NEW TAX SOFTWARE

MARCH 1993

BYTE

THE WORLDWIDE COMPUTING AUTHORITY

6 New Macs Page 40

Smarter E-Mail

Intelligent E-Mail will change the way you work See page 90

PLUS

SPECIAL REPORT

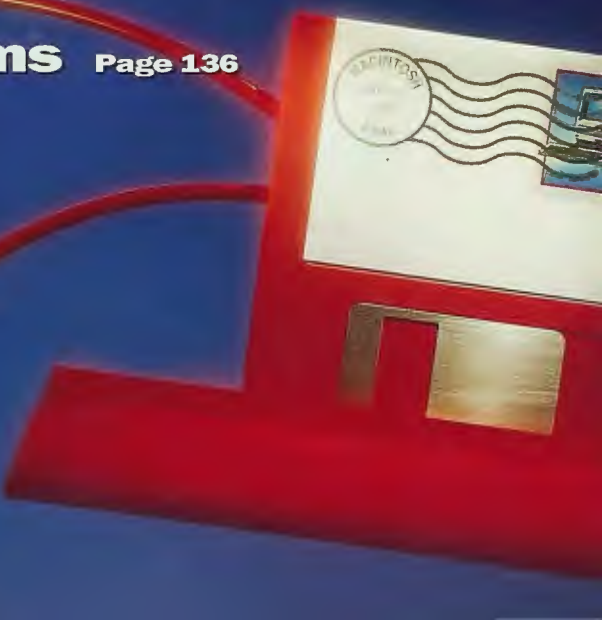
- Where groupware is headed Page 112

EXCLUSIVE RATINGS

- The best E-Mail programs Page 136

5 New 600-dpi Laser Printers

Beyond DOS: Next-Generation OLE



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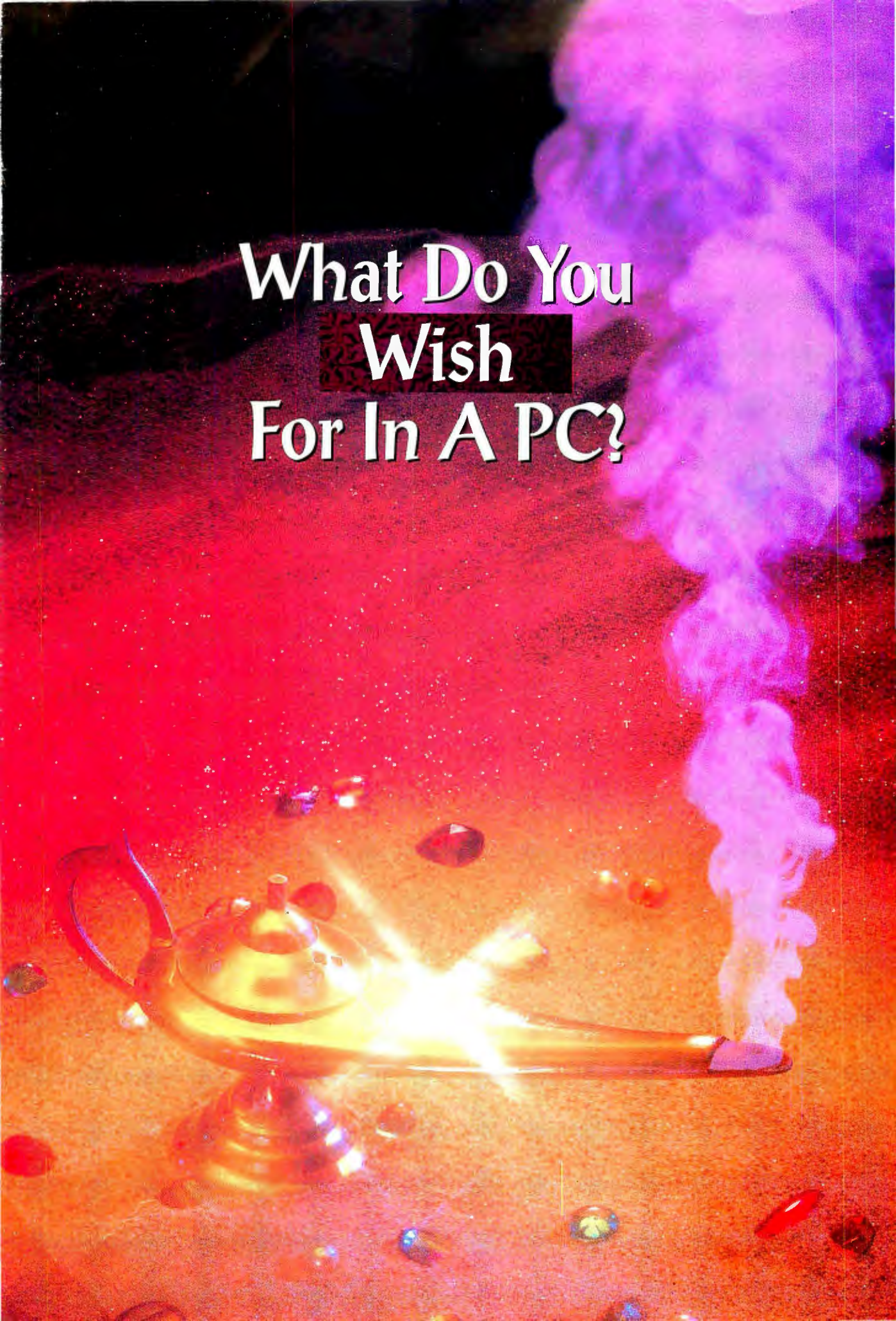
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For In A PC?

Your wish is our command at Gateway 2000! We can grant you the three most universal PC wishes in the wink of an eye. As a fringe benefit, we won't limit you to three wishes here. Most anything your heart desires in computers (sorry, we can't grant wishes for romance or riches), you can get from Gateway.

