow compared to the same program doing the same thing under DOS. I know there are those who say Windows is a plot to slow down your machine, but this was ridiculous.

Meanwhile, I got E-mail from OS/2 enthusiast friends who'd been using Commander 3.0 and had switched to 4.0, and they loved it. I'd already determined to give OS/2 2.1 a good try, and since I liked Commander 4.0's mail-handling capability a lot, this seemed like a good time to get OS/2 going.

I did, and I don't regret it, as you'll see in a moment. Meanwhile, if you use Commander, get the upgrade; even without the mail handler, it's a solid improvement over Commander 3.0. If you don't use Commander, you ought to try it. Even under Windows, I use it a lot more than I use File Manager. With Commander, it's easy to view and edit files and generally do housekeeping. Recommended.

I use a PS/2 Model 77 486DX2 as my CD-ROM test-bed, so I can rule out hardware incompatibility if I run into problems. Even so, there had been some difficulties installing OS/2 2.0 the first time; but I'm pleased to report that the installation of version 2.1 went like magic. My Model 77 has a CD-ROM drive, and that's what I used to install OS/2 2.1. However, I have reports from many others who say that installation from disks, although more tedious, is no harder. In addition to everything else, they've enormously improved OS/2's installation. (If you buy a PS/2, you can skip the installation entirely, since OS/2 2.1 comes installed.)

Using OS/2 is as easy as using Windows, but it's different. For one thing, OS/2 makes use—good use, in my judgment—of the right mouse button, and that takes getting used to. When you click on an

icon with the right mouse button, nothing happens for a good part of a second; then a small menu panel with a bunch of options opens. It's handier than the pull-down or drop-down menus you get with Windows or the Mac.

I spent some time fooling around with OS/2. There's a great deal I have to learn, but I can now get around in it well enough to get my work done, and I can make use of some of its features. I particularly like having the ability to set up different CONFIG.SYS and AUTOEXEC.BAT files for each DOS window. I've got a lot more to learn, but it looks as if it will be worth the trouble.

My next step was to transfer a bunch of programs and files. Alas, I have no network board for the Model 77, which is a Micro Channel architecture machine, but that's a minor problem. I installed Traveling Software's LapLink from floppy disks and used the parallel port to connect the PS/2 with one of the machines on my Windows

for Workgroups network. That gave me access to every disk drive on the network, and it wasn't long before I had a whole bunch of DOS and Windows programs transferred.

The next step was to migrate the programs. Migration is OS/2 terminology for making them usable under OS/2. The procedure is a bit odd, but it's more than adequately described in the manual. In fact, it's pretty simple if you have faith and follow directions. You end up with your program icon in a general folder with the program set to run under the default OS/2 run-time values. You can then move or copy that program to another location—a different folder, or for more important programs you use a lot, just lay it out on the desktop—and proceed to customize the installation.

This, too, is a process that is easier to do than to explain. It involves opening an on-screen book of values that are associated with this particular program and changing the settings. There are a lot of those settings, and using them is not always terribly obvious.

It's particularly important to get them right for communications programs. In addition to using Commander for MCI Mail, I use Procomm Plus to connect to BIX and Aladdin as a front end for GENIE. In each case, my preference is to send a program



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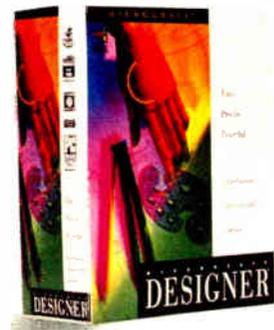


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script out to collect all my E-mail and BBS messages so that I can compose replies off-line. Naturally, I want those communications to run in the background so I can get other work done while everything is downloading.

That sort of works in Windows. By sort of, I mean that most times everything is all right, but sometimes when I run communications in the background, I later find that I've downloaded garbled messages. Everyone tells me that OS/2 never has that problem, so I was eager to convert all my communications to the OS/2 machine.

So, of course, immediately I watched it drop characters from incoming messages, and this was when the program was operating in the foreground. It didn't drop just a few characters, either. When I told OS/2 users my tale of woe, they were universally astounded. Time to check the various OS/2 settings. This is sort of equivalent to looking at the program's PIF

(program information file) for Windows, but with OS/2 you have many more knobs to twist.

I first tried the OS/2 manuals, which are vastly improved over earlier versions. There's a section on what to do if your communications program drops incoming letters. Like the section on migration, the instructions were easy to follow, even if I didn't completely understand the reasons for doing things that way.

I took the manual's advice and changed various settings. One pair of them, IDLE_SENSITIVITY and IDLE_SECONDS, have a function that is similar to setting the time ticks in Windows and determine the priorities when OS/2 allocates computer cycles among programs running in the foreground and background. The manual also suggested changes in my start-up CONFIG.SYS file. I did all that, rebooted, and tried again. Same result. Dropped letters. I decided it

was time to get on-line and ask for advice again.

It wasn't long before someone solved the problem. The very first OS/2 configuration variable is COM_DIRECT_ACCESS. I wasn't too clear on what that did, but it seemed reasonable that it should be set to on for a communications program. That turns out not to be the case: for nearly all communications programs, it must be off. Once that was done, there were no more dropped letters, foreground or background. Indeed, I even ran Aladdin on COM1 to download some mail while simultaneously using LapLink to bring a file over from the network through the parallel port. All files arrived intact. OS/2 runs communications in the background just fine.

The next problem was even more mysterious. Procomm Plus would communicate all right, but when I told it to download some files, it would beep as if it had already done that—but there were no files.

I played with the OS/2 environment settings. Same result every time. I called IBM technical support. That turned out to be a relatively pleasant experience. First I got

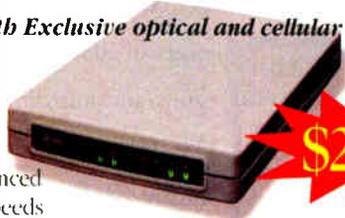
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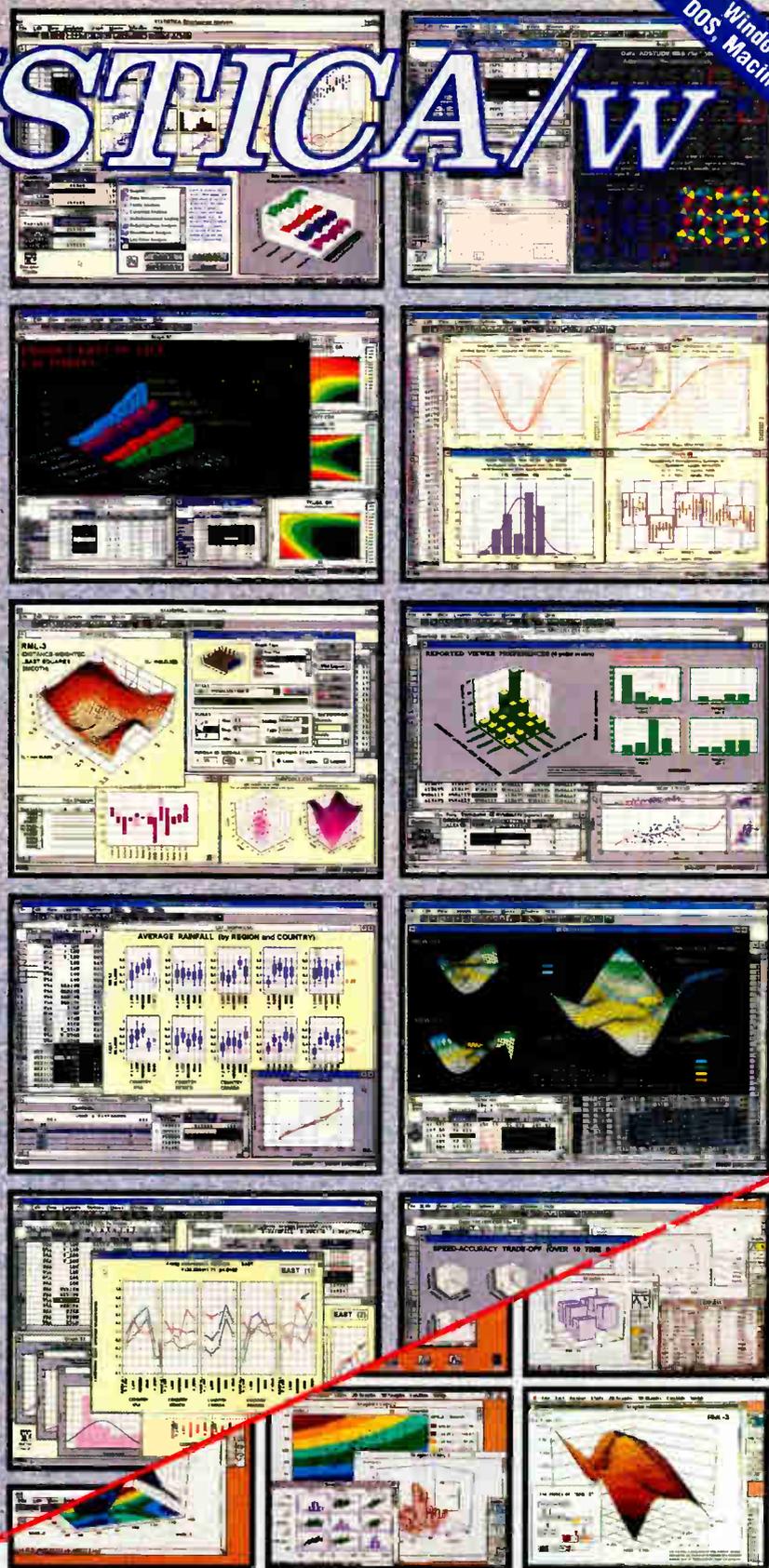


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a pleasant young person who gave me a "problem number" and then transferred my call to a technician. That resulted in a very long wait, punctuated by recorded messages telling me to hang on. Since I'd originally called an 800 number, it didn't cost anything, and I used the speakerphone, so I wasn't sitting with a dead telephone attached to my ear. After about 15 minutes, I was connected to a young man named Suman Reza. He asked several questions, and finally, "It's probably pretty stupid, but are you sure you have Procomm Plus set up properly?"

"Yes, of course—" And it struck me. I'd brought Procomm Plus over from the Cheetah, where it resides on the C drive; but on the PS/2, I've been putting OS/2 and Windows programs on the C drive and DOS programs on the D drive. I looked at the Procomm Plus set-up, and sure enough, it was told to put downloads in the C:\PROCOM2\ subdirectory; only there was no C:\PROCOM2\ subdirectory. When Procomm Plus made noises as if it had already downloaded what I was after, it was trying to tell me it couldn't open a file.

I don't think that's a very helpful way to tell me that, but telling Procomm Plus that the default directory for downloads was D:\PROCOM2\ fixed the problem. I've now tried OS/2 with several communications programs, and they all work without dropping characters. Meanwhile, I learned that IBM's OS/2 2.1 technical support works just fine. It takes a while, but you get to talk to smart people.

I'm running OS/2 on the PS/2 Model 77 with a built-in sound board, a CD-ROM drive, and 8517 terminal support. It's a good computer that's solidly built—heavy plastic lined with metal on the inside—and everything works.

The keyboard has a good, solid feel, as IBM keyboards do. This one has the function keys across the top rather than over to the left side, and I find that annoying. Niven, on the other hand, loves that arrangement and everything about the keyboard.

Keyboards can be replaced, although the PS/2 has a nonstandard keyboard connector, so you can't just plug your old keyboard in. Fortunately, you can get an adapter: the difference between the PS/2 connector and a standard one is mechanical, not electrical.

The biggest problem with the PS/2 is the video. The video board and 9517 monitor work all right—it's good color—but it's pretty slow compared to the ATI Technologies board in my big Cheetah. Also,

I'm not entirely pleased with the DOS character set when I run DOS programs full-screen. I'm told there are ATI PS/2 boards with OS/2 drivers, and I'm angling to get one. I expect it will take care of any reservations I may have about the PS/2 Model 77, since I like everything else about it.

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PCMCIA is a name no one can love. There's a PCMCIA Association, and by the time you read this, they may have a better name for the product. I certainly hope so, because PCMCIA is going to be a very important technology in years to come.

PCMCIA is a slot that takes a card about the size of a business card, only thicker. It's also known as flash memory and credit-card memory, and that's an important function; but in fact it's more than that. It's really an external means of accessing your computer through a new expansion bus. You can use PCMCIA slots to connect your system to a modem, network, or SCSI devices, as well as use it as a memory system. The latest portables have PCMCIA slots; indeed, the new Hewlett-Packard laptop has four. If they get the standards problem solved, it's likely that in a couple of years all palmtops and most laptops will have PCMCIA slots.

Alas, while committees are working on them, there aren't any standards yet; while

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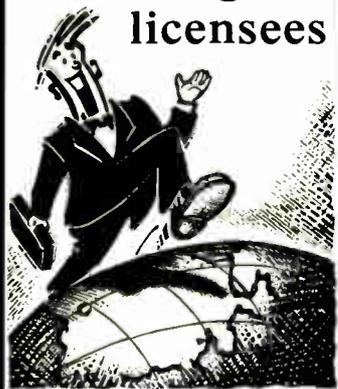
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the hardware is final, software glitches have meant that cards aren't always interchangeable between machines. There are several standard PCMCIA cards. These are largely determined by the thickness of the card they'll accept. That thickness goes up to Type III, which is large enough to

accommodate a small hard drive. (Toshiba uses a nonstandard Type IV specification, which is even larger.)