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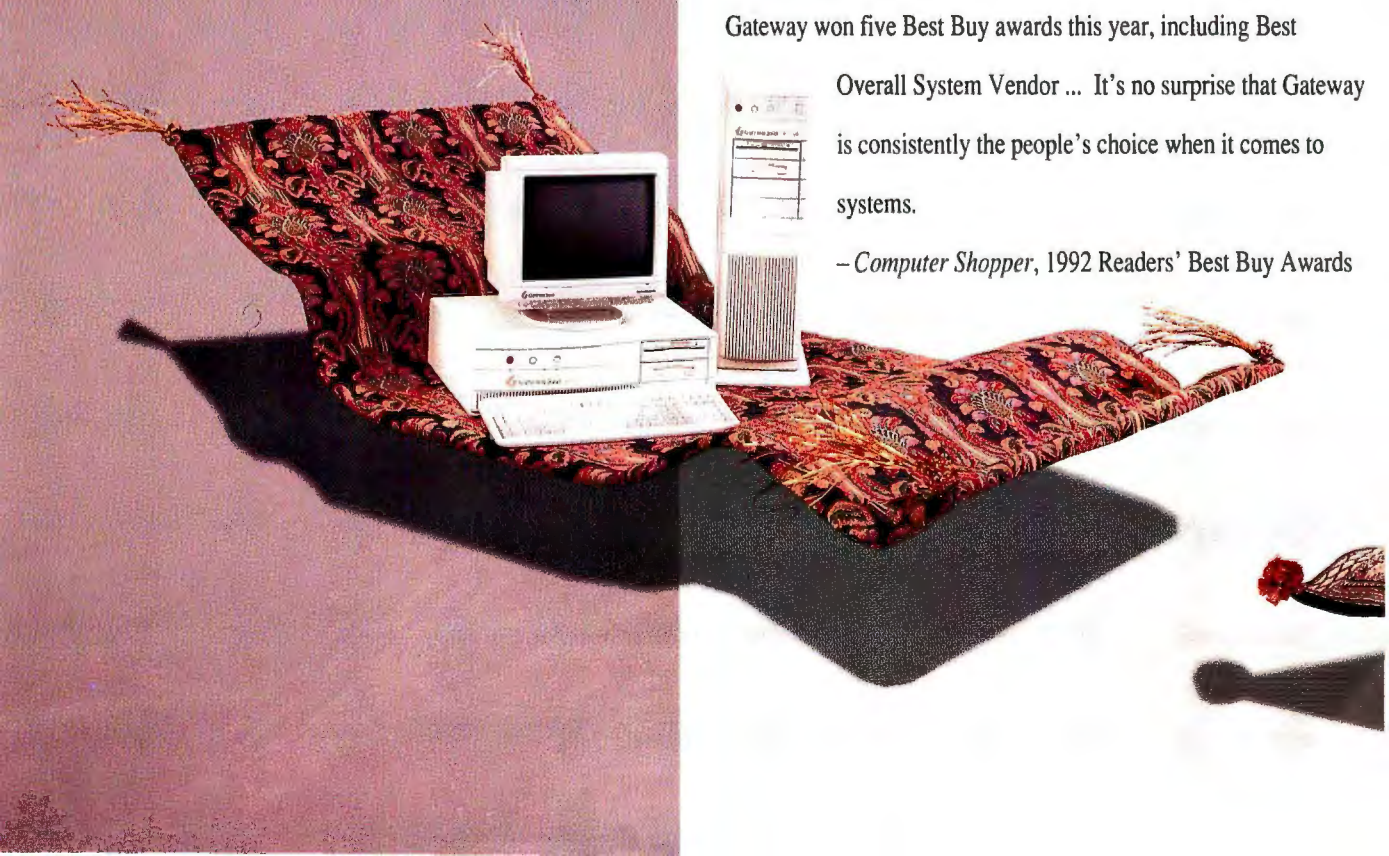
– *PC Computing*, 1992 MVP Awards

"Gateway 2000 was the big 1992 Best Buy winner, sweeping not only the desktop awards as it did last year, but the newly expanded notebook categories as well ... Altogether, Gateway won five Best Buy awards this year, including Best Overall System Vendor ... It's no surprise that Gateway is consistently the people's choice when it comes to systems.

– *Computer Shopper*, 1992 Readers' Best Buy Awards



ommand!

"I wish I could be sure I'm buying from a PC company that will provide excellent service and support - a company that will be around for me." Your wish is our command!

Twice in 1992, Gateway was honored for outstanding service. *PC World* readers ranked Gateway number one in service and support. And *PC Magazine* readers gave Gateway the best overall scores in the 1992 Service and Reliability Survey.

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Gateway is among the few financially robust companies in the industry. Our 1992 revenues exceeded $1 billion and our earnings are among the strongest in the industry. The company is virtually debt-free. At a time when other companies have been forced to lay off employees, we added 300 people to our staff. You now have 1,800 friends in the business. Rest assured Gateway is your oasis that will never leave you high and dry. We'll be here for you!

"I wish I could find the combination of features I need in a portable PC - at the right price." Your wish is our command!

No matter what you need in a portable, you'll find it in one of our Nomad notebooks. Gateway customers selected Nomads as the winners in 386 and 486 notebook categories of *Computer Shopper's* 1992 Best Buy Awards.

"There are faster laptops, there are cheaper laptops, there are color laptops, but there is no better laptop ... Weighing in at only 5.6 pounds, the Nomad combines the powerful punch of a 25MHz i486DX with a working battery life of more than six hours. At long last, we have a laptop that can really go the distance when there's no power outlet in sight."
– *Computer Shopper*, 1992 Readers' Best Buy Awards

PC Sources echoed *Computer Shopper's* conclusions. "The Nomad 425DXL packs an awful lot of computing into a case that's just 1.7 inches high. Its excellent 79-key keyboard has a great typing feel ... The fine video system includes a large backlit black-on-white LCD ..."

New this month is the Nomad 450DXL including Intel's 50MHz 486DX2L processor for blazing performance.

Our Caravan Of Extras.

Software Selections

Your every software need is our command. With mini desktop, desktop and tower systems that include "choice of application software," select one of the following applications, all latest versions:

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- Microsoft Word and Bookshelf 92,® CD-ROM Edition
- Microsoft PowerPoint for Windows™
- Microsoft Project for Windows™
- The MS Entrepreneur Pack (Works,™ Publisher,™ Money,™ TurboTax for Windows® from ChipSoft, and games)
- Borland Paradox® or dBASE IV®
- The Windows Programmer Pack (MS Quick C,™ Visual Basic and more)
- Upgrade to Microsoft Office™ for $175

If the system you want comes with Works for Windows,™ you can upgrade to one of the software choices above for only $150.

Utilities Included, Too

Cool Tools for DOS, a diagnostic and utilities package, comes with all Gateway desktop systems and includes: QA Plus™ from Diagsoft,™ Central Point® Anti-Virus, RAM Boost, Defrag and Emergency Disk.

Microsoft Windows™ for Workgroups

Windows for Workgroups is ideal for e-mail, group scheduling and resource sharing, and includes an Ethernet adapter and software. Hardware and software are factory-installed. You can see Windows for Workgroups running on Gateway systems in any of over 200 Egghead Software® stores in the U.S. Stop by for a demonstration! With the purchase of a system, Windows for Workgroups is specially priced at just **$159**!

Microsoft Windows Sound System™

This sound system designed especially for business use lets you speak to your PC for hands-free operation. It even reads numbers back to you for proofing. You can also embed audio messages in all your Windows OLE applications. Package includes soundboard, microphone, headset and software. You pay only **$149** with the purchase of a system.

CD-ROM Kit

Includes CD-ROM, interface card, and everything you need to add MPC-compliant CD-ROM to your PC. With a system purchase, or if you own a Gateway system, you can buy this CD-ROM kit for only **$225**!

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- 14" Color CrystalScan™ 1024NI
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- 124-Key AnyKey™ Keyboard
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- Cool Tools for DOS
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- Cool Tools for DOS
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- Local Bus IDE Interface
- Windows Accelerated Video with 1MB DRAM
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- Mini Desktop Case
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- 124-Key AnyKey Keyboard
- MS-DOS, Windows & Mouse
- Cool Tools for DOS
- Choice of Application Software

$1995

4SX-33V

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- Cool Tools for DOS
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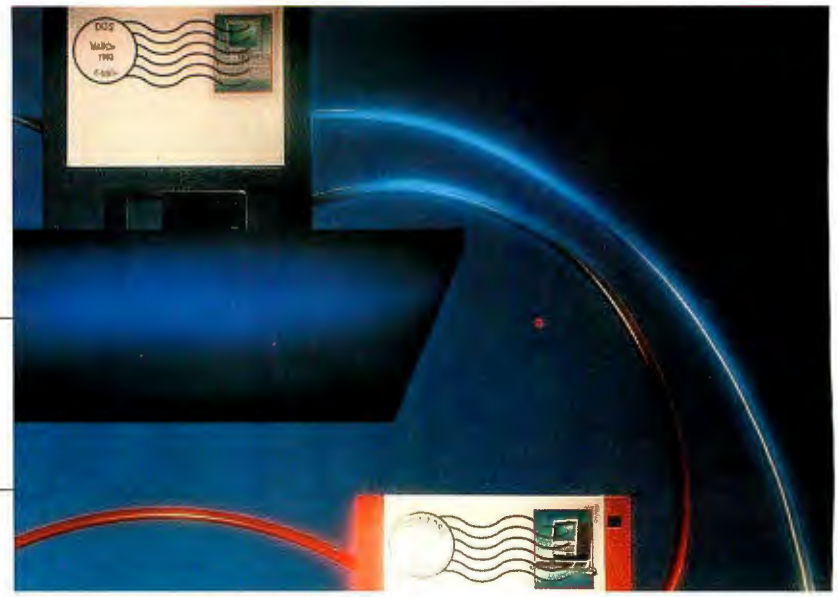
March 1993 Volume 18, Number 3



COVER STORY

FEATURE

Smarter E-Mail Is Coming

PAGE 90

SOLUTIONS FOCUS

A Review of E-Mail Packages

PAGE 136

NEWS

FEATURES

STATE OF THE ART

COLLABORATIVE COMPUTING

REVIEWS

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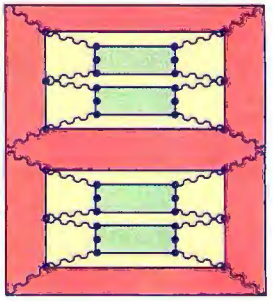
HANDS ON

OPINIONS



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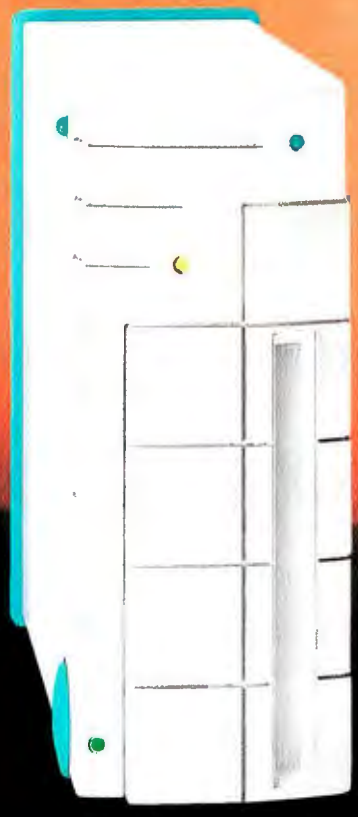
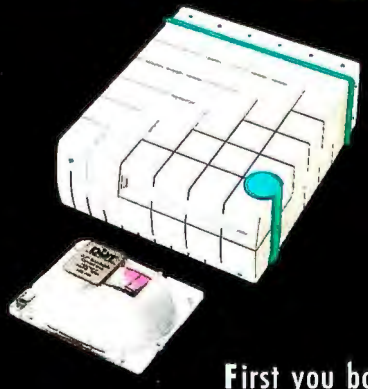


"... the PMO-650 delivers unparalleled performance..."

John Quain
PC Magazine



TYPE: 3.5" OPTICAL
CAPACITY: 128 MB
SIZE: 6.9" (H) x 2.7" (W) x 8.3" (D)
WEIGHT: 4.11 LBS
MOUNTING: VERTICAL OR HORIZONTAL

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ELAPSED TIME IN SECONDS				
Xcopy 20MB Tree to Optical Drive	135.3	210.6	165.5	178.9
Xcopy 50MB Tree to Optical Drive	379.5	496.8	375.1	428.7

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NSTL OPTICAL VS. OPTICAL

Drive Tested	Pinnacle PMO-650™	Sony® SMO-E502	Maxoptix Tahiti™ II	Hewlett-Packard Corsair™	Ricoh RO-5031E
ELAPSED TIME IN SECONDS					
Xcopy 20MB Tree to Optical Drive	135.3	506.5	440.6	198.1	477.5
Xcopy 50MB Tree to Optical Drive	379.5	1241.2	1047.9	492.7	1134.8