If your system doesn't have a PCMCIA slot, the simplest way to read PCMCIA cards is with Adtron's IC Card Drive: just connect the drive to the parallel port and

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If you're buying a CD-ROM drive for the Mac, get **CD-ROM Toolkit** (\$79) from **FWB, Inc.** (2040 Polk St., Suite 215, San Francisco, CA 94109, (415) 474-8055). The package supports most CD-ROM drives; includes caching and Kodak Photo CD software; and makes installation easy. **Circle 1146 on Inquiry Card.**

Pioneer's new **DRM-604X** six-disc high-speed CD-ROM drive (\$1845) is four times faster than my old model, and it's ideal for sharing a suite of CD-ROM applications over a network. Highly recommended. Contact **Pioneer Communications of America**, 600 East Crescent Ave., Upper Saddle River, NJ 07458, (201) 327-6400. **Circle 1147.**

Don't have a PCMCIA slot? The **IC Card Drive** (\$295) is an external PCMCIA drive that attaches to any parallel port or serial port. An internal version (\$395) hooks up to your system's IDE interface or ISA bus slot. Contact **Adtron Corp.**, 3050 South Country Club Dr., Suite 24, Mesa, AZ 85210, (602) 926-9324. **Circle 1148.**

The **Mac Classic II** is a great starter machine for computer novices, and it's a heck of a bargain to boot. Prices start at \$1079 for a system with 4 MB of RAM, an 80-MB hard drive, a keyboard, a built-in monochrome monitor, and System 7.1. If you want multimedia capability, however, you'll need a color system and the **QuickTime 1.6 Starter Kit** (\$139). If you're using System 7.0, I recommend **System 7.1** (\$99), which puts your fonts into a separate fonts folder and supports Worldscript for international language support. Contact **Apple Computer, Inc.**, 20525 Mariani Ave., Cupertino, CA 95014, (408) 996-1010. **Circle 1149.**

Multimedia ToolBook (\$695) is your best choice for creating multimedia applications. It includes built-in macro recorders and a freely distributable run-time package. Contact **Asymetrix** at 110 110th Ave. NE, Suite 717, Bellevue, WA 98004, (800) 448-6543 or (206) 637-1500. **Circle 1150.**

Norton Commander for DOS 4.0 is a solid improvement over the previous version. The mail handler works better, and even under Windows I often use it instead of File Manager to view and edit files. Recommended. **Symantec Corp.**, 10201 Torre Ave., Cupertino, CA 95014, (800) 441-7234 or (408) 252-3570. **Circle 1151.**

OS/2 2.1 multitasks much better than does Windows 3.1, and I like it enough to seriously consider converting to OS/2 for all my operations. OS/2 2.1 was specially priced at \$119 at press time (the regular price is \$249), but the deal was to run out on September 14. Contact **IBM Corp.**, 1 Old Orchard Dr., Armonk, NY 10504, (800) 633-8266 for the latest information. **Circle 1152.**

Procomm Plus 2.01 has some peculiarities, but it's easy to use and handles all communications in Chaos Manor. It's available for \$129 from **DataStorm Technologies, Inc.**, 3212 Lemone Blvd., Columbia, MO 65201, (314) 443-3282. **Circle 1153.**

IBM's **PS/2 Model 77 486DX2** is my machine of choice for running OS/2. The 33-/66-MHz processor has plenty of power. The PS/2 comes with a 212-MB SCSI hard drive, a 2.88-MB floppy drive, 8 MB of RAM, XGA graphics (no monitor), a mouse, a keyboard, and OS/2 for \$3335. The Micro Channel architecture bus limits expansion options, but the three-year parts and labor warranty and 24-hour support line are top-notch. Contact **IBM Personal Computer Corp.**, Rte. 100, Somers, NY 10589, (800) 772-2227. **Circle 1154.**

Publicity Builder (\$129) does a good job of helping you publicize your products. It includes PR templates, tips on who to send your releases to, and more. Contact **JIAN Tools for Sales, Inc.**, 127 Second St., Los Altos, CA 94022, (415) 941-9191. **Circle 1155.**

ScriptX isn't shipping yet, but this device-independent multimedia programming language should make developing platform-independent multimedia applications much easier. Contact **Kaleida Developer Services**, Kaleida Labs, Inc., 1945 Charleston Rd., Mountain View, CA 94043, (415) 966-0400. **Circle 1156.**

SuperCard (\$299) is a hypertext scripting language for the Mac that we're using at Chaos Manor to convert Roberta's DOS-based reading program. Recommended. Contact **Aldus Consumer Division**, 5120 Shoreham Place, San Diego, CA 92122, (619) 558-6000. **Circle 1157.**

Attitude TrueType Fonts



MasterPiece TrueType Font Library

Agnes **ASPEN** **BAMBAM** benediction
 Cambria **CARTOON** Casual Catacomb
 Chancellor **CHILL** ~~Chisler~~ Country Club
COYOTE DALMATION DECORAGE
DELHI Doily ~~DOORWAY~~ DUNCAN |||||
 EMPIRE **FIRE** FLAMINGO Flores
 Frankenfooter **FRISS!** Gaslight HORROR
Invitation Knarly Lakeside Lizard
LOOP! MOO-GOO ~~MORBID~~ Moulon Rouge
 MOZAMBIQUE **Nervous** Nottingham Omate
 PENCILPOINT **PICANTE** **RAHRAH** RANSOM
 Renaissance Rhino Ripper Roady Rooster
 Ruhr SAHARA SALOON SCRAWL **SEASCAPE**
 Sesar **SUNSHINE** SLAVIC SPANKY SPEAKEASY
 STICK **UGANDA** UNDERGROUND Uppercrust
 Waterfall Whitewash Willroge **ZAP** Zephyr



The MasterPiece TrueType Font Library from Attitude, Inc. now contains over 150 one-of-a-kind, designer TrueType soft fonts. These totally unique display and headline fonts are what you need in order to get the attention your memos, brochures, flyers and correspondence deserve. And with the MasterPiece TrueType Font Library you'll have the headline fonts to complement your collection of text faces. So don't settle for the basic vanilla text fonts. Get an Attitude!

Also included is the new Attitude TrueType Installer. This utility will allow you to view any TrueType format font, either on screen or in a printout, as well as install, remove or check if any font is already installed.

This is only a partial listing of the over one hundred and fifty fonts in this package

Attitude, Inc.
 14742 Beach Blvd., Dept. 440
 La Mirada, CA. 90638
 TEL: (714) 680-8112 FAX: (714) 680-6640

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Pournelle

run the software. Obviously, this isn't going to transfer files at bus speeds (there's a serial-port connection capability that's even slower), but you will be able to read most PCMCIA cards. If you have a portable with PCMCIA capability, this is a very convenient sneakernet capability; and you can use the Adtron box with a portable that doesn't have PCMCIA.

Adtron also makes a bus-card IC Card Drive, which installs more or less like a standard disk drive. It's much faster than the parallel-port version and lets you experiment with various PCMCIA connector devices like modems and Ethernet connections. One warning: I got my unit directly from Adtron, and it didn't come with a bezel or mounting hardware. That's not a serious problem, but you will need to arrange for that. Otherwise, there are no installation difficulties.

The big breakthrough with this type of PCMCIA drive will come when all computers have the new superfast parallel-port hardware. Some machines already have it, and the rest will have to follow suit: it's enormously convenient to move data through a port at what amounts to bus speed.

The book of the month is Rita Kramer's *Ed School Follies: The Miseducation of America's Teachers* (Free Press, 1991), a warmly written critical look at what our teachers are learning—and not learning—in our colleges. She has important things to say about why our school system doesn't seem to work so well.

The computer book of the month is Ed Krol's *The Whole Internet Users Guide & Catalog* (O'Reilly & Associates, 1992). Just about everything you'd want to know about the Internet. Back in 1975, I said that by the year 2000, anyone in the Western world would be able to get the answer to any question. That's on schedule, and the Internet is helping to make it happen.

Next week I travel to Brazil for a computer show; a full report next month. Also, SyDOS Personal CD, the latest marvels from BSE, the wonderful little MX Modem, and more on my experiences with OS/2. It's a full life. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerrypp."



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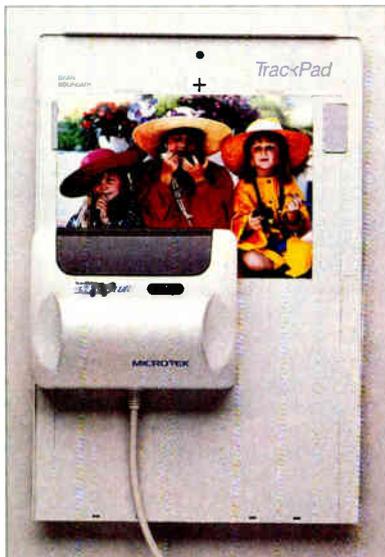
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What's New Hardware



A SCANNER SCOOTER ▲

A self-moving hand scanner for graphics and text, ScanMaker Scooter (\$549) has a built-in motor that steadily moves it across an image. The scanner auto-merge function creates a seamless finished scan that ensures that the halves of a large image will merge precisely. The Microtek (Torrance, CA) Scooter can stitch images at a resolution as high as 400 dpi. The 24-bit scanner reproduces images in color, gray scales, and black and white.

Phone: (213) 321-2121.

Circle 1084 on Inquiry Card.

WIZARD CONNECTIONS ▼

The BSE Connectivity Kit (\$99.95) and the BSE Serial Kit (\$49.95) for the Sharp OZ-9600 let you connect your palmtop computer to other PCs, printers, and peripherals. The BSE Company (Flagstaff, AZ) Connectivity Kit includes a compact



RS-232 converter cable and a self-power serial-to-parallel converter. The Serial Kit has the serial cable converter and a null modem adapter.

Phone: (602) 527-8843.

Circle 1087

on Inquiry Card.

FAX MODEM FOR THE THINKPAD

The V.32bis fax modem (\$569) from Apex Data (Dublin, CA), designed for the ThinkPad 720 and 720C, has data and V.17 fax speeds as high as 14.4 kbps. The modem goes into hibernation along with the ThinkPad to save

battery life.

Phone: (800) 841-2739 or

(510) 803-2020.

Circle 1082 on Inquiry Card.

SCSI-2 ADAPTER FOR PCI-BASED SYSTEMS

Creating a direct channel from SCSI peripherals to a host computer, the BT-946C (\$499) host adapter makes 32-bit data transfers at up to 132 MBps across a PCI (Peripheral Component Interconnect) bus. The BusLogic (Santa Clara, CA) unit is compatible with PCI Specification revision 2.0 for use with Pentium-based PCI systems and supports up to 8-GB hard drives. A maximum of three adapters can run simultaneously. Fully programmable, the adapter includes a standard PCI 2.0 connector, a 50-pin SCSI-2 connector, and PCI software utilities.

Phone: (408) 492-9090.

Circle 1083 on Inquiry Card.

PC SECURITY

Provide security for your PC with Creative Secure (\$139) from Applied Systems (Deerfield Beach, FL). Capable of storing a master and 64 user passwords, Creative Secure records a time-

stamped audit trail of computer boot activity. A motion detector and anti-theft sensor sounds an alarm if the computer is moved, and you can tie directly into a remote alarm system.

Phone: (800) 338-0463 or

(305) 428-0534.

Circle 1086 on Inquiry Card.

SPEEDIER DATA TRANSFER

Designed to handle multiple-sector transfers, the AT I-Ideal Enhancer card (\$29.95) lets you enhance your ISA system without upgrading to the VL-Bus. The card, compatible with DOS, Windows, OS/2, Unix, and NetWare, increases IDE-drive data transfer rates by as much as 91 percent, according to Atronics International (Fremont, CA).

Phone: (510) 656-8400.

Circle 1088 on Inquiry Card.

PACKED FOR PERFORMANCE

The Pro-System 486 PCs from National MicroComputers (Salt Lake City, UT) ship with a 245-MB hard drive, 4 MB of RAM, and a 32-bit S3 805 VGA accelerator card with 2 MB of RAM. The system board has a ZIF (zero insertion force) socket that will accommodate the Pen-

tium SX processor. A 32-bit VL-Bus hard drive controller, 128 KB of static RAM cache, and a flat-screen color monitor round out the units. Prices start at \$1850.

Phone: (801) 265-3700.

Circle 1089 on Inquiry Card.

POCKET MULTIMEDIA AND CONNECTIVITY

Franklin Electronic Publishers (Mt. Holly, NJ) has put speech, sound, and serial connectivity in its latest Digital Book System. The 4.6-ounce DBS-2 (\$129) reads two matchbook-size digital-book ROM cards, each of which contains up to 20 MB of



compressed information. You access the data by entering key words or the first few letters of a word, and you can cross-reference the two installed books.

Phone: (609) 261-4800.

Circle 1085 on Inquiry Card.

A POWERFUL PORTABLE, ANY WAY YOU SLICE IT

The MediaMach family of integrated-presentation portables provides a complete portable multimedia production and delivery system. You use the ComposerSlice (from \$1731) and the PresentationPlayer (from \$7195) joined together while you create your production; then you take only the PresentationPlayer on the road for the show. All required sound, video, and other hardware and software are installed, giving you a ready-to-run system. Systems are available for the major video compression and playback standards, such as DVI, AVI, and JPEG; a PresentationPlayer is also available for MPEG playback.

Contact: Dolch Computer Systems, Milpitas, CA, (408) 957-6575.

Circle 1078 on Inquiry Card.



Hardware

FAST THERMAL COLOR

A 2-ppm plain-paper printer, the SpectraStar GT (\$4495) color thermal printer runs at 33 MHz and supports PostScript Level 2. Two built-in cartridge slots accommodate plug-in cartridges. The General Parametrics (Berkeley, CA) printer comes with Pantone-certified color matching, 6 MB of RAM, and 52 fonts.

Phone: (510) 524-3950.

Circle 1090 on Inquiry Card.

LOCAL-BUS DISPLAY

The Legend 24VL/IDE VL-Bus controller provides Windows acceleration, a 32-bit local-bus IDE hard drive interface, a floppy drive controller, two serial ports, and a parallel port. The \$199 card, from Sigma Designs (Fremont, CA), supports 24-bit color at 640- by 480-pixel resolution.

Phone: (800) 845-8086 or (510) 770-0100.

Circle 1092 on Inquiry Card.

LAN FAXING

A network fax server the size of an external modem, the Lan-Fax/V (from \$1795) offers fax on demand along with multiline, broadcast, and automatic routing capabilities. From Vidicode (Wilmington, NC), the server automatically routes incoming faxes to the proper node and is operative even when the network is unavailable.

Phone: (919) 452-5600.

Circle 1093 on Inquiry Card.

DOUBLE DOCKING

Besides being a standard HDI-30-to-DB-25 cable adapter, SCSI DOC (\$49) lets your PowerBook dock as a SCSI device with another Mac when coupled with a cable. A switch on the APS Technologies (Kansas City, MO) adapter provides the dual personality.

Phone: (816) 373-5800.

Circle 1094 on Inquiry Card.

Another way to dock your Mac is via the Lapis (Alameda, CA) SCSI Dock (\$199). A small

docking station for the PowerBook Duo 210 and 230, the unit lets you dock the Duo to any other Mac and operate in SCSI disk mode. You can also connect the Duo directly to an external SCSI device.

Phone: (510) 748-1600.

Circle 1095 on Inquiry Card.

MAC FAXING AND MORE

The TelePort/Bronze II fax modem (\$109) from Global Village Communication (Mountain View, CA) lets you send faxes at 9600 bps, receive faxes at 4800 bps, and access on-line services at 2400 bps. The TelePort/Bronze II cable plugs into the serial port for fax and data communications. The modem is powered by the Mac via the ADB (Apple Desktop Bus) port.

Phone: (415) 390-8200.

Circle 1096 on Inquiry Card.

MULTIMEDIA ► ANYWHERE

The portable LitePro 550 active-matrix LCD projector from In Focus Systems (Tualatin, OR) accepts European and U.S. video formats and power sources. Compatible with most PCs and Macs, the \$8999 LitePro 550's TFT (thin-film transistor) screen can display more than 1.4 million colors simultaneously at a resolution of 640 by 480 pixels. The hand-held SmartRemote control lets you switch seamlessly between video and computer sources.

Phone: (800) 327-7231 or (503) 692-4968.

Circle 1091 on Inquiry Card.