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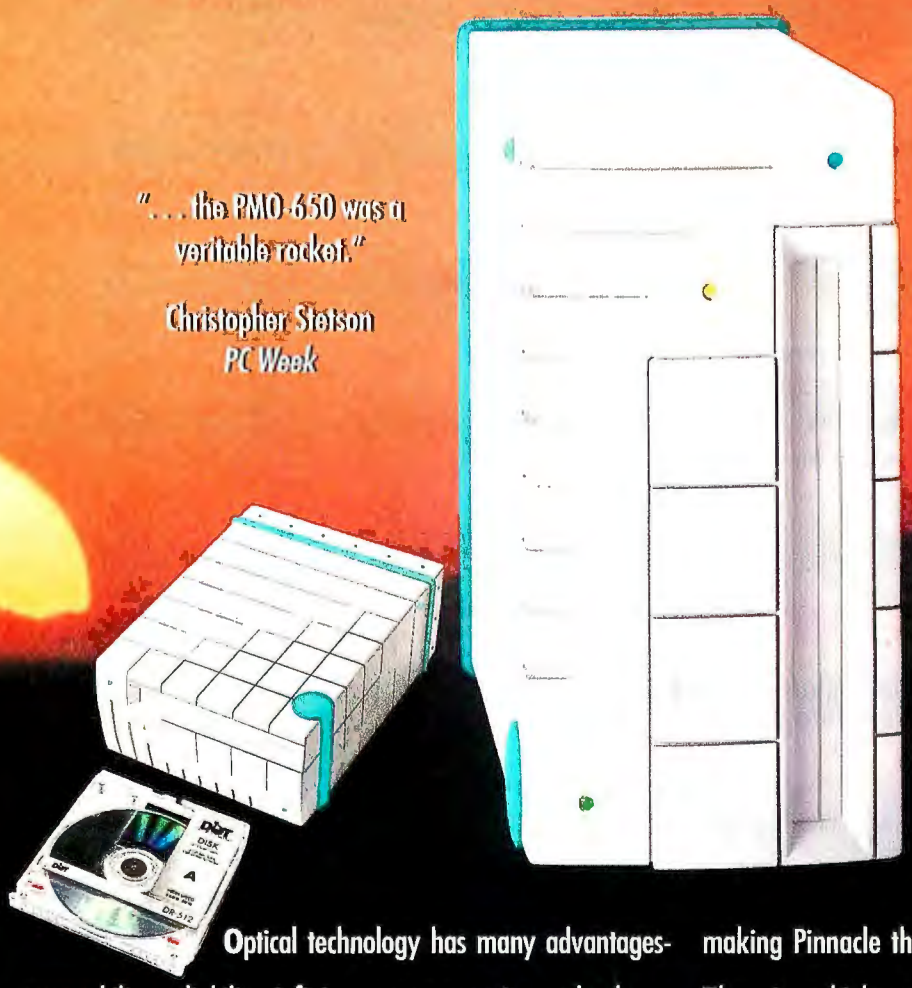

TYPE: 5.25" OPTICAL
CAPACITY: 650/600 MB
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INSIDE BYTE

BYTE Topic Index

This index helps you find articles that contain information on each of the listed topics. (The topic list changes each month.) Combined with the table of contents (page 4) and the Editorial Index by Company (page 254), you can identify articles by type, subject, title, author, or product discussed.

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...You Choose the Computer

LabWindows for DOS

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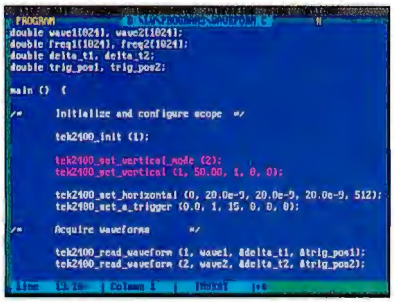
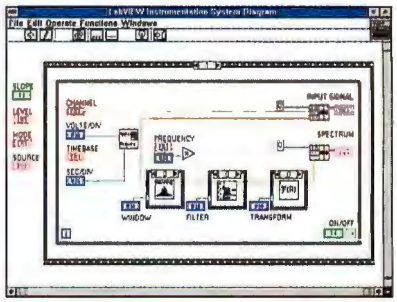
ACQUISITION





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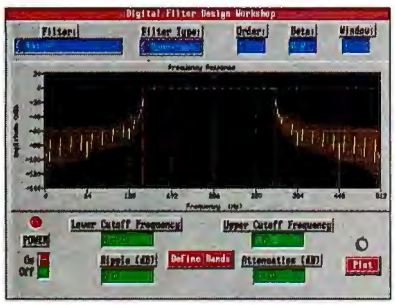
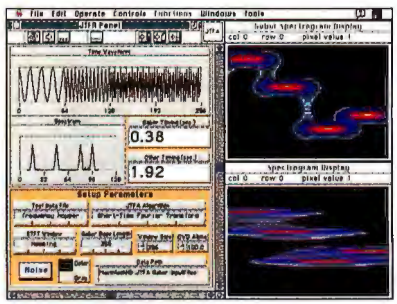
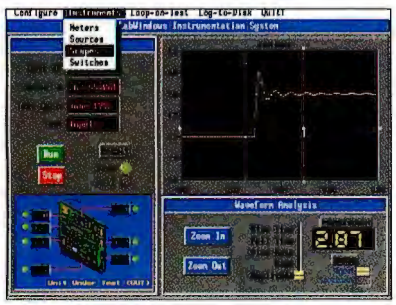
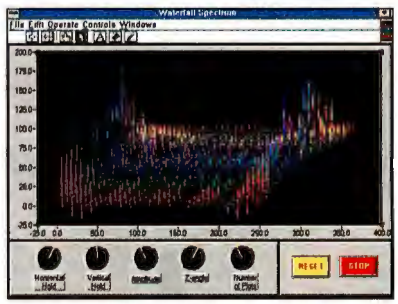




DSP • Statistics • Linear Algebra • Filters • Windows

PRESENTATION





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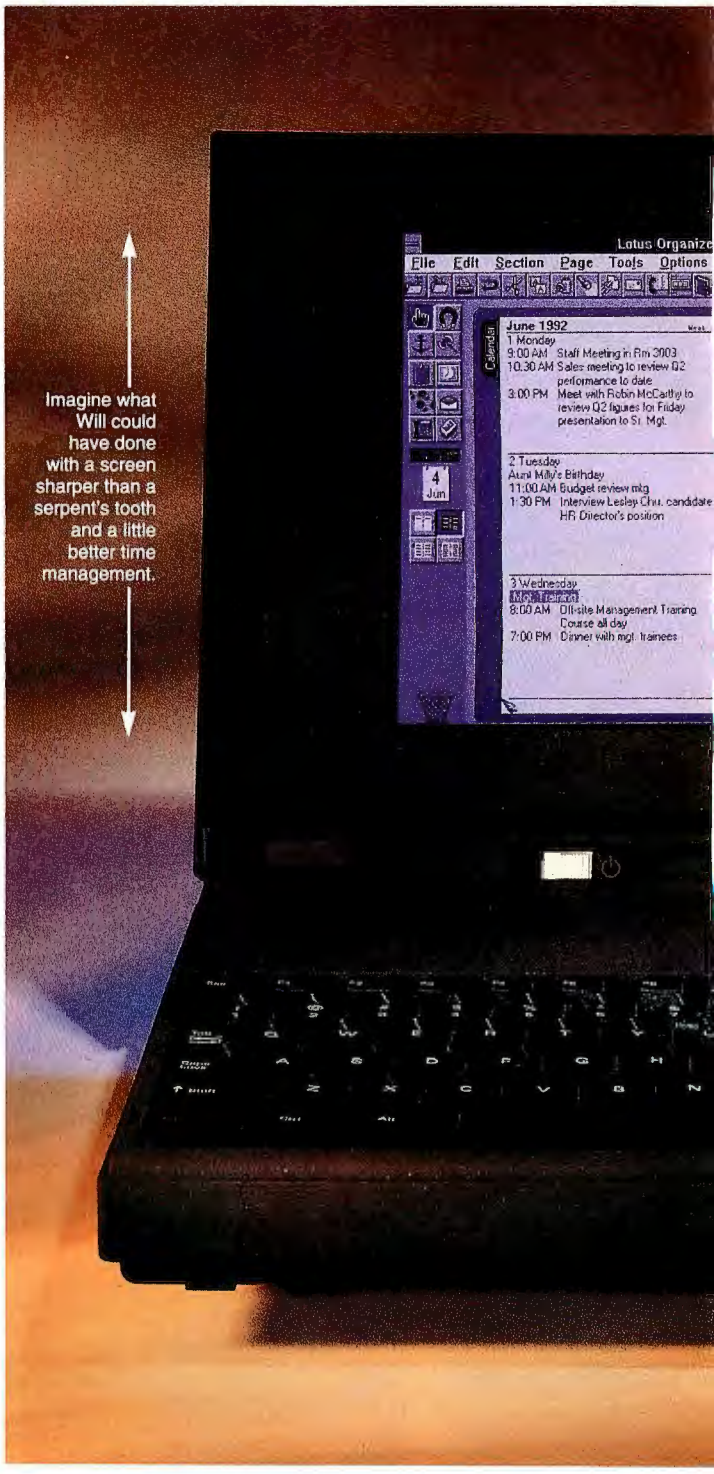
ThinkPad

ThinkPad 300 comes with 4MB of memory upgradable to 12MB and 80MB of hard disk space, upgradable to 120MB. There's even a math co-processor available.

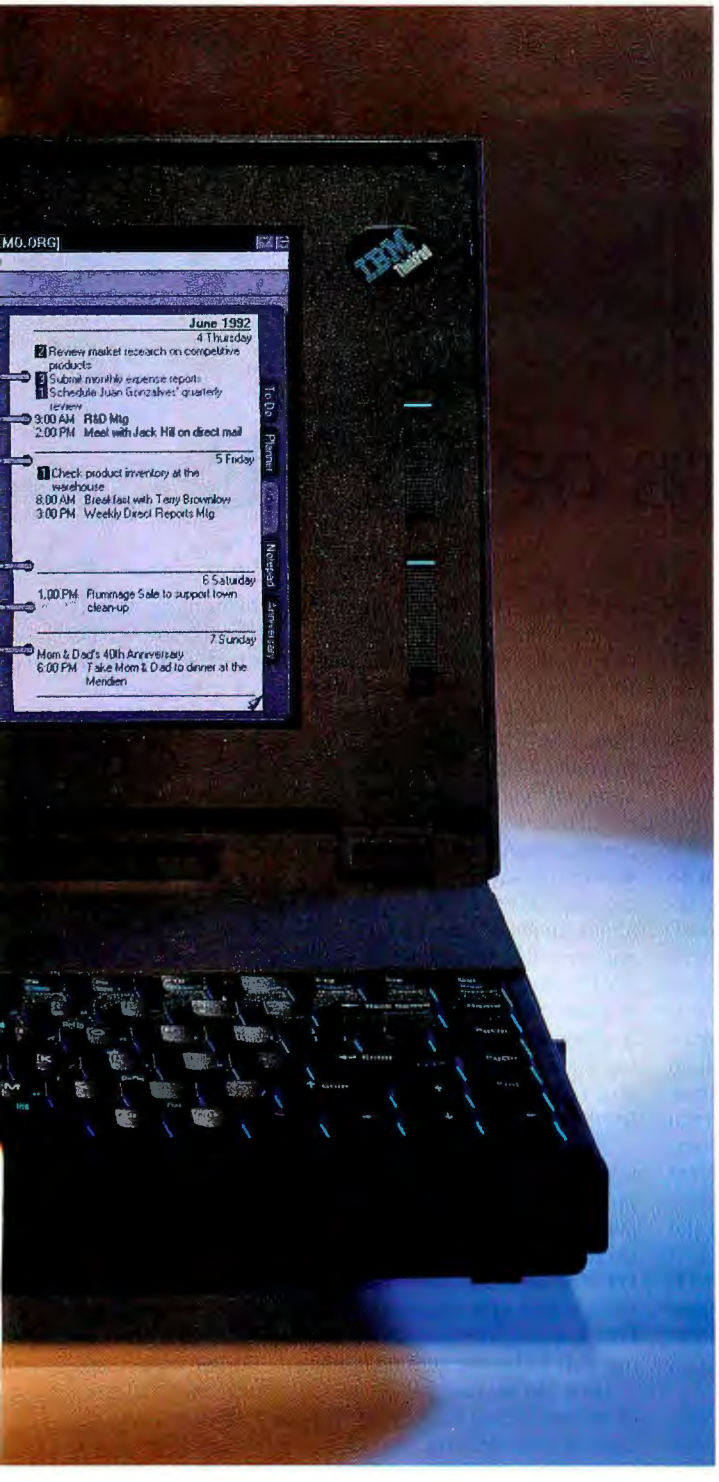
But while ThinkPad is the ultimate tool for your mind, we didn't forget the rest of you. So there's a comfortable, ergonomically designed keyboard with a numeric keypad built in. And a feature that lets you take a break and pick up where you left off. The display is a big 9.5″ with incredibly sharp 640×480 VGA resolution. Since complex ideas are rarely black and white, ThinkPad displays 64 dramatic shades of gray—enough to express the subtleties of anyone's gray matter.

ThinkPads set you free, with a world-

*Depending on usage and configuration. **MSRP. Dealer prices may vary. IBM is a registered trademark and ThinkPad, and HelpWare are trademarks of International Business Machines Corporation. The Intel Inside Logo is a trademark of Intel Corporation. © 1992 IBM Corp.



It's what Shakesp used on a flig



wide AC adapter and a port replicator, so you don't have to detach and reattach peripheral cables when you take your ThinkPad with you. There's an Ethernet LAN port right on the machine, with Data Only (2400 baud) and Data/Fax (2400/9600) modems available, too. The dual VGA connector lets you display on other monitors and keep the control right in your lap.

ThinkPad	Model 300
Processor	386SL/25 MHz
Display	9.5" Monochrome Display 64 Grayscale Screen
Battery Life*	4-10 Hours
Weight	5.9 Lbs.
Warranty	1 Year
Price**	$2,375

Alas, even great thinkers don't always have all the answers. So ThinkPad comes with HelpWare,™ an invaluable service package including a one-year international warranty and 24-hour, seven-day-a-week assistance by fax, electronic bulletin board or toll-free phone, as you like it. To learn more about ThinkPad, or to order, call **1 800 IBM-2YOU**. Or visit your nearest IBM authorized dealer.