MAKE YOUR PC A HUB

The DigiBoard PC IMAC/4 expansion card (from \$1195) turns your PC into an ISDN communications hub for remote LANs and telecommuters. With the DigiBoard (Eden Prairie, MN) card, you can support up to 40 simultaneous telecommuter calls with a single PC.

Phone: (612) 943-9020.

Circle 1110 on Inquiry Card.

SINGLE-SLOT SPARC SERVER

Although it provides 64 serial ports for Sparc-based LANs, the 6400S terminal and peripheral server occupies only a single SBus slot. From Aurora Technologies (Waltham, MA), the \$5999 6400S has 16-byte-per-channel I/O buffers to preserve data integrity. All 64 lines can operate simultaneously at speeds of up to 38.4 kbps. The server includes on-board 80-MIPS RISC processors and a Streams-based device driver.

Phone: (617) 290-4800.

Circle 1097 on Inquiry Card.

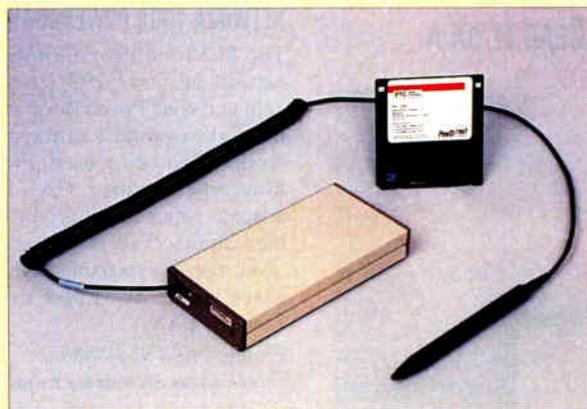
SCAN COLOR TRANSPARENCIES

From Tamarack Technologies (Milpitas, CA), the 12000C 1200-dpi, 24-bit color flatbed scanner (\$1995) has an optional Slide Kit (\$795) attachment for scanning transparencies. With an 8 1/2- by 11 1/4-inch scanning surface, the unit includes hardware gamma correction, 200 levels of brightness and contrast, and built-in Mac and PC SCSI connections.

Phone: (408) 956-0144.

Circle 1098 on Inquiry Card.

ATTACH A LIGHT PEN TO YOUR PC

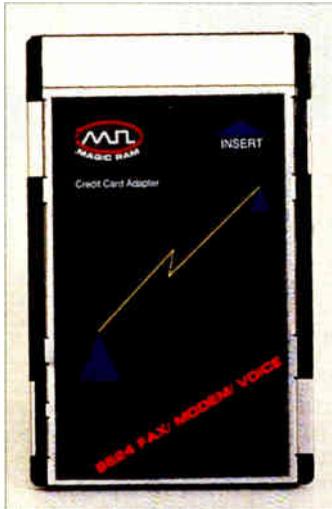


Bringing pen computing to desktop PCs, PenDirect for Windows (\$498) consists of a light pen, a light-pen interface, and Pen Extensions for Windows. Able to recognize handwriting, the software also responds to editing gestures, providing on-screen editing capabilities; you use the pen to make your changes on the screen of your desktop system. All common mouse actions are available at the stroke or tap of the pen, and you can sign your name to an electronic document. A pen holder attaches to the side of the monitor so you can park the pen when you're using your mouse or keyboard.

Contact: FTG Data Systems, Stanton, CA, (800) 962-3900 or (714) 995-3900.

Circle 1079 on Inquiry Card.

What's New Hardware



VOICE JOINS THE FAX MODEM ▲

A Type II PCMCIA card, the Mercury card (\$395) combines fax, modem, and voice for notebook, palmtop, and pen-based computers with PCMCIA Type II or III slots. The Magic RAM (Los Angeles, CA) card has full send and receive fax capabilities,

with transmission rates of up to 9600 bps. The data modem operates at speeds of up to 2400 bps, with V.24 MNP 2 to 4 error correction and V.24bis MNP 5 data compression.

Phone: (213) 413-9999.

Circle 1103 on Inquiry Card

OPEN-SYSTEM WORKSTATION

The AV 500 2-D graphics workstation from Data General (Westboro, MA) is binary compatible with other Aviiion open-system units. The expandable \$15,000 system has 16 KB of on-chip cache and 256 KB of integrated secondary cache, 16 MB of error-correction-code memory, integrated SCSI-2 and Ethernet interfaces, and a 17-inch monitor with 1280- by 1024-pixel resolution. You can use the AV 500 for software development and as a client in distributed enterprise computing.

Phone: (508) 898-4000.

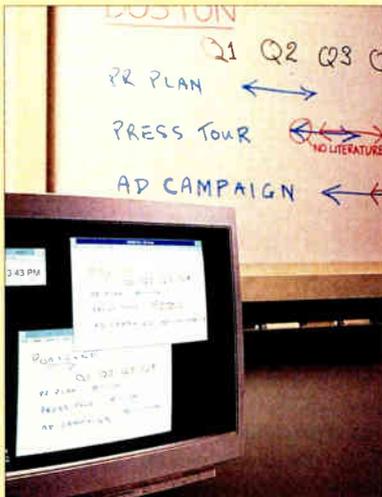
Circle 1099 on Inquiry Card.

WRITE IT ON A SOFTBOARD, READ IT ON A MONITOR

When you write on SoftBoard (\$2995), your information is simultaneously displayed on your PC or Mac monitor. You can save the data, print it, use it in other applications, and share it with others either locally or at a remote location. SoftBoard works via two laser beams that continuously scan a whiteboard. The lasers locate, identify, and track in real time the position of the markers you use to write on the board. They then translate the data onto your computer display. You can set up multisite sessions using a modem and standard phone lines.

Contact: Microfield Graphics, Inc., Beaverton, OR, (800) 334-4922 or (503) 626-9393.

Circle 1080 on Inquiry Card.



DATA MANAGEMENT RELIEF

With an on-board processor and data management algorithms, the powerStore IDE drive controller (\$295) takes over all low-level management functions from your CPU, predicting and holding the most-often-used data in cache memory. From Perceptive Solutions (Dallas, TX), powerStore's accuStat monitoring software assists in this management.

Phone: (214) 954-1774.

Circle 1101 on Inquiry Card.

REMOTE-CONTROLLED DMM

Prairie Digital's (Prairie du Sac, WI) Model 150-02 digital multimeter (\$179) connects to your PC via a serial port for data output and control input. The remote-controlled front panel lets the host computer request readings, change ranges, select AC or DC current, enter or exit hold mode, and reinitialize the unit.

Phone: (608) 643-8599.

Circle 1102 on Inquiry Card.

NETWORK YOUR POWERBOOK

The SCSI-490PB multimedia network adapter (\$299) lets you connect your PowerBook to a network regardless of the network media being used. From MacNet (San Jose, CA), the adapter, which is fully compatible with EtherTalk at the register level, also lets you connect most Macs with a SCSI port to an Ethernet LAN.

Phone: (408) 954-8888.

Circle 1106 on Inquiry Card.

SENSITIZE YOUR MONITOR

Now you can retrofit your monitor with a touchscreen. From MicroTouch Systems (Methuen, MA), the pocket-size SMT-1 (\$318), with CMOS circuitry, plugs into your monitor's housing and can be mounted on the monitor. The needed 5 V of power comes from the monitor's power supply, the PC, or an external power supply.

Phone: (508) 659-9000.

Circle 1112 on Inquiry Card.

NOTEBOOK COLOR

The 5½-pound ColorBook (from \$1995) is a 486SX-based notebook that features a 9.4-inch backlit VGA LCD with dual-scan STN (super-twist nematic) color. The expandable unit, from Gateway 2000 (North Sioux City, SD), has 4 MB of RAM,



an 80- or 170-MB hard drive, an integrated trackball, and a PCMCIA Type III slot.

Phone: (605) 232-2000.

Circle 1100 on Inquiry Card.

MOUSE TRACKS

Version 4.0 of the Expert Mouse trackball (from \$149.95) from Kensington Microware (San Mateo, CA) adds a software application that integrates the hardware features for complete cursor control. This includes the ability to jump the cursor to any spot on the screen using the Brilliant Cursor technology, pixel-by-pixel control with the Slow Cursor technology, custom acceleration that matches the way you work, and programmable mouse buttons that let you do such things as chording.

Phone: (415) 572-2700.

Circle 1116 on Inquiry Card.

The Freedom Station (\$29.95) mousepad from CPRResearch (Augusta, ME) has a projection-suspension tower through which you feed your mouse cord to let the mouse glide around the mousepad unencumbered. The Freedom Station simulates the feel of a wireless mouse via the length, tensile strength, and projection angle of the tower.

Phone: (207) 622-1867.

Circle 1117 on Inquiry Card.

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For a limited time, you can get a single-user POET Personal Edition for Windows for just \$99. The Personal Edition is 100% compatible with the client/server Professional Edition and supports either a Borland or Microsoft Compiler.**

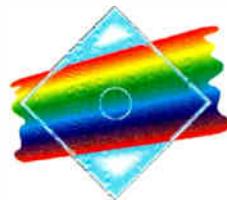
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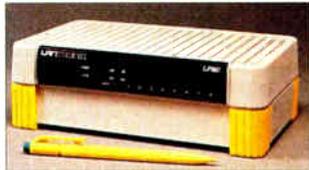
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Circle 196 on Inquiry Card.

What's New Hardware

SIMPLIFIED NETWORK CONNECTION

The LPM2, LPM4, and LPM8 (from \$395) from Lantronix (Laguna Hills, CA) have two, four,



and eight ports, respectively, that let you connect up to eight nodes on an existing network via a single transceiver. In stand-alone mode, the LPMs let you set up a two-, four-, or eight-node LAN.

Phone: (800) 422-7022 or (714) 367-0050.

Circle 1108 on Inquiry Card.

LAN TO WAN

Able to provide a seamless link between multiple LANs on a WAN (wide-area network), the WIN card (\$995; software, \$205) can also link a PC on the LAN and a host on the WAN, thus eliminating bridges and routers. The WIN card, from Network Automation (Northboro, MA), includes built-in emulations for IBM, Unisys, DEC, Tandem, and Fujitsu and is X.25 compliant.

Phone: (508) 393-1777.

Circle 1107 on Inquiry Card.

SEND VOICE MAIL FROM YOUR NOTEBOOK ▼

The Inex 4000 Series upgradable 486SX notebooks (from \$2199) feature pocket-size high-speed



communication modules that support LANs and WANs (wide-area networks), including wireless cellular data. With an AudioDrive multimedia chip, the Inex Technologies (Santa Clara, CA) notebooks provide the means for audio presentations, vocal script, and voice E-mail. The units support up to 20 MB of main memory and up to 200 MB of storage on the removable hard drives. The LCD screen is also upgradable.

Phone: (800) 783-4639 or (408) 986-9941.

Circle 1105 on Inquiry Card.

CHECK THE HANDSHAKE

Chefford Canada's (Nepean, Ontario, Canada) LanLoc works with PC and Unix networks or systems to prevent unauthorized users from gaining access via a modem. Customized to fit each application, the combination hardware and software LanLoc uses an encrypted challenge/response handshake to verify a name and password. Prices start at \$80 per node (\$155 per node with communications package).

Phone: (613) 596-4108.

Circle 1109 on Inquiry Card.

PCMCIA FAX MODEM

A V.32bis fax modem in a PCMCIA card, the PractiCard 144 (\$499) from Practical Peripherals (Thousand Oaks, CA) provides 14.4-kbps data transmission as well as Class 1 and Class 2 14.4-kbps send and receive fax transmissions. Providing V.42 error correction and V.42bis data compression, the PractiCard is able to reach computer-to-modem speeds as high as 115.2 Kbps.

Phone: (805) 497-4774.

Circle 1111 on Inquiry Card.

LARGER, FASTER STORAGE

Memorybank (Ann Arbor, MI) has added two members to its Memorybank II line of disk and tape subsystems. A Memorybank

II with a 3-GB hard drive (from \$9520) features a seek time of 12 ms, 5400-rpm disk speed, and a Fast SCSI-2 connection; the unit holds two drives, for up to 6 GB of disk capacity. A Memorybank II with a Tape Autoloader (from \$7040) has a 732-KBps data transfer rate and uses standard 4-mm DAT (digital audio-tape) cartridges.

Phone: (800) 562-7593 or (313) 761-2782.

Circle 1104 on Inquiry Card.

KEYBOARDS TWO WAYS

A 101-key keyboard with an integrated IsoPoint, the ISO-1000 (\$189) performs all the functions of a mouse. From Key Source International (Hayward, CA), the IsoPoint is a linear control device that provides on-screen cursor movement that is directly proportional to the movement of your hand or finger.

Phone: (510) 783-6066.

Circle 1113 on Inquiry Card.

The VersaKey Mac (\$395) lets you capture repetitive functions with a single keystroke. From Quest Computers International of Adelaide, Australia, and available from People & Profits (St. Paul, MN), the programmable keyboard has 60 additional keys, to double the number of key definitions available. To program it, you turn on the Learn key, select a Special Application key, input the keystrokes you want saved, and turn off the Learn key.

Phone: (612) 452-8018.

Circle 1114 on Inquiry Card.

SPEEDY DIAL-UP MODEM

Western DataCom's (Westlake, OH) 672 Quadra Pump V.35-based modem operates synchronously over standard switched phone lines without needing special services from long-distance carriers. Batch file transfer speed is 72 kbps. Price is \$1895.

Phone: (800) 262-3311 or (216) 835-1510.

Circle 1115 on Inquiry Card.

A SMART LEGACY

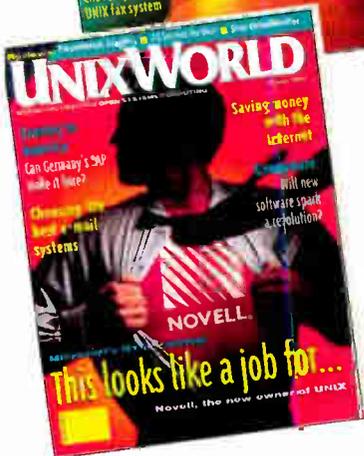
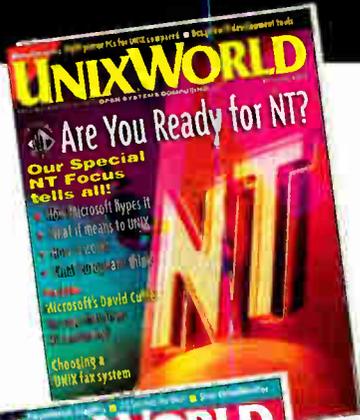
The Legacy SmartArray (from \$7460) incorporates monitoring and sensing components such as audible alarms and visual messages to alert technicians to a failure in a storage device, power supply, or fan. This equipment is hot-swappable, so you can replace it without system or network downtime. Temperature sensors inform the network administrator of abnormal temperature fluctuations. The SmartArray accommodates as many as nine half-height hard drives configured as a RAID level 0 or 1 or RAID level 5 disk array; total storage capacity is as much as 12.6 GB.