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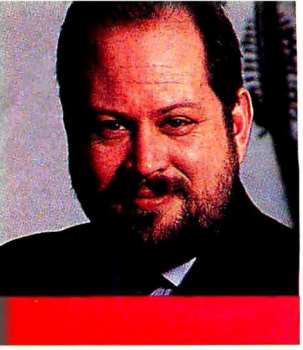


EDITORIAL

DENNIS ALLEN

THE STATE OF BYTE

Since I offered my first state-of-BYTE editorial a year ago, BYTE has made some important advances in how it serves you. And this year we have even greater things in store for you. I would like to share a glimpse of what you can expect from BYTE in 1993. First, though, here's a quick review of where we are today.

In 1992, BYTE began doing a new kind of cover story. Our approach combines reportorial breadth with technical depth—a combination that no other computer magazine delivers. To accomplish that goal, we literally threw all BYTE's editorial resources at each cover story. We garnered firsthand reports from our bureaus and staff editors, and, where appropriate, we backed it up with testing from the BYTE Lab. The result has been first-class articles that provide you with information not available elsewhere. Even publications outside the computer field, such as *BusinessWeek* and the *Wall Street Journal*, have quoted from BYTE's cover stories.

The changes we're making this year are being made for only one reason: to serve you better

Another change came in September 1992 with the globalization of BYTE. Because technology and product developments are not exclusive to North America, BYTE is committed to covering the most important technologies and products from around the world. BYTE also expanded its worldwide position with translations in such places as Brazil, Czechoslovakia, and Croatia.

Additionally, we produced two special issues in 1992: BYTE's *Essential Guide to Windows* and *Essential Guide to Portable Computing*. These issues departed from BYTE's usual technology-centric coverage to provide practical hands-on and buying information for the two fastest growing segments of users.

All these changes were in direct response to your information needs. In 1993, BYTE will continue to respond to your needs. We'll do so by applying the breadth and depth of our cover stories to other feature articles. BYTE will continue and strengthen its commitment to worldwide reporting on technologies and products. We will also continue to provide the two elements of BYTE that you say you like best: our legendary State of the Art articles that focus on a specific technology topic each month, and the wit and wisdom of industry sage and user advocate Jerry Pournelle. And this spring, BYTE will introduce an updated look that will make finding the information you need easier.

In 1993, BYTE is committed to bringing you two bonus issues on using Windows—one in the spring, the other in the fall. We're also going to provide you with information in forms beyond the pages of a magazine.

We will be listening to you more closely than ever before. Don't be surprised if you receive a survey questionnaire—or a phone call—from BYTE editors, because we want to hear from you firsthand.

All this close communication brings me to our most important announcement of the year. In our May issue, we will introduce the most exciting and innovative product coverage ever. We know that you expect BYTE to write about advanced technologies and leading-edge products, and we will continue to fill that need in a way that only BYTE can. However, we have learned that you also need to know about commodity products for your organization. In other words, it's not enough for BYTE to cover leading-edge dye-sublimation printers, for example—you also need to know which personal laser printer is best for the applications in your business.

Therefore, BYTE will provide large-scale exhaustive testing on commodity products every month. The first product-testing report will be on, you guessed it, printers, and we won't cover just a select few. This roundup will encompass virtually every significant printer on the market. But we won't bore you with 80 to 120 pages of endless printer specifications and features lists; instead, BYTE will deliver only the information you need, in a format that will make zeroing in on that information a cinch.

How can we do it? With our 20,000-square-foot state-of-the-art testing facility, the National Software Testing Labs in Philadelphia. No other computer magazine has such a lab, and no other magazine is listening to its readers in the way that BYTE does.

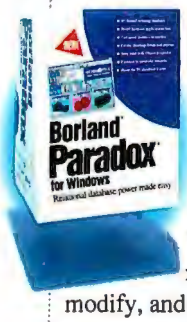
Moreover, at no other magazine on the planet can you find a better qualified group of technical journalists/engineers than at BYTE, BYTE Lab, and NSTL.

But it is you, BYTE's readers, who make BYTE a success. No other group of readers demands the kind of excellence in technical reporting that you do.

—Dennis Allen
Editor in Chief

Introducing Borland's Paradox for Windows

Special Offer!



Experience the magic of easy database power

If you're looking for the easiest-to-use, most powerful, and most reliable Windows database, this is it! With new Paradox® for Windows, there's no limit to what you can do. The graphical interface makes it easy to access, modify, and present your data. Create customer lists in seconds, automatically generate reports with the push of a button, or retrieve data from different sources into a single answer table.

The best way to manage Paradox and dBASE data

Paradox for Windows makes it easy to work with your Paradox and dBASE® data. You can view, edit, query, and link to all your data, with no limitations. You make your request for data simply by checking off boxes with easy-to-use Query By Example. Then the Paradox for Windows query optimizer automatically determines the fastest way to deliver the answer.

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Insert 1,000 records*	29 sec	147 sec
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All tests run on IBM PS/2 Model 70 386/20 mhz, 4Mb RAM, Novell 3.11 NetWare, Ethernet network. Special offer good in the United States and Canada only. Prices in U.S. dollars.

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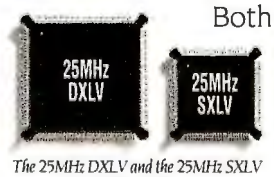
Increased 386 Perform

AMD's 3-Volt 386 Microprocessors Deliver The Longest Battery Life For Portable Computing.

The power struggle continues. While you can get a 386 microprocessor that goes fast, you'll still burn through a battery charge in a hurry. Low-voltage 386 CPUs from AMD are the answer—the Am386™SXLV and Am386DXLV micro-processors.

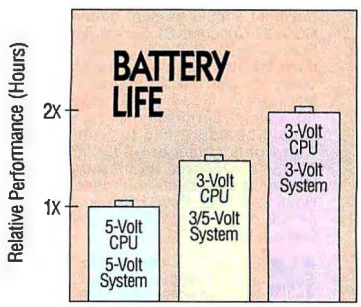
Here are two CPUs made not only to go fast, but to go the distance with portable computer users. Unlike common power-hungry 386s, these low-voltage CPUs run on 3 volts. And they automatically slip into a static "sleep" mode to save power whenever the processor is idle. So users depend less on recharge units—and get the longest operational battery life.



The 25MHz DXLV and the 25MHz SXLV are available in PQFP packaging.

Both Am386 CPUs were designed to fit as comfortably in your budget as they do your portable computers. But you won't compromise on performance because the Am386SXLV and Am386DXLV 3-volt microprocessors both run at 25MHz. So

ance At No Extra Charge.



they're plenty powerful for running Windows.™

Now there's nothing stopping you from charging forth with more efficient 3-volt laptops, notebooks, and palmtops. AMD also has your memory needs covered with our 3-volt EPROMs. And now that the industry at large has welcomed low-voltage portable computing, you'll find the rest of your components equally easy to come by.