Contact: Legacy Storage Systems, Inc., Hopkinton, MA, (508) 435-4700.

Circle 1081 on Inquiry Card.



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What's New Software



WINDOWS APPLICATION BUILDER

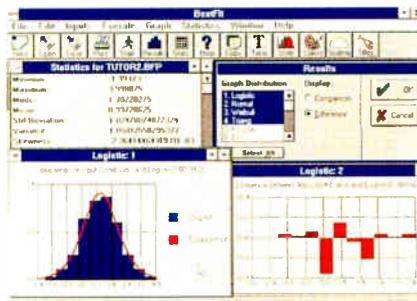
Visual Baler (\$495), a spreadsheet-based visual development tool for creating stand-alone Windows programs, lets you build your application using spreadsheet-like components such as @ functions and macro commands. From Baler Software (Rolling Meadows, IL), Visual Baler also lets you import existing spreadsheets, such as those created with 1-2-3. You can add security controls to your spreadsheets and design graphical input screens with custom dialog boxes, radio buttons, and check boxes.

Phone: (800) 327-6108 or (708) 506-9700.

Circle 1122 on Inquiry Card.

QUICK FILE CONVERSION

An HPGL/2-to-AutoCAD DXF converter, Tailor Made Software's (Kent, WA) entry-level Hp2Design LFV (\$99) can convert all or some of the files in a directory at once, in batch or interactive mode. Typically handling a conversion in less than 15 seconds, the program gives you control over functions such as choice of line-end character, whether mapping is by color or by layer, and whether colors are mapped in HPGL number se-



quence or as in AutoCAD.

Phone: (800) 732-2585 or (206) 631-1513.

Circle 1124 on Inquiry Card.

WINDOWED BAR CODES

PrintBar Bar Code Fonts for Windows and OS/2 1.0, from Bear Rock Technologies (Shingle Springs, CA), supports most bar code symbology families and all Windows 3.1-compatible printers. When you highlight the information to be converted into a bar code and select the proper font from the pull-down menu, a bit-map image of the bar code appears on the screen, and PrintBar automatically translates the text and numbers into a bar code. Prices: Postnet and FIM, \$79; others, \$179.

Phone: (800) 232-7625 or (916) 672-0244.

Circle 1125 on Inquiry Card.

PRINT BOOKLET PAGES

ClickBook (\$69.95) from Book-Maker (Palo Alto, CA) is a Windows printing utility that lets you turn any Windows document into a double-sided booklet. ClickBook automatically reduces pages and positions them for double-sided printing. The program supports several personal-organizer paper sizes and types, including DayRunner, Franklin, Filofax, and Day-Timer.

Phone: (415) 617-1101.

Circle 1131 on Inquiry Card.

▼ FIT YOUR DATA TO THE BEST DISTRIBUTION

BestFit (\$299) works in Windows to give you the best probability distribution to fit your data.

In addition to providing a running graphical display of possible best fits, the software, from Palisade (Newfield, NY), also builds

difference graphs of the fits, giving you a visual connection between the actual data and the various distributions. An optimizing algorithm ensures that you get the best distribution type with the best parameters.

Phone: (800) 432-7475 or (607) 277-8000.

Circle 1123 on Inquiry Card.

COLOR PRINTING UNDER UNIX

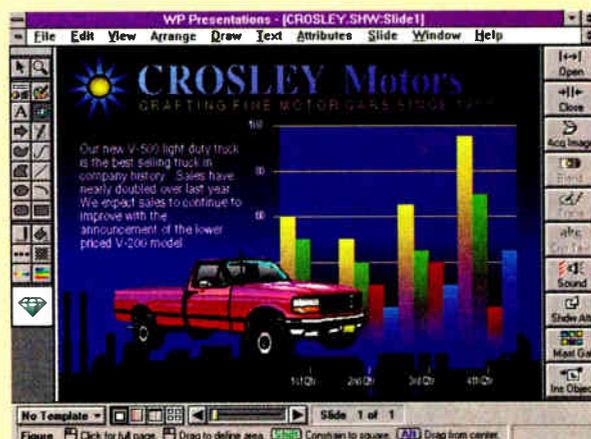
Chameleo universal print-imaging software, designed for working in multiple applications, runs on Silicon Graphics workstations

in support of color printers and film recorders. From GW Hanaway & Associates (Boulder, CO), Chameleo lets you print Unix raster files from files such as TIFF, SGI, X Window System, and Wavefront to a variety of SCSI color-output peripherals. Chameleo supports printer-independent scaling and orientation, as well as volume and animation batch printing. The plug-in-module architecture lets you add or change printers easily. Price: \$595, plus \$395 and up for plug-in modules.

Phone: (303) 440-9631.

Circle 1143 on Inquiry Card.

COMPREHENSIVE WINDOWS PRESENTATION PACKAGE



WordPerfect Presentations 2.0 for Windows (\$495), all-in-one Windows presentation graphics software, supports the TWAIN interface, letting you scan images directly into your file using any compatible scanner. (The Logitech ScanMan hand-held scanner is included in initial shipments.) You can edit the bit-map image and convert it into a vector image with Autotrace. The package includes QuickTutors, on-line tutorials from Usability Sciences.

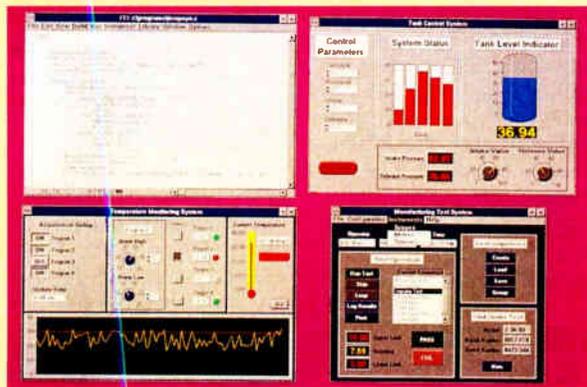
As an OLE server and client, Presentations supports direct CD-ROM sound, as well as the Roland Audio Producer Card, which lets you combine and edit WAV and MIDI sound files. The split-screen chart editor allows you to adjust your text at the top of the screen and see the changes reflected in your chart on the bottom of the screen. Drawing tools include Bézier curves, transparent shadow, and cross hair and ruler. The Slide List and Slide Outliner are among the presentation tools.

Contact: WordPerfect Corp., Orem, UT, (800) 451-5151 or (801) 225-5000.

Circle 1118 on Inquiry Card.

Software

DEVELOP MULTIPLATFORM APPLICATIONS IN C



A 32-bit development environment, LabWindows/CVI is automatic code-generation software for designing instrumentation applications with C under Windows and Solaris. The software includes an ANSI C compiler as well as a linker, a debugger, a variable-trace display, and memory-checking capabilities. Libraries are included for designing GUIs; acquiring, analyzing, and presenting data; and networking. You can incorporate your own C source files, object modules, and DLLs, and port programs developed with the LabWindows/CVI between Windows and Solaris. Price: \$1995 for the full development system for Windows; \$3995 for a Solaris single-user floating license, available in December.

Contact: National Instruments, Austin, TX, (800) 433-3488 or (512) 794-0100.

Circle 1119 on Inquiry Card.

PUT IT ON A CD

CD-IT software (\$1295) from OptImage Interactive Services (West Des Moines, IA) enables you to record CD-ROM, CD audio, or CD-I mixed-mode and multisession CDs directly from your Macintosh computer. You use a Philips CDD-521 Recorder to record data to a WORM CD. Software for all the modes, as well as the Philips CDD-521, is available in the CD-ITALL package (\$7995).

Phone: (515) 225-7000.

Circle 1127 on Inquiry Card.

NUMERICAL DATA ANALYSIS

A numerical data analyzer, Mathplot from Dynacomp (Webster, NY) is able to analyze up to 200 data points, calculate simple statistical parameters, fit least-squares polynomials, and

numerically integrate under a curve defined by the points, among other functions. A menu lets you display the results numerically and graphically. Price: \$49.95.

Phone: (716) 265-4040.

Circle 1128 on Inquiry Card.

BECOME CUSTOMER-AWARE ►

An application to record and track customer problems, Aware can import data from business applications such as Act and DacEasy. From Integritech Software (Bedford, TX), Aware also provides user-definable pick lists for data entry fields and lets you add solutions to new problems, among other features. Single-user version, \$99; network version, \$399.

Phone: (800) 942-6499 or (817) 267-3163.

Circle 1126 on Inquiry Card.

GAIN FINANCIAL ACUITY

Competence Software's interactive tutorial program Financial Competence (\$99) covers the principles of business finance, how they are reflected in financial statements, how they can be used in managing your business, and how the statements relate to one another. The program, consisting of seven 30-minute lessons, guides you through parts of an income statement, a balance sheet, and a cash-flow report. The lessons also help you create a financial statement line-by-line. Tests at the end of each lesson identify specific sections of the lesson you should restudy based on incorrect test answers.

Phone: (603) 435-7042.

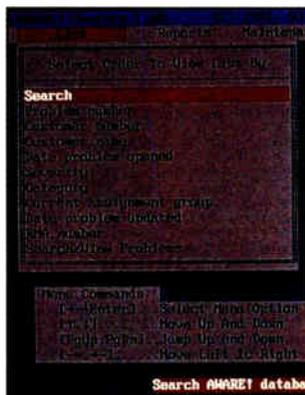
Circle 1121 on Inquiry Card.

SOPHISTICATED FILE MANAGEMENT

The Radix2 ADI (Advanced DOS Interface) system (\$249) lets you custom-configure and manage any directory in a DOS system. From Radix2 Software Engineering (Libertyville, IL), Radix2 ADI is based on a hierarchical command-concatenation processing engine that integrates DOS wild cards, file attributes, a quick sort, and a multiple-file text-string search, providing a high level of control over file manipulation.

Phone: (708) 549-6733.

Circle 1140 on Inquiry Card.



Software Update

Improv for Windows 2.1, Lotus (Cambridge, MA), adds data access to Paradox, dBase, text, Btrieve, and Excel via drivers from Q+E Software; support for .WK4 1-2-3 Release 4 for Windows files; and Notes-specific Application Field Exchange, which lets you exchange Improv worksheets with Lotus Notes fields. \$495.

Phone: (617) 577-8500.

Circle 1145 on Inquiry Card.

M-Mail 3.0, InterActive (Humboldt, SD), adds auto color conversion; printing of multimedia elements such as pictures and text without leaving the application; message forwarding with annotation; OLE support; a playback



capability; and E-mail functions. \$89.

Phone: (605) 363-5117.

Circle 1271 on Inquiry Card.

K-Star 9.2 software upgrade kit for FastPath 5, Shiva (Burlington, MA), adds TunnelTalk, zone filtering, device filtering, an SNMP community table, a UDP time server, syslogging, log message filtering, and improved DECnet management. \$199.

Phone: (617) 270-8500.

Circle 1272 on Inquiry Card.

PortShare Lite 2.0, Stalker Software (Moscow, Russia; Campbell, CA), adds support for Apple Remote Access software. **PortShare Pro 2.0** adds a statistics panel that logs real-time serial-port throughput and network transmission errors. Lite, \$49; Pro, \$149.

Phone: (800) 262-4722; fax (408) 370-3170.

Circle 1273 on Inquiry Card.

What's New Software

SYNCHRONIZE YOUR AUDIO AND VIDEO

The Audio Visual Recorder (\$149) lets you work in Windows to record, play back, and save video sequences in AVI (Audio Video Interleave) file format. You need a video-capture card with an AVI driver and an MPC-compatible sound card.



The software lets you record audio and video from most sources and then save the video files at any size. Since you can view audio-wave and video information simultaneously, you can easily edit your work. You can import and export Autodesk animation files as well as WAV, PAL, and single or serial BMP files. You can also export video sequences to FLC and FLI files, map them onto objects in 3D Studio, and then reimport them into Audio Visual Recorder and add a sound track. The package includes Microsoft and Intel Indeo compressors.

Contact: In Sync Corp., Bethesda, MD, (301) 831-5008.
Circle 1120 on Inquiry Card.

3-D VIRTUAL EXPLORATION

An object-oriented, interactive 3-D modeling program, Virtus WalkThrough for Windows (\$595) from Virtus (Cary, NC) displays in one window a 3-D representation of an object that you're drawing in an adjacent window. With your mouse, you can navigate within the space, viewing the object from different perspectives.

Phone: (800) 847-8871 or (919) 467-9700.

Circle 1132 on Inquiry Card.

PC BRAILLE TRANSLATION

MegaDots (\$500) from Raised Dot Computing (Madison, WI) is a braille translation program for the PC. Based on the rules of braille's contraction system, MegaDots uses a style-based word processor for formatting and has automatic table formatting and an easy-to-use interface.

Phone: (800) 347-9594 or (608) 257-8833.

Circle 1133 on Inquiry Card.

INDUSTRIAL DESIGNS IN 3-D

Built-in photorealistic rendering with a ray tracer lets you see natural illumination effects, such as shadows, reflection, and refraction, in DeskArtes (\$14,995) from Nth Graphics (Austin, TX). DeskArtes has new techniques for creating complex 3-D surfaces, and it includes texture-mapping and lighting tools. The computer-aided industrial design program can exchange data with other CAD/CAM systems.

Phone: (800) 624-7552 or (512) 832-1944.

Circle 1134 on Inquiry Card.

DECIPHER A NEW LANGUAGE

The Rosetta Stone (\$395), an interactive multimedia program, combines more than 3600 color pictures, voices of native speak-

ers, and written sentences in 12 run modes to teach Spanish, German, French, or English to a beginner. The software, from Fairfield Language Technologies (Harrisonburg, VA), has a listen-record-play mode that lets you compare your voice with that of the native speaker. The Rosetta Stone also includes diction and test modes.

Phone: (800) 788-0822 or (703) 432-6166.

Circle 1135 on Inquiry Card.

UNIX MOVES MAC AND DOS FILES

From Digital Instrumentation Technology (Los Alamos, NM), TransferPro for Solaris 2.1 and TransferPro for Motif (\$349 each) let Unix systems read and write DOS and Mac disks. Thus, Unix users can move data among different types of computers without a network. The company claims that TransferPro is faster than Sun's PC NFS.

Phone: (505) 662-1459.

Circle 1136 on Inquiry Card.

REAL-WORLD OPTICAL DESIGN ▼

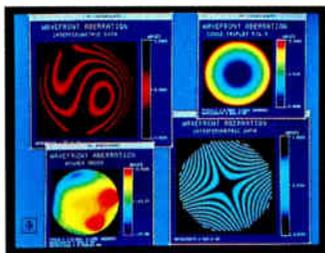
You can now run Code V from Optical Research Associates (Pasadena, CA) on your PC to develop and analyze optical design systems and configurations. The Global Synthesis feature solves practical problems in real-world design. Vector diffraction-

based image evaluation includes polarization effects, and MTF tolerance allows you to simulate and predict fabrication problems. Nonsequential

surface modeling is also included. You can specify and define tasks via menus and screens. Monthly lease (including maintenance), \$800.

Phone: (818) 795-9101.

Circle 1137 on Inquiry Card.



Software Update



Failure Mode, Effects and Criticality Analysis FME-2.0, Power-

tronic Systems (New Orleans, LA), adds support for MIL-STD-1629A, Notice 1, MIL-STD-2165, MIL-STD-1388 2A/2B, and AMC-P 750-2; enhanced modes of entry; analysis at assembly, sub-assembly, and part levels; built-in libraries of failure modes; support for NetWare and NetBIOS; and enhanced report outputs. \$1700.

Phone: (504) 254-0383.

Circle 1284 on Inquiry Card.

SpaceManager 1.5, Vertisoft Systems (San Francisco, CA), adds SuperCompress; memory reduction of module sizes; and SelectCompress, SuperExchange, SuperMount, FortuneTeller, and Super-Monitor modules. \$49.95 through November 15.

Phone: (415) 956-5999.

Circle 1274 on Inquiry Card.

LANlord 2.0, Client Server Technologies Group, Microcom (Yonkers, NY), adds support for LAN Manager and LAN Server and compatibility with NetBIOS-compatible networks; remote control based on Carbon Copy for Windows; support for multiple LANlord servers; alert forwarding capabilities; and a stand-alone PC inventory program. 50-user license, \$2495.

Phone: (914) 968-2300.

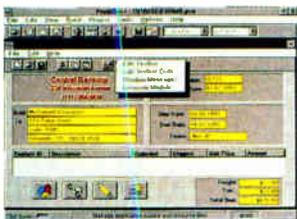
Circle 1275 on Inquiry Card.

Red Brick Warehouse 2.0, Red Brick Systems (Los Gatos, CA), adds support for databases in excess of 75 GB, new business extensions and a report generator to RISQL, and incremental load capabilities. From \$23,000.

Phone: (408) 354-7214.

Circle 1276 on Inquiry Card.

Software



VISUAL DEVELOPMENT SYSTEM

A fully integrated visual development workbench, ProtoGen+ (introductory price, \$199) from ProtoView Development (Dayton, NJ) enables you to develop C/C++ and Pascal Windows applications more quickly. Key features of the open environment include recent advances in object-oriented programming; a live, interactive test mode; range validation; DDE-link field editing; MDI (multiple document interface) support; toolbar support; dynamic status-line functions; and 3-D effects.

Phone: (800) 231-8588 or (908) 329-8588.

Circle 1130 on Inquiry Card.

ENHANCED CONNECTION

The PowerConnection utility (\$59.95) from Performance Technology (San Antonio, TX) provides two-

way access between users on a Windows for Workgroups network and someone using a DOS-only PC running Workgroup Connection. PowerConnection lets the Windows for Workgroups users access disks, printers, and CD-ROM drives attached to the DOS-only machine.

Phone: (800) 327-8526 or (210) 349-2000.

Circle 1138 on Inquiry Card.

ART HISTORY ON CD-ROM

Cameron's Fine Art Poster Catalog on CD-ROM (\$49) presents in three segments more than 580 works of art and more than 450 fine art posters, all accompanied by music. Pictures at an Exhibition shows paintings from the Old Masters through contemporary painters, along with the history of each work and artist. Sculptures on Video displays pieces from the Tang Dynasty to Rodin, with historical facts on each. The third segment consists of a collection of fine art posters. You can also use the software, from Cameron Enterprises (Ros-

well, GA), as a sound and video utility.

Phone: (800) 765-1278.

Circle 1144 on Inquiry Card.

FAX UNIX DRAWINGS DIRECTLY

You can fax large-format drawings directly from your Unix workstation to conventional fax machines using CADfax (from \$1999). The computer-aided distribution sends the faxes over standard phone lines. The Formtek (Pittsburgh, PA) software uses an intuitive Motif GUI with pop-up windows that guide you through the procedures. CADfax operates directly on the native CAD file, eliminating the fax scanning process.

Phone: (800) 367-6835 or (412) 937-4900.

Circle 1141 on Inquiry Card.

SPREADSHEET SQUEEZER

An on-the-fly compression utility for spreadsheets, Compress-Mate (\$79 through December) achieves an average compression ratio of 10 to 1 for typical spreadsheet files of text, values, and formulas. Large files can be compressed at ratios of more than 100 to 1. From Intex (Needham, MA), the utility can be used by itself or with disk doublers such as DoubleSpace and Stacker.

Phone: (617) 449-6222.

Circle 1142 on Inquiry Card.

CUSTOMIZE YOUR CURSOR

Magic Cursor II (\$39.95) customizes Windows mouse cursors. The Fanfare Software (Santa Monica, CA) toolkit has more than 300 color and monochrome cursors, as well as the Cursor Editor, which lets you adjust any cursor, create your own cursor, or import from any icon. User-defined hot keys let you activate a CAD-style full-screen cross-hair cursor, a real-time magnifying glass, and the blinking rate of the main arrow cursor.

Phone: (310) 828-8448.

Circle 1139 on Inquiry Card.

Software Update

Peachtree Complete Accounting 7.0, Peachtree Software (Norcross, GA), adds an Order Entry module and enhance-



ments to most other modules. \$249.

Phone: (404) 564-5700.

Circle 1279 on Inquiry Card.

MKS RCS 6.1 configuration management software, Mortice Kern Systems (Waterloo, Ontario, Canada), adds support for Windows 3.1, a GUI, the MKS Make configuration tool, and additional prefixes to configuration options. \$349.

Phone: (519) 884-2251.

Circle 1280 on Inquiry Card.

Accent GraphicVUE Project Management System 1.4, National Information Systems (San Jose, CA), adds compatibility with DEC's Alpha AXP computers running OSF/1 Unix. From \$1450.

Phone: (408) 985-7100.

Circle 1281 on Inquiry Card.

LandDesigner 3.0, Green Thumb Software (Boulder, CO), adds easier editing capabilities, additional graphical symbols, a

database search function, a high-resolution printing capability, and new text sizes and styles. \$89.

Phone: (303) 499-1388.

Circle 1282 on Inquiry Card.

LanSoft 3.1, Imagine LAN (Nashua, NH), adds Windows support, coexistence with NetWare, the EPAX 1.0 PC protection tool, improved client/server module performance, and support for many network interface cards. \$64 per user at four-user level.

Phone: (603) 889-5889.

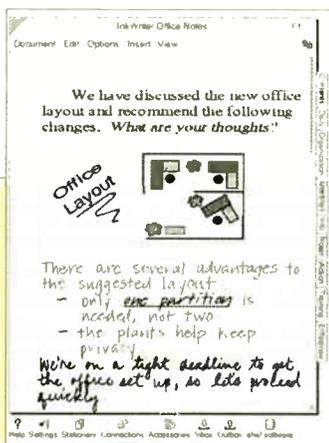
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INK FOR PEN PADS

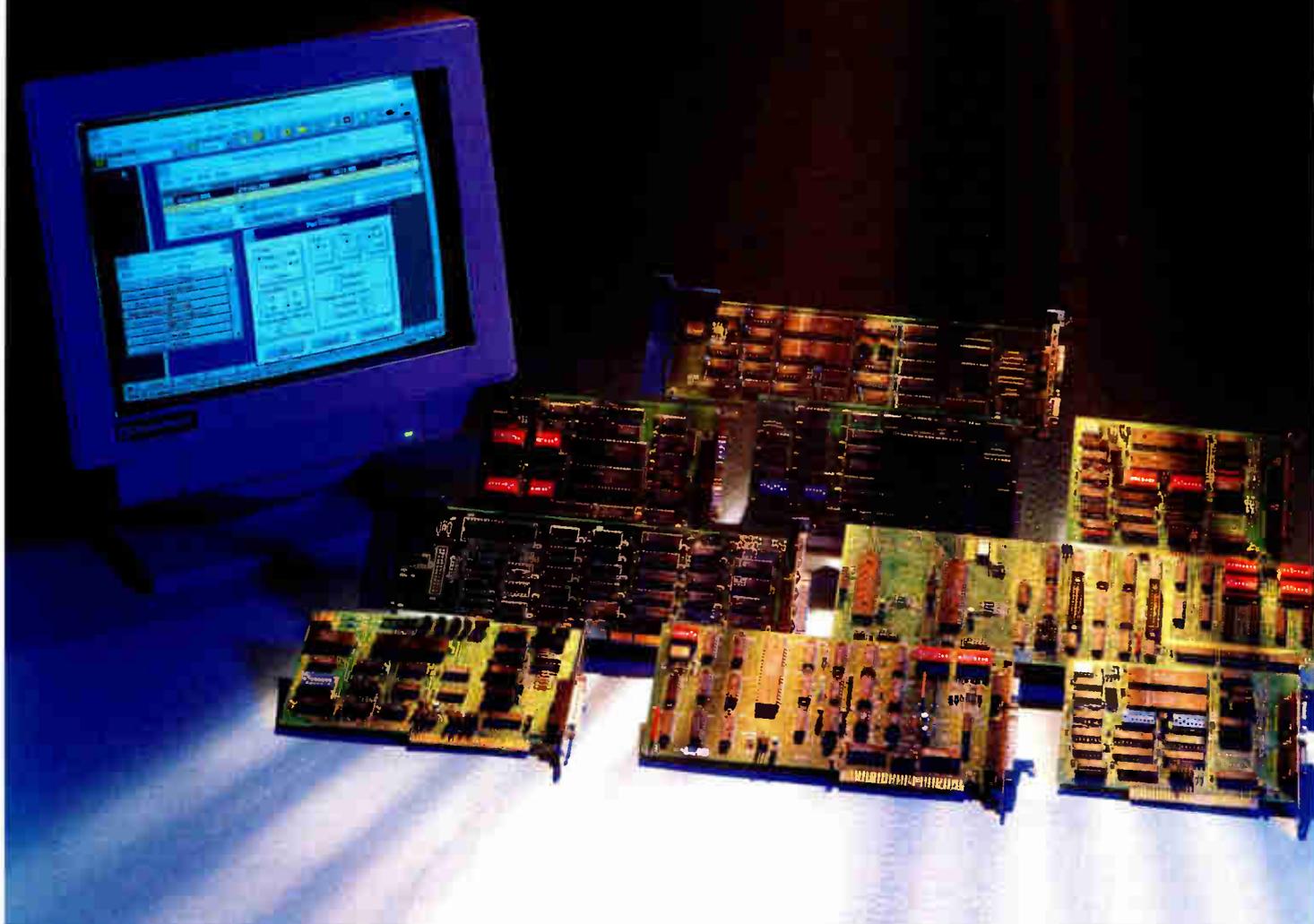
The first in Aha Software's (Mountain View, CA) InkProcessor product line, InkWriter (\$249) lets you edit and search computer text and handwritten notes on a pen-based device. Based on Smartlink technology, InkWriter automatically recognizes when you are writing paragraphs, making lists, marking up, drawing, or editing, and handles each item appropriately. You can search through documents to find a word. The initial release runs under Go Corp.'s PenPoint, on 386-/486-based tablets, or on an EO communicator.

Contact: Aha Software, Mountain View, CA, (800) 242-7638 or (415) 988-2080.

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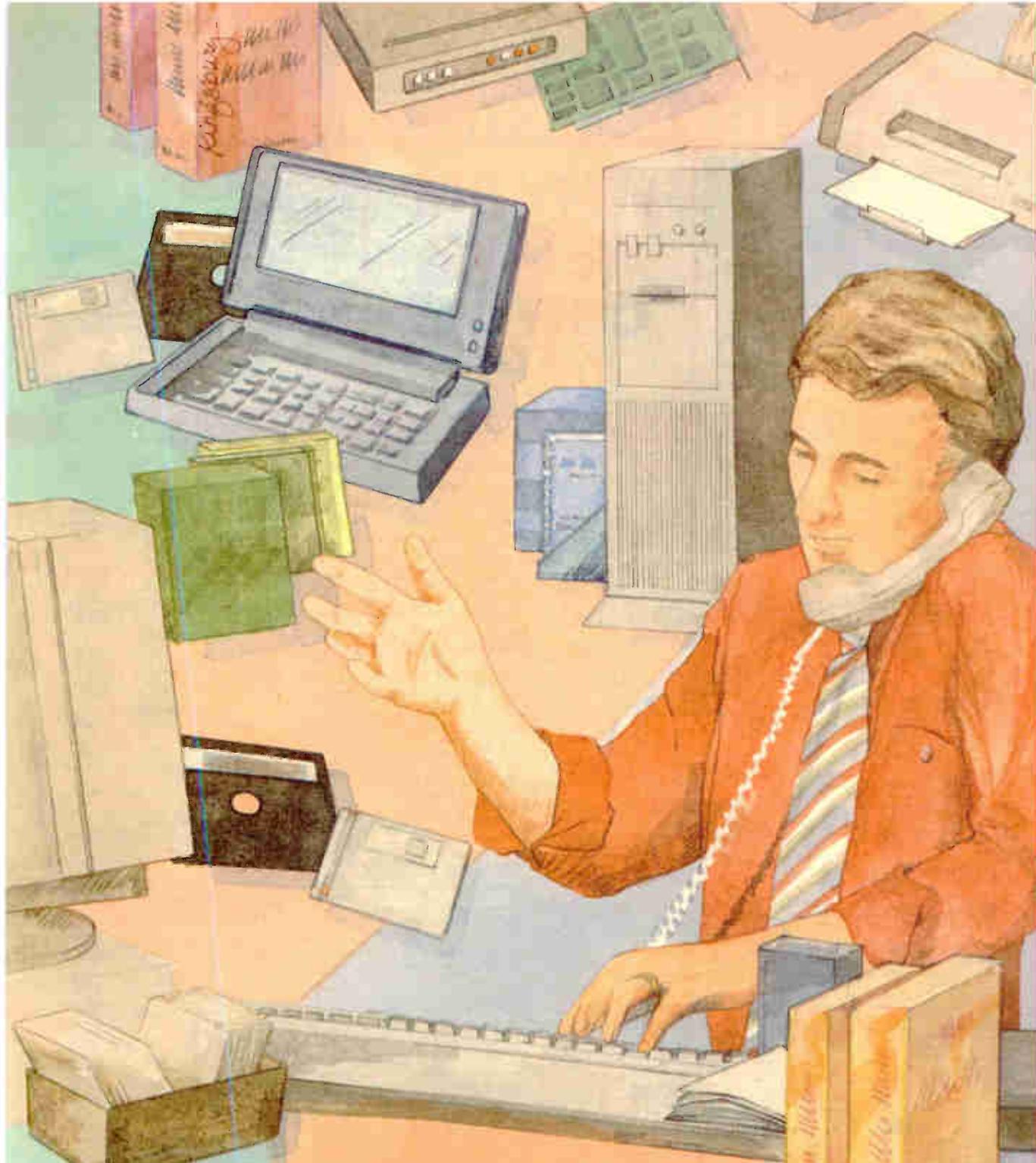
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Bravo LC 456D 120C 10HD	1825.84/2068.54
Bravo MT 430D 170/340HD	1512.22/1956.67
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POWEREXEC 200MB Special Edition MONO	2352.17
POWEREXEC 200MB Special Edition COLOR	3917.39
Premmia 433SX/433DX 170HD	1909.29/2139.41
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Canon