For more information on low-voltage 386 microprocessors and support logic, call **1-800-222-9323** and ask for Literature Pack 15F. And become the current leader in portable computing.

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BYTE

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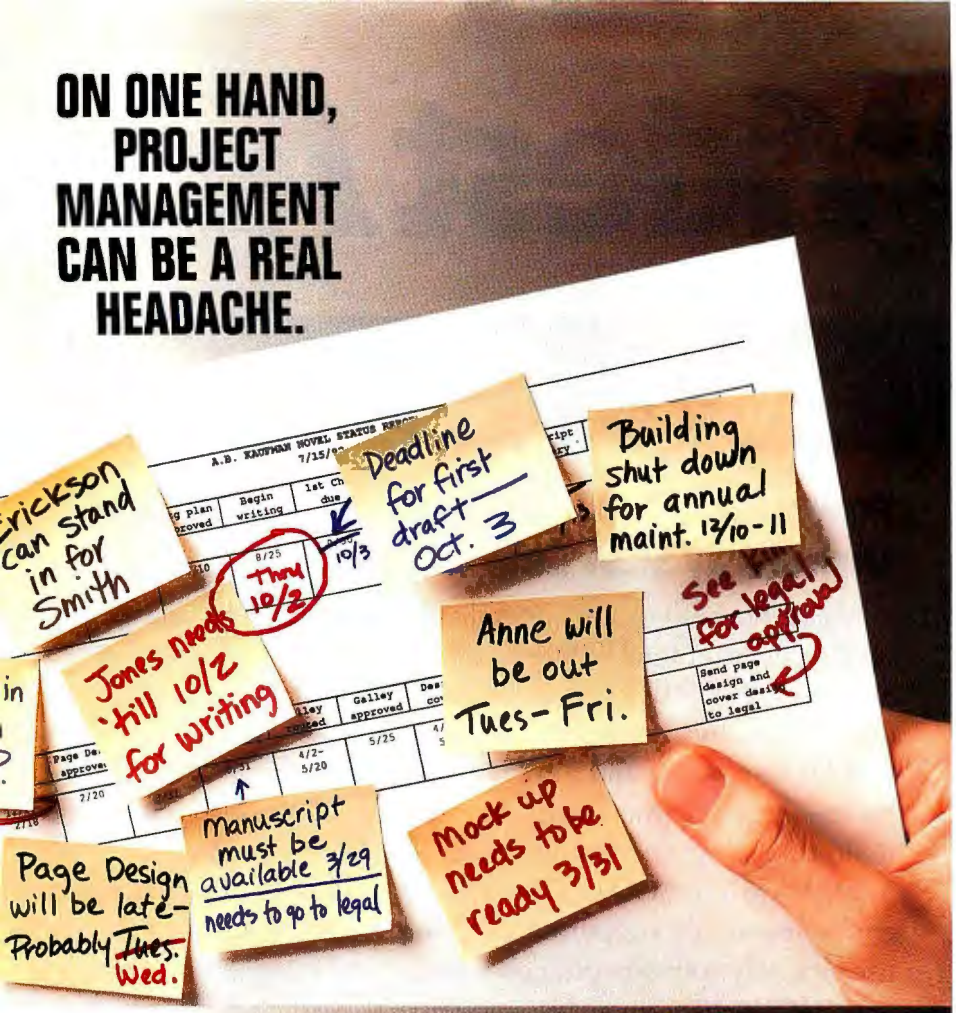
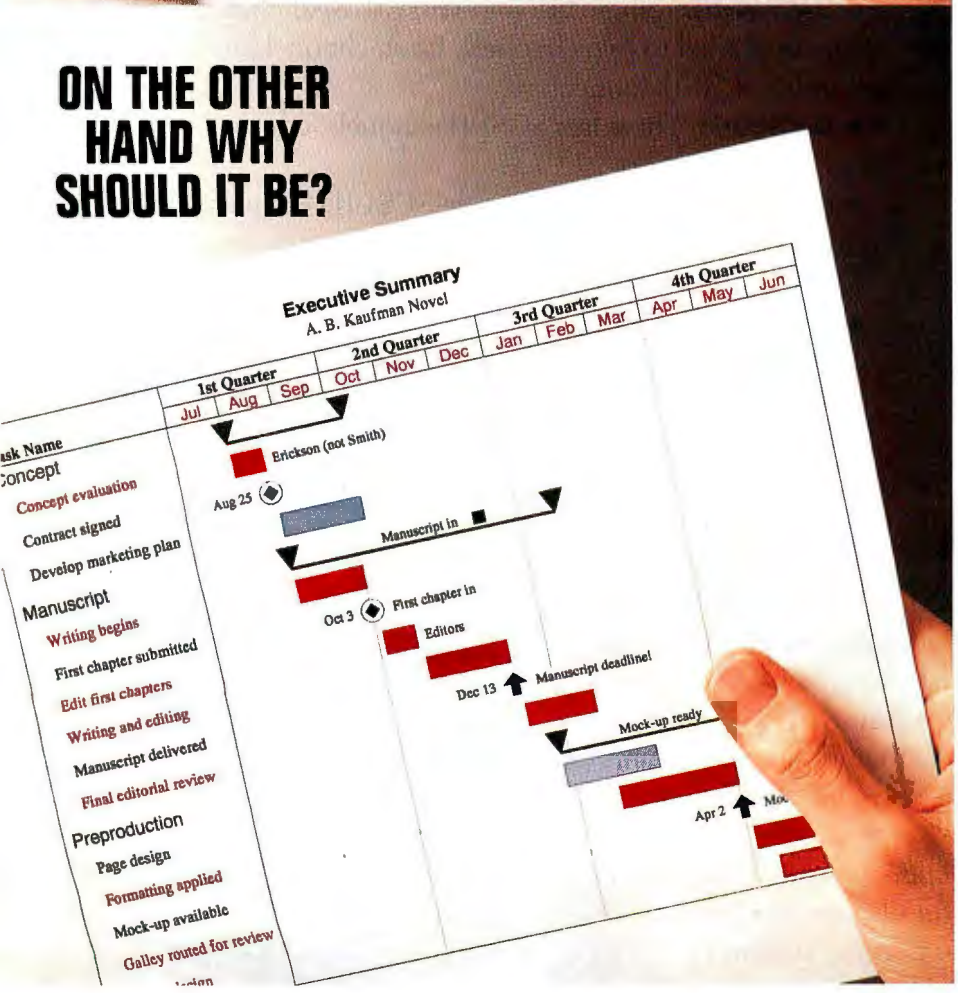
ON ONE HAND, PROJECT MANAGEMENT CAN BE A REAL HEADACHE.



ON THE OTHER HAND WHY SHOULD IT BE?