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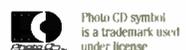
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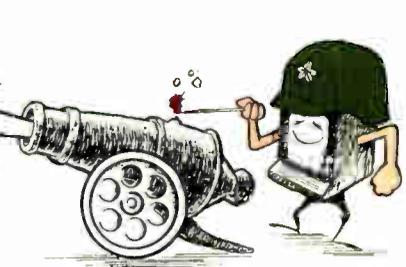
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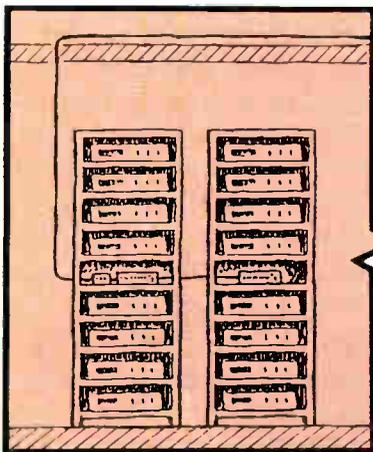
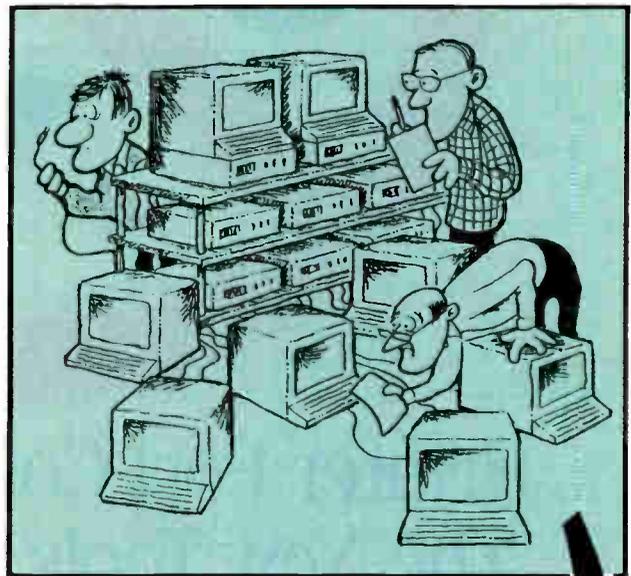


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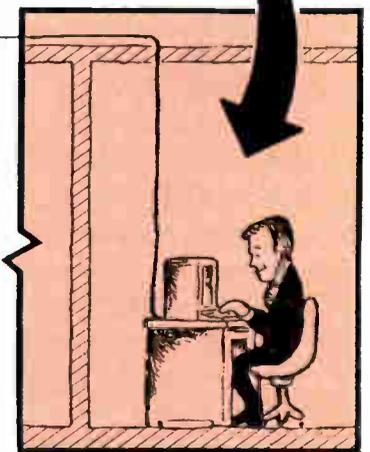
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MODEL	SIZE	SPEED	TYPE	PRICE
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CP3012A (1 1/4")	170MB	17MS	IDE	\$208
CP3025A (1 1/4")	200MB	15MS	IDE	\$278
CP3035A	540MB	10MS	SCSI	\$749
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Maxtor 2 YEAR WARRANTY

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7213A (1 1/4")	213MB	15MS	IDE	\$234
7213S (1 1/4")	213MB	15MS	SCSI	\$275
7245A (1 1/4")	245MB	15MS	IDE	\$269
7345A (1 1/4")	345MB	15MS	IDE	\$339
MXT5405L	540MB	13MS	SCSI/IDE	\$649
PANTHER (FH) 10125	1000MB	13MS	SCSI	\$998
RAMTRON (FH) P117	1000MB	13MS	SCSI	\$1288

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2623A/3 (3.5")	420MB	12MS	SCSI/IDE	\$728
2624A/3 (3.5")	530MB	12MS	SCSI/IDE	\$735
2265S (FH)	108MB	15MS	SCSI	\$999
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	8MB	128877001	\$444
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	8MB	141742001	\$399
Proline 4/25; 4/33, 4/50	2MB Module	141684001	\$328
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	2MEG MOD	118304001	\$108
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	2MEG BRD	117081002	\$109
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Ute 386S/20	1MEG BRD	121125001	\$98
	4MEG BRD	121125002	\$218
Ute L/10, 25, 25C	2MEG BRD	129769001	\$138
	4MEG BRD	129769002	\$248
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LTE Ute/20 & L/10, 25, 25C	16MB Card	N/A	\$1045
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	2MB	30F5360	\$114

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	4MB	139498001	\$238
	8MB	139499001	\$418
	8MB	146520001	\$228
	8MB	146521001	\$471
	16MB	146522001	\$548
SLT/286	1MEG MOD	110235001	\$79
	4MEG MOD	110237001	\$208
SLT/386	1MEG MOD	118303001	\$79
	2MEG MOD	118304001	\$108
	4MEG MOD	118305001	\$238
Ute 286	1MEG BRD	117081001	\$79
	2MEG BRD	117081002	\$109
	4MEG BRD	117081004	\$238
Ute 386S/20	1MEG BRD	121125001	\$98
	4MEG BRD	121125002	\$218
Ute L/10, 25, 25C	2MEG BRD	129769001	\$138
	4MEG BRD	129769002	\$248
	8MEG BRD	129769003	\$421
	16MEG BRD	129769004	\$1395
LTE Ute/20 & L/10, 25, 25C	16MB Card	N/A	\$1045
LTE Ute 486/25C	16MB Card	142337002	\$239
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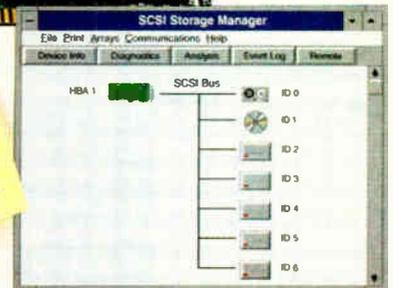
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AST POWEREXEC 486/25SL 120MB LCD W/ 4MB	\$2119
AST POWEREXEC 486/25SL 200MB W/ 4MB, Win. Mouse	\$2289
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IBM THINKPAD/500 486SLC/2 25/50 170MB LCD W/ 4MB	\$2488
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NEC ULTRALITE VERSA 486SL/25 120MB LCD W/ 4MB	\$2724
NEC ULTRALITE VERSA 486SL/25 180MB LCD W/ 4MB	\$2964
NEC ULTRALITE VERSA 486SL/25C 120MB Active Color W/ 4MB	\$3801
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TEX. INSTR. WinSLC/25 486SLC/25 80MB LCD, 2MB, Win, Mouse	\$1589
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TEX. INSTR. TM4000 WinSX/25 120MB LCD, 4MB, Win, Mouse	\$1840
TEX. INSTR. TM4000 WinSX/25 120MB Pass. Color, 4MB, Win, Mouse	\$2509
TEX. INSTR. TM4000 WinDX/25 120MB LCD, 4MB, Win, Mouse	\$2342
TEX. INSTR. TM4000 WinDX/25 200MB LCD, 4MB, Win, Mouse	\$2509
TEX. INSTR. TM4000 WinDX/25 120MB LCD, 4MB, Win, Mouse	\$2815
TEX. INSTR. TM4000 WinDX/25 200MB LCD, 8MB, Win, Mouse	\$2928
TEX. INSTR. TM4000 WinDX/25 200MB Active Color, 4MB, Win, Mouse	\$4142
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TOSHIBA T1850 386SX/25 120MB LCD W/ 4MB, Windows, Mouse	\$1488
TOSHIBA T1850C 386SX/25 80MB Passive Color W/ 4MB	\$1647
TOSHIBA T1850C 386SX/25 120MB Pas. Color 4MB, Windows, Mouse	\$1987
TOSHIBA T1900 486SX/20 80MB LCD W/ 4MB, Windows, Mouse	\$1817
TOSHIBA T1900 486SX/20 120MB LCD W/ 4MB, Windows, Mouse	\$1745
TOSHIBA T1900 486SX/20 200MB LCD W/ 4MB, Windows, Mouse	\$2001
TOSHIBA T1900C 486SX/20 120MB Passive Color, 4MB, Win., Mouse	\$2384
TOSHIBA T1900C 486SX/20 200MB Passive Color, 4MB, Win, Mouse	\$2640
TOSHIBA T4400C 486SX/25 120MB Active Color W/ 4MB	\$3406
TOSHIBA T4400C 486DX/25 200MB Active Color W/ 4MB	\$3879
TOSHIBA T4500 486SX/20 120MB LCD W/ 4MB	\$2022
TOSHIBA T4500C 486SX/20 120MB Active Color W/ 4MB	\$3199
TOSHIBA T4600 486SL/33 120MB LCD W/ 4MB, Windows, Mouse	\$2810
TOSHIBA T4600 486SL/33 200MB LCD W/ 4MB, Windows, Mouse	\$3065
TOSHIBA T4600C 486SL/33 120MB Active Color w/ 4MB, Win, Mouse	\$4002
TOSHIBA T4600C 486SL/33 200MB Active Color w/ 4MB, Win, Mouse	\$4258
TOSHIBA T4600C 486SL/33 340MB Active Color w/ 4MB, Win, Mouse	\$4684
TOSHIBA T5100 386DX-16 100MB Gas Plasma W/ 4MB (DEMO)	\$1278
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THINKPAD 500 4MB/8MB \$215/\$397
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Bravo 486/25 386	2Meg Kit	500700-005	120.00
Bravo 486	8Meg Kit	500700-001	298.00
	4Meg	500997-003	155.00
	8Meg Kit	500997-004	655.00
Premium 386/25 16 SX	1Meg	500718-001	55.00
Premium 386/33	1Meg	500718-002	54.00
Premium II	1Meg	500700-003	WBP 60.00
386SX/20 486-25 25E 33	4Meg	500700-004	WBP 160.00
Premium Tower 386/33/1E 486/25/1E 486/33/1E	8Meg	500700-001	WBP 320.00
Cupid Memory Board	0-32Meg	500818-001	149.00

ZENITH MEMORY MODULES

MODEL	AMT. UPGRADED	AST PART #	PRICE
Z386SX 25 20 33E	1Meg	Z4300EM	50.00
Z386SX 25 20 33E 486/25E	4Meg	Z4300EM	150.00
Z386SX	2Meg	Z-605-T	modules 99.00

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Intel SL Mobil	89.00
Intel 16SX	54.00
Intel 20SX	59.00

IBM PS/2 SIMM MODULES

IBM PART NO.	WORKS WITH MODEL NO.	PRICE
30F5348 (512K)	30-286	30.00
30F5360 (2Meg)	30-286, 25-286, 50 MTHR BD	79.00
33G9288 (2Meg)	Thinkpad 300	109.00
33G9288 (8Meg)	Thinkpad 300	339.00
6450375 (1Meg)	80-041	79.00
6450379 (2Meg)	80-111, 311-121, 321, 081, 161	94.00
6451060 (4Meg)	80-A-21, A-61, 80-A31, 80-111, 80-311	189.00
6450603 (1Meg)	35-45X, 45SX, Model-70S, P-70	45.00
6450604 (2Meg)	70-061 681, 121, 52, 55S, 65SX, P-1	82.00
	54LS, 65LS, X-Station 120 & 130, 35SX, 40SX	
	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX	86.00
	Value Point 325T	
78X8955 (128K)	25	35.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 55LS, 65LS	159.00
87F9977 (4Meg)	55LS, 65LS, 40SX, 35SX, 35LS	159.00
1057035 (512K)	P/S1-286	40.00
92F9835 (2Meg)	P/S1 & P/S1/386SX-2121	92.00
92F9894 (4Meg)	P/S1 & P/S1/386SX, Model-2121	144.00
6450902 (2Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC	89.00
	Value Point 77 486DX2, 486SX, SVR 85	
6450128 (4Meg)	57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Models 2123, 2133, 2155, Value Point 77 486DX2, 486SX, SVR 85	165.00
6450129 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC	319.00
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79F0999 (2Meg)	LX40, N33SX, PS Note	89.00
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07G1827 (4Meg)	N51 (all)	179.00
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07G1420 (4Meg)	CL57LSX LpTp, Thinkpad 700, 700C, 720, 720C	189.00
07G1421 (8Meg)	CL57LSX LpTp, Thinkpad 700, 700C, 720, 720C	319.00
92F8004 (2Meg)	N45SL	99.00

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DeskPro 386/33, 386/33L	2Meg Module	115144-001	89.00
486/25, 486/33L	8Meg Module	115551-001	339.00
486/50 System Pro	32Meg Module	115559-001	1599.00
DeskPro 386/33L, 486/33L	(Exp Bd)	115559-001	289.00
DeskPro 386/25, 386/20	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	174.00
DeskPro 386/5-16MHz	1-Meg Exp Bd	113633-001	110.00
	4-Meg Exp Bd	113634-001	210.00
	1Meg Module	113645-001	75.00
	4Meg Module	112534-001	174.00
DeskPro 386/20E	1Meg Exp Bd	113644-001	219.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	339.00
	1Meg Module	113131-001	75.00
	4Meg Module	113132-001	174.00
DeskPro 286N, 386M, 386SX/20, 386/25M, 486/33M, 486SX/25M, 486/33M	1Meg Module	118688-001	50.00
	4Meg Module	118689-001	85.00
	8Meg Module	118690-001	149.00
Port 486C	8Meg Module	128877-001	339.00
M Series Exp Bd	0-64Meg	129160-001	279.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	269.00
	8Meg Kit	108069-001	339.00
	1-2Meg Exp Bd	108068-001	389.00
	4-8Meg Exp Bd	108067-001	689.00
DeskPro 286	1/2 12K Kit	112012-001	89.00
Protinea 386 3/25S, 3/25E	1Meg	149728-001	89.00
	4Meg	149729-001	289.00
Protinea 486 4/25S, 4/33	1Meg	149730-001	85.00
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4/50, 4/66, CDS	4Meg	141684-001	159.00
	8Meg	141685-001	319.00
Prosignia PC Server, 486/33, 486 DX/66	16Meg	149320-001	349.00
	32Meg	149321-001	1949.00

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LTE286	2Meg Bd	117081-002	99.00
LTE286	4Meg Bd	117081-003	179.00
LTE386/20	4Meg Module	12111-002	199.00
LTE LITE/20, 25, 25C	4Meg Module	129709-002	199.00
LTE LITE/20, 25, 25C	8Meg Module	129709-003	319.00
LTE LITE/20, 25, 25C	16Meg Module	129709-004	639.00
LTE LITE 4/25E	4Meg Module	142327-002	199.00
LTE LITE 4/25C	8Meg Module	142327-003	299.00
LTE LITE 4/25C	16Meg Module	142327-004	749.00
SLT7286	1Meg Module	118303-001	79.00
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SLT7386	1Meg Module	118303-001	79.00
SLT7386	2Meg Module	118304-001	99.00
SLT7386	4Meg Module	118305-001	159.00
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Contura 4/25, 4/25C, 4/25CX	4-Meg	146520-001	169.00
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	16-Meg	146531-001	939.00

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TOSHIBA LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
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T2000/2000SX	2Meg	PC18-PA8317U	84.00
T2000SX/11000LE	4Meg	PC18-PA8317U	159.00
T2000SX/11000LE	4Meg	PC14-PA8317U	275.00
T2000SX/2200SX/T1800, 1650, C	4Meg	PC-PA2000U	84.00
T2000SX/2200SX/T1800, 1850, C	4Meg	PC-PA2001U	159.00
T2000SX/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	279.00
T4400SX, S			



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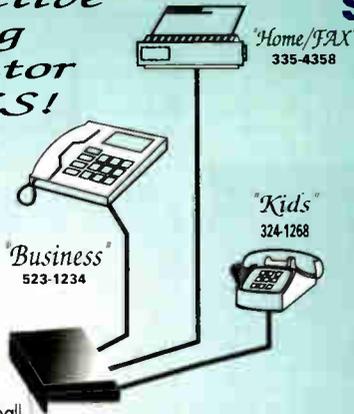
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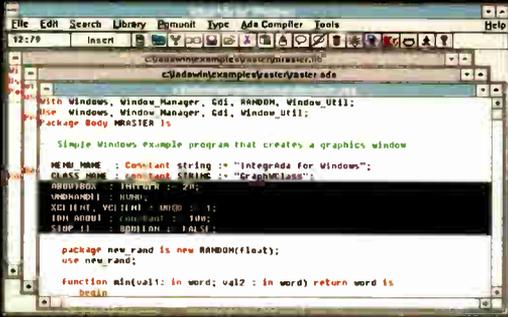
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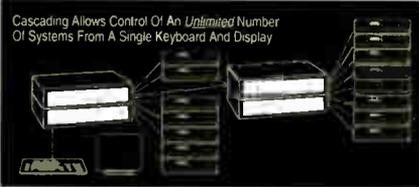
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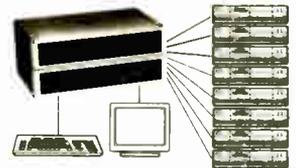
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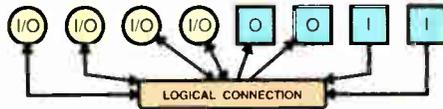
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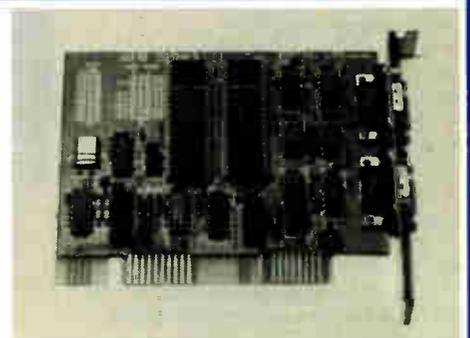
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Features:

- 16550 UARTS allows windows background modem operation without loss of data.
- Eight (8) I/O address selections: COM1, 2, 3, 4, LPT1, 2, 268H, 368H.
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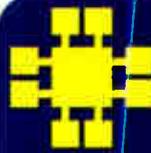
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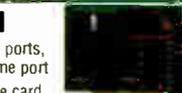
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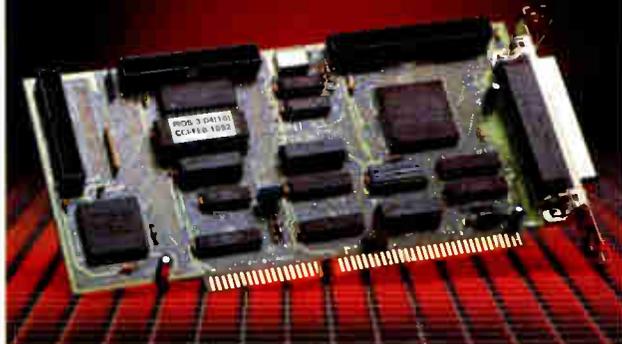
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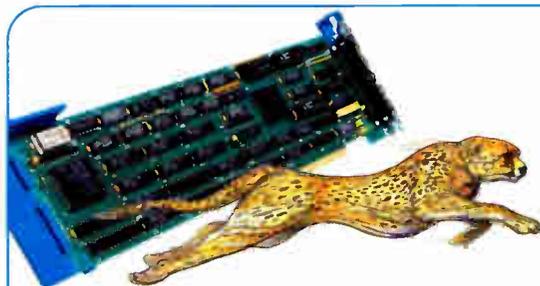
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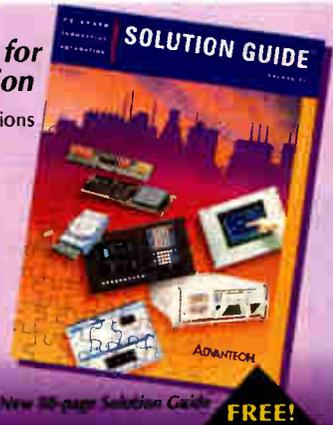
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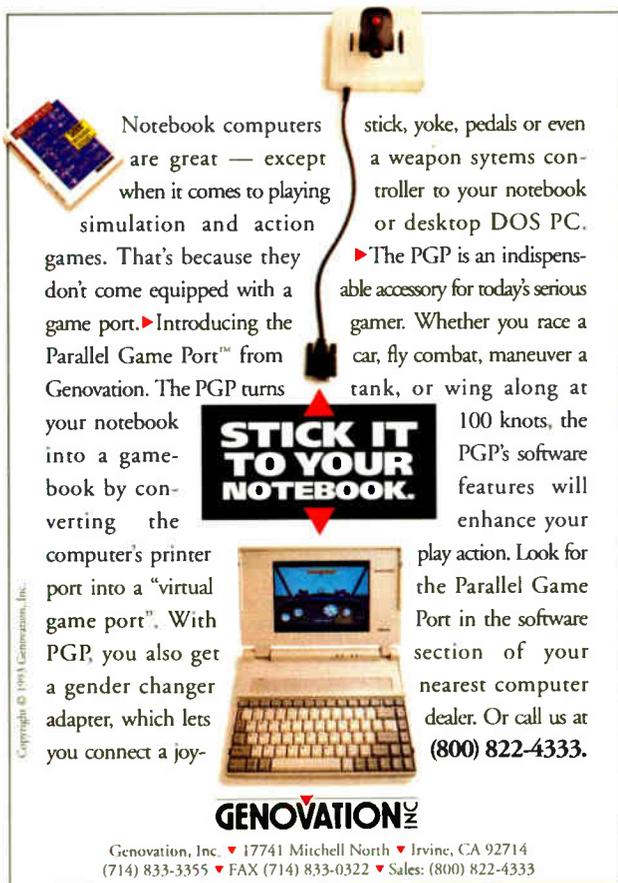
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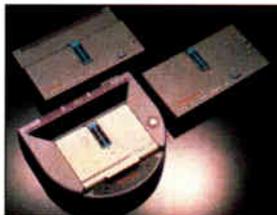
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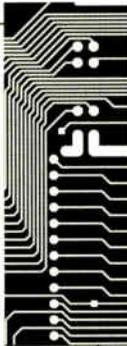
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EDN-Hands On Section, EDN magazine, June 1993.

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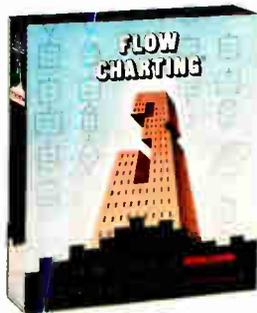
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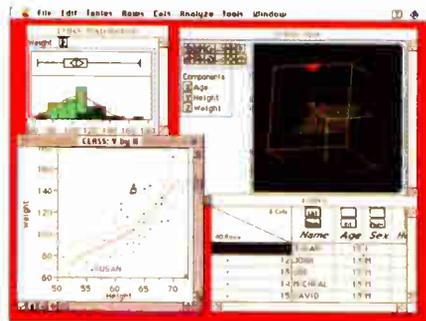
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450	287	800-695-4775			ext. 924	* MICROSOFT CORP	19	
501-502	48IS 7	407-997-6227	286-287	226	800-962-3900	* MICROSOFT CORP	191	
292	266	612-694-0595	513-514	48IS 26	713-496-9400	* MICROSTAR LABORATORIES	270	206-453-2345
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245			562					ext. 29
179			524			UNIXWORLD	241	800-257-9402
271-272			138					ext. 29
111			542-543			151-152	UNLIMITED SYSTEMS	188
			139					619-622-1400
Q			139			V		
132			139			VALITEK INC	56	413-549-2700
246			260			154-155	VERBATIM CORP	103
131			140			156	VERMONT CREATIVE S/W	116
			544			251	VICTORY ENTERPRISES TECH	271
R			178			252	VIDEX, INC	269
RADIO SHACK (N.A.)	30-31	817-390-3011	167			157-158	VIEWSONIC	63
RAIMA CORP	35	800-327-2462	143-144	SYSTAT INC	153	282-283	VISIONWARE	235
RAINBOW TECHNOLOGIES	75	800-852-8569				W		
522	4818	+36-1-2018925				WATCOM	27	519-886-3700
216-217	RECORTEC INC	261	248	TALKING TECHNOLOGY INC	269	160	WATCOM	129
266	RESEARCH SYSTEMS, INC	275	249	TALKING TECHNOLOGY INC	275	561	WELLS FARGO BANK	264PC 1
135	ROSE ELECTRONICS	148	525	TECHPOWER COMPANY LTD	239	253	WINTEK CORP	274
			145	TEKTRONIX	53	163-165	WOLFRAM RESEARCH	121
S						218	WORLDWIDE TECHNOLOGIES	250
540-541	SAMTRON (INT'L)	31		TEXAS INSTRUMENTS	144A-J			215-922-0116**
247	SAS INSTITUTE INC	275	146	TEXAS INSTRUMENTS	176-177			
136	SEQUITER SOFTWARE INC	218	147	TOSHIBA AMERICA INC	186-187			
274-275	SHAFFSTALL CORP	274	215	TOTE-A-LAP	259			
261-262	SIGMA TECH SOFTWARE	269	255	TRANTOR SYSTEMS LTD	270			
85-86	SMART PRINT / DRESSELHAUS	216	148-149	TRAVELING SOFTWARE	175			
137	SN'W COMPUTERS & ELEC	154	550	TRAVELING SOFTWARE	4818 2			
187	SOFTARC	152	257	TRI VALLEY TECHNOLOGY INC	270			
193-194	SOFTLANDING SOFTWARE	102	250	TRIBAL MICROSYSTEMS	273			
						X		
						161-162	XVT SOFTWARE INC	194
								800-678-7988
						Z		
						531	ZECKS	4818 14
						166	ZEOS INTERNATIONAL	168-169
						254	Z-WORLD ENGINEERING	273

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Category No. Inquiry No.	Page No.	Category No. Inquiry No.	Page No.	Category No. Inquiry No.	Page No.
HARDWARE					
1 ACCESSORIES/SUPPLIES					
533	239	229	270	166	168-169
277	268	234	270	14 MAIL ORDER	
537	48IS 21	241	270	*	88-88D
245	268	*	270	74	208
138	104	242	274	219	258
531	48IS 14	*	48IDRC 1-2	202	248-249
		132	246	506	226
		7 DISK & OPTICAL DRIVES			
		292	266	106	225
		554	48IS 5	220-221	263
		265	270	210	254
		564	221	137	154
		211-212	251	218	250
		213-214	253	15 MEMORY/CHIPS/UPGRADES	
		548-549	48IS 10	219	258
		127-128	7	84	16-17
		129	77	208-209	256
		255	270	104	48A-D
		154-155	103	105	64A-B
		8 DISKETTES/DUPLICATORS			
		251	271	106	225
		9 FAX BOARDS/MACHINES			
		526-527	95	108-109	109
		120	83	226-227	260
		10 GRAPHICS TABLETS/MICE/PEN INPUT			
		191-192	79	218	250
		285	102	16 MISCELLANEOUS HARDWARE	
		286-287	226	225	264
		*	191	102	222
		11 KEYBOARDS			
		503	230-231	17 MODEMS/MULTIPLEXORS	
		233	271	180-181	220
		233	271	182-183	228
		173-174	101	276	272
		12 LAN HARDWARE			
		504-505	48IS 15	501-502	48IS 7
		504-505	230	*	267
		204-205	252	526-527	95
		508-509	CIV	228	262
		*	70-71	151-152	188
		516	33	18 MONITORS & TERMINALS	
		222	266	232	272
		528	48IS 8	232	272
		548-549	48IS 10	517	48IS 31
		123-124	61	116-117	221
		85-86	216	521	12-13
		13 LAPTOPS & NOTEBOOKS			
		*	88-88D	540-541	31
		70-71	173	157-158	63
		230	271	19 MULTIMEDIA	
		538	203	533	239
		278-279	271	289	224
		529	48IS 29	172	47
		235	272	268-269	272
		*	15	186	179
		JDR MICRODEVICES	267	175	203
		MICRO ELEC MEI / MICRO CENTER, INC	171	122	119
		220-221	263	*	30-31
		551	48IS 23	20 PRINTERS/PLOTTERS	
		552	48IS 25	64	130-131
		539	173	78	12-13
		137	154	222	266
		544	30	556	257
		*	144A-J	537	48IS 21
		146	176-177	120	83
		147	186-187	*	117
		215	259	271-272	273
				85-86	216
				145	53
				21 PROGRAMMABLE HARDWARE	
				512	48IS 9
				238	273
				*	267
				250	273
				254	273

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Category No. Inquiry No.		Page No.	Category No. Inquiry No.		Page No.	Category No. Inquiry No.		Page No.
22	SCANNERS/OCR/DIGITIZERS		33	GRAPHICS				
518	LIGATURE LTD	48IS 24	68	AITECH INTERNATIONAL	207	88	ELIASHIM MICROCOMPUTERS	52
120	OKIDATA	83	191-192	ARISTO GRAPHIC SYSTEMS	79	511	EUTRON	48IS 22
522	RECOGNITA	48IS 18	291	ATTITUDE INC	233	512	FAST ELECTRONIC GMBH	48IS 9
			83	COREL SOFTWARE	29	90-91	GLENCO ENGINEERING	157
			273	LEAD TECHNOLOGIES	274	133-134	RAINBOW TECHNOLOGIES	75
			113-114	MICROGRAF X	227	524	SOFTWARE SECURITY (INT'L)	CIH
23	TAPE DRIVES		116-117	NANAO USA CORP. (N.A.)	221			
554	CHRISTIE ELECTRONICS LTD	48IS 5	122	PASSPORT DESIGNS INC	119	45	UNIX	
76-77	COLORADO MEMORY SYSTEMS	199	244	PATTON & PATTON	275	506	COMPUTER QUICK (INT'L)	226
240	LAGUNA DATA SYSTEMS	273	266	RESEARCH SYSTEMS, INC	275	89	FRAME TECHNOLOGY (N.A.)	122-123
211-212	MICRO SOLUTIONS COMP PROD	251	542-543	SPEA SOFTWARE AG	48IS 13	188-189	INFORMATION FOUNDATION	223
213-214	MICRO SOLUTIONS COMP PROD	253				115	MKS / MORTICE KERN SYSTEMS	158
548-549	MULTIPOINT COMPUTER-SYSTEME	48IS 10				*	NETWORK COMPUTING DEVICES (N.A.)	185
243	OVERLAND DATA INC	273	35	MAIL ORDER		193-194	SOFTLANDING SOFTWARE	102
246	QUALSTAR CORP	273	202	COMPUTER DISCOUNT WAREHSE	248-249	178	SUNSOFT	2-3
274-275	SHAFFSTALL CORP	274	535	OMNI PLUS	48IS 32	282-283	VISIONWARE	235
153	VALITEK INC	56	111	PROGRAMMER'S PARADISE	54-55	163-165	WOLFRAM RESEARCH	121
			523	SOFTLINE CORP (INT'L)	104			
24	UPS					46	UTILITIES	
69	AMERICAN POWER CONVERSION	144	36	MATHEMATICAL/STATISTICAL		67	ALADDIN KNOWLEDGE SYSTEMS	87
554	CHRISTIE ELECTRONICS LTD	48IS 5	532	NAG	48IS 26	75	CENTRAL POINT SOFTWARE	135
121	MINUTEMAN	59	247	SAS INSTITUTE INC	275	176-177	FIFTH GENERATION	91
123-124	PC POWER & COOLING	61	139	SPSS INC (INT'L)	143	263	HARPER COLLINS	275
			139	SPSS INC (N.A.)	143	141-142	LANDMARK RESEARCH INT'L CORP	93
			140	STATSOFT	229	567	LOGICIELS ET SERVICES DUHEM (INT'L)	132
			143-144	SYSTAT INC	153	288	MICRO 2000	265
			163-165	WOLFRAM RESEARCH	121	130	PKWARE INC	156
						167	SYMANTEC	149
						156	VERMONT CREATIVE SOFTWARE	116
25	BUSINESS		37	MISCELLANEOUS SOFTWARE		47	WINDOWS	
81	COMPUTER ASSOCIATES	107	185	E. J. BILINGUAL	139	61-62	ABACUS SOFTWARE	51
263	HARPER COLLINS	275	530	ON TIME MKT / KARSTEN PETERSEN	48IS 30	195	ASK ME INFORMATION CENTER	52
92-93	HORIZONS TECHNOLOGY	215				75	CENTRAL POINT SOFTWARE	135
*	LOTUS DEVELOPMENT	96-97	38	ON-LINE SERVICES		89	FRAME TECHNOLOGY (N.A.)	122-123
			450	BIX	287	515	GREY MATTER LTD (INT'L)	201
			*	COMPUSERVE (INT'L)	160A-B	107	KEA SYSTEMS LTD	219
26	CAD/CAM		79	COMPUSERVE (INT'L)	161	141-142	LANDMARK RESEARCH INT'L CORP	93
191-192	ARISTO GRAPHIC SYSTEMS	79	*	COMPUSERVE (N.A.)	160A-B	197	MICRO ELEC MEI / MICRO CENTER, INC	171
259	CADSOFT COMPUTER, INC	274	79	COMPUSERVE (N.A.)	161	116-117	NANAO USA CORP. (N.A.)	221
253	WINTEK CORP	274				258	PACIFIC SOFTWARES	275
			39	OPERATING SYSTEMS		125	PERSOFT INC	197
			64	ADOBE SYSTEMS INC (N.A.)	130-131	542-543	SPEA SOFTWARE AG	48IS 13
			97	IBM PERSONAL SOFTWARE PRODUCTS	36-37	282-283	VISIONWARE	235
			98	IBM PERSONAL SOFTWARE PRODUCTS	39			
			99	IBM PERSONAL SOFTWARE PRODUCTS	41	48	WORD PROCESSING/DTP	
			100	IBM PERSONAL SOFTWARE PRODUCTS	43	89	FRAME TECHNOLOGY (N.A.)	122-123
			546-547	IGC INC	48IS 11	263	HARPER COLLINS	275
			*	NETWORK COMPUTING DEVICES (N.A.)	185	*	MICROSOFT CORP	19
			131	QUARTERDECK OFFICE SYSTEMS	20-21			
			40	PROGRAMMING LANGUAGES/TOOLS				
			199	AETECH	264	49	BOOKS/PUBLICATIONS	
			80	COMPUTER ASSOCIATES	85	61-62	ABACUS SOFTWARE	51
			510	DR HUGGLE & PARTNER GMBH	48IS 28	\$	COMPUTER PROF BOOK SOCIETY (N.A.) 200A-B	
			515	GREY MATTER LTD (INT'L)	201	*	COMPUTER PROF BOOK SOCIETY (N.A.)	201
			110	LAHEY COMPUTER SYSTEMS	120	*	OBJECT MAGAZINE	48IDRC 1-2
			519	LOGIC PROGRAMMING ASSOCIATES	48IS 30	*	OSBORNE MCGRAW-HILL	204
			*	MICROWAY	150	566	SOFTVISION INTERNATIONAL (N.E.)	262
			*	MICROWAY	216	*	UNIXWORLD	240A-B
			115	MKS / MORTICE KERN SYSTEMS	158	*	UNIXWORLD	241
			530	ON TIME MKT / KARSTEN PETERSEN	48IS 30			
			126	PHAR LAP SOFTWARE INC	147	51	MISCELLANEOUS	
			196	POET SOFTWARE (N.A.)	239	*	BYTE BACK ISSUES	281
			179	POWERSOFT CORP. (N.A.)	132	*	BYTE EURODECK	262
			136	SEQUITER SOFTWARE INC	218	*	BYTE PUBLICATIONS	257
			562	SOFTWARE PRODUCTIONS	264PC 4	*	BYTE SUB MESSAGE	154
			249	TALKING TECHNOLOGY INC	275	*	DATAPRO INFO SERVICES GRP (INT'L)	122-123
			159	WATCOM	27	*	DECUS	264PC 2
			160	WATCOM	129	*	DIALOGIC TELECOM EUROPE	48IS 32
			161-162	XVT SOFTWARE INC	194	*	GTC TELE COMMUNICATIONS (INT'L)	232
							MANNESMANN TALLY	48IS 21
			41	SECURITY			MMG-SYSTEMS	48IS 17
			67	ALADDIN KNOWLEDGE SYSTEMS	87			
			503	CHERRY MIKROSCHALTER GMBH (INT'L)	230-231			
			184	DALLAS SEMICONDUCTOR	50			

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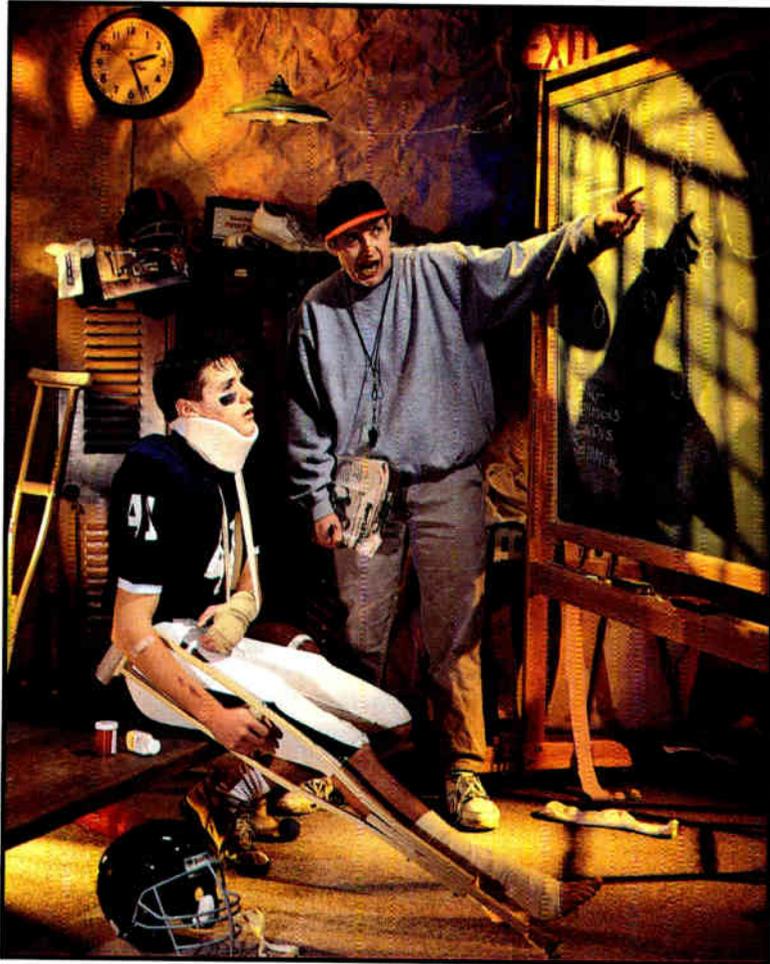


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World Radio History

Building Component Software

GUIs have driven the development of component software; distributed objects are the next frontier

Nowadays, when a software developer visits BYTE to show us a new application, we're not surprised to see that it can run on Windows and the Macintosh and perhaps also Motif. But this routine mastery of multiple GUIs is, in fact, astonishing. It's instructive to think about just why applications have been able to pick themselves up and move from platform to platform.

Remember when everyone worried about the GUI wars? Well, nobody really won, but in the end it didn't matter. What we got was a convergence on some useful things—movable windows, dialog boxes, scroll bars, and so on. That convergence has made applications easier to use, but it has had other powerful benefits, too.

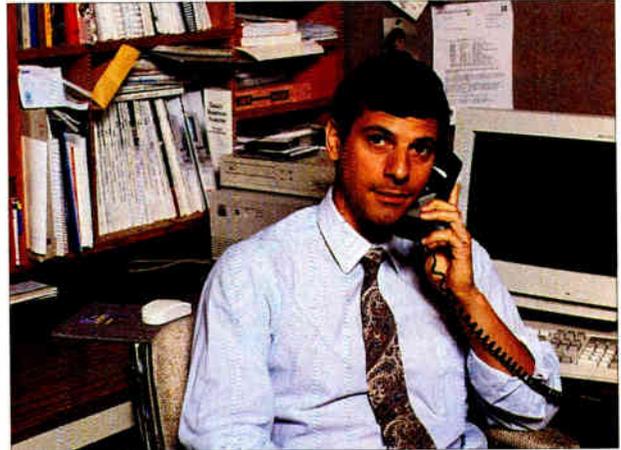
The Holy Grail of software development is reusable components, prefabricated "software ICs" you can pull off the shelf and use. Some say these things are still years in the future. I think they're right under our noses. You needn't look any further than the GUIs: Windows, the Mac, and Motif. These building blocks do a lot of work for the applications layered on top of them. Thanks to the convergent evolution of GUIs, an application built on one GUI can pretty easily move to another.

Things get really interesting when the building blocks themselves start to move from platform to platform, carrying whole families of applications with them. That's happening now. The new generation of operating systems, including Windows NT, IBM's Workplace OS, and the Novell/Unix Systems Laboratories version of Unix, are all built to accept pluggable GUI components. That means you'll be able to run Windows and Mac applications on all these operating systems. Better yet, the operating systems are portable and will run your applications on any of the up-and-coming processors.

The new RISC PCs don't have Intel inside, and they sure don't boot DOS when turned on. So can they really become a major force in computing? I think they can, thanks to a building block called Windows. But this isn't just a Windows phenomenon. I'm just as bullish on the prospects of another RISC PC on the horizon—a new kind of Mac built around the PowerPC chip.

The success of these new RISC PCs will depend on two things. First, today's Windows and Mac applications will have to run on them acceptably and without change. Second, the applications will have to port, with minimal change, to the native RISC hardware. GUI building blocks make both of these things possible.

To run existing Windows and Mac software on a RISC PC, you need software emulation of the Intel and Mo-



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torola chips. But you want to avoid pure processor emulation that turns the Alpha or Mips or PowerPC chip into a 286 or 68000. Fortunately, a strategy I call *hybrid emulation* buys back a lot of the performance lost with pure emulation. Windows and Mac programs spend a lot of time executing code inside the GUI building block. On a RISC PC, that building block talks straight to the hardware, giving a big performance boost over pure emulation.

Eventually, you'll want to run your Windows and Mac applications natively on your RISC machine. That will be pretty straightforward, too, again thanks to the use of components. Existing Windows programs can be rebuilt to run natively under NT on any of the processors NT supports. Early indications are that Mac programs will migrate just as easily onto PowerPC systems.

With the GUI problem largely solved, distributed computing is the next great challenge. Here, we lack the necessary building blocks. The network equivalents of movable windows, dialog boxes, and scroll bars don't exist. What we have are a bunch of promising technologies that all seem to have the word *object* in their names: Microsoft's Object Linking and Embedding, IBM's Distributed System Object Model, Sun's Distributed Objects Everywhere, and some others. No one knows yet just how these objects are going to work, but they'll deal with things like directory services, interapplication communication, and distributed compound documents.

Should we now worry about distributed-object wars? Will developers have to back the winning standard to survive? I hope not. With luck, we'll see a repetition of what happened with GUIs. Applications will increasingly rely on several competing distributed-object technologies. The features and capabilities of these building blocks will converge, the benefits of reusing them will accrue to everyone, and distributed computing will suddenly seem quite ordinary. ■

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

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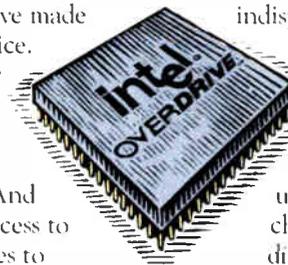
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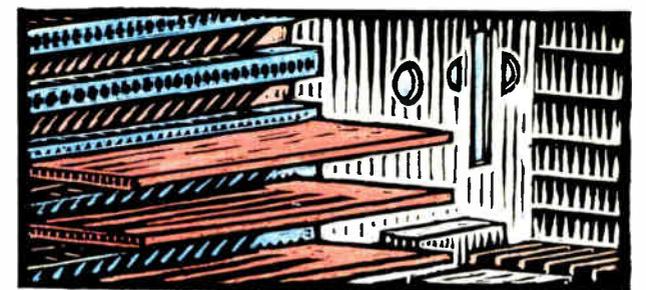
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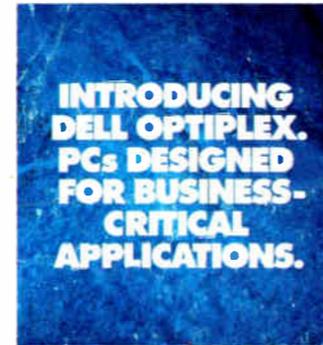
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