MICROSOFT PROJECT FOR WINDOWS

MICROSOFT WINDOWS

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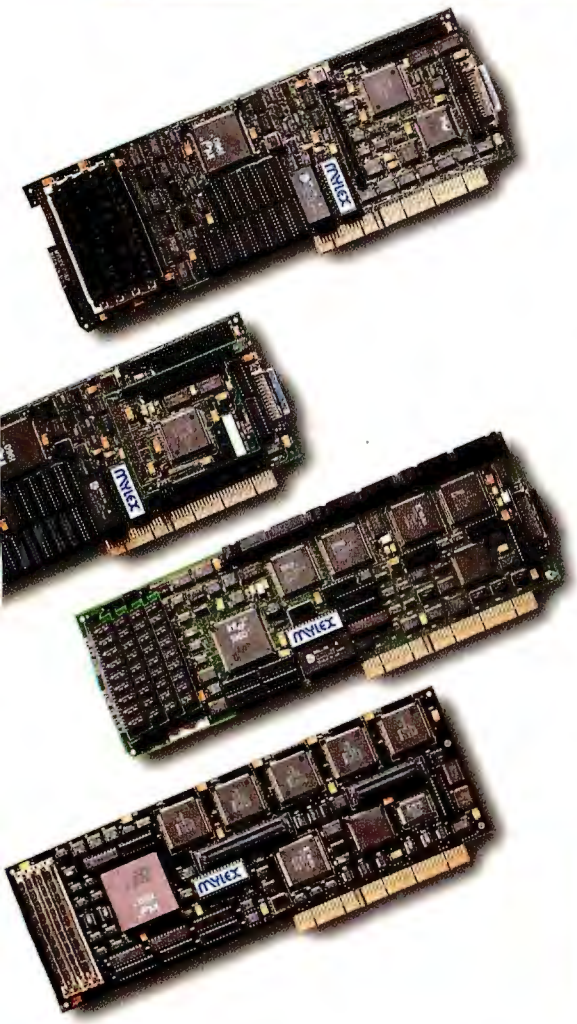
The Widest Arra

Fault Tolerant Disk Array Controllers, Subsystems and Servers supporting NetWare, SCO UNIX and OS/2.



Powerful 1, 2, 3, and 5-Channel Disk Array SCSI Controllers

Mylex now offers a range of disk array controllers, all based on the powerful Intel i960CA™ RISC processor. The controllers feature 4/16/64-Mbytes of cache, an EISA host interface and extensive software support.

RAID levels 0, 1, and 5 are supported, with hot swapping, on-the-fly reconstruction, background rebuild, hot standby, multi-threading, and scatter/gather features.

NetWare 3.11, SCO UNIX 3.2.4 and IBM OS/2 2.0 operating environments are supported. All controllers are offered with user-friendly software utilities.

- **DAC960-1/2:** Single fast and wide SCSI-II channel, which can be upgraded to two channels. Each channel has both 8-bit and 16-bit SCSI-II connectors.
- **DAC960-3:** Three fast SCSI-II channels, which can support up to 21 SCSI drives.
- **DAC960-5:** Five fast and wide SCSI-II channels, with the option to drive 8-bit or 16-bit fast SCSI drives.

NetWare, UNIX, OS/2
All Mylex disk array products support Novell NetWare 3.11, with optional support for SCO UNIX 3.2.4 and IBM OS/2 2.0.

Disk Array Subsystem

The disk array subsystem (DAS) features a DAC960 five-channel disk array controller and a flexible enclosure which houses up to five 5.25″ or 3.5″ SCSI drives. Each drive is powered by its own power supply for improved system reliability. Disk drives are offered as an option. Up to four of these enclosures can be powered by a single DAC960-5 controller, allowing up to 20 drives for each controller.

The DAS can be used in conjunction with any EISA-based computer to build a powerful file server. Up to four controllers can be configured into the system to offer virtually unlimited disk capacity.

Novell Labs Tested & Approved™

y of Disk Arrays.

Integrated Disk Array Server: IDAS2000

The Mylex IDAS2000 is a high-performance integrated disk array server, utilizing state-of-the-art disk array technology.

▶ **CPU Subsystem:** Intel 486™ DX2-66MHz EISA system with 256-Kbytes of cache, 8-Mbytes of system memory upgradable to 256-Mbytes, six bus master EISA slots, built-in I/O, flash BIOS and future CPU upgrades with the ZIF socket.

▶ **Disk Subsystem:** Features a one-channel disk array controller that is upgradable to two channels for increased performance. The controller utilizes the powerful Intel i960CA RISC processor and includes a standard cache of 4-Mbytes that's upgradable to 64-Mbytes. RAID levels 0, 1, and 5 are supported with fault tolerance, hot replacement, hot sparing and background rebuild capabilities. Both 8- and 16-bit fast and wide SCSI-II drives are supported. Software support for NetWare 3.11 (Novell certified). Optional support for SCO 3.2.4 and IBM OS/2 2.0 operating environments. Extensive user-friendly software utilities included.

▶ **Enclosure:** Includes three redundant power supplies, five cooling fans, 10 drive bays for 3.5" SCSI drives, and four additional drive bays for tape drives, floppy, etc.

The system includes an EISA LAN adapter and super VGA graphics. Disk drives are optional.

We've Benched the Competition

When Mylex conducted benchmark tests to compare our disk array system's performance to our competitors', we outperformed the competition's RAID 3 and 5 systems, as well as duplexed and spanned systems, by a wide margin.

Benchmarks: Disk Array Subsystems

	CIPRICO NetArray RAID 3	CORE IAS RAID 3	MICROPOLIS RAIDion RAID 5	ULTRASTOR U124 RAID 5	MYLEX DAC960 RAID 5
NCOPY all drives enabled	13:19	15:00	13:30	10:06	4:25
NCOPY one drive down	14:05	15:00	15:30	10:36	4:30
NCOPY during rebuild	26:32	–	20:49	18:30	10:17

▶ LAN Technology's performance tests for Ciprico, Core and Micropolis consisted of copying 2400 files–totaling about 80-Mbytes–from one directory to another using NetWare's NCOPY. The Mylex and UltraStor test configuration included a 486 DX2-50MHz CPU-based EISA system using five HP 97556-30 796-Mbyte drives. Times are shown in minutes.

Flexible Purchase Options

Controllers only, a complete system without disk drives, or a complete system with the drives are offered.

For more information on Mylex disk array systems and controllers, call 1-800-MYLEX or 1-510-796-6100. Or, fax us at 1-510-745-8016.

Visit us at CeBIT - Hall 8/EG, Stand B40.

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LETTERS

The Truth About OS/2


USER'S COLUMN

PONDERING OS/2

I want to clarify one point in Jerry Pournelle's comments about OS/2 2.0 ("Pondering OS/2," November 1992). Referring to Windows 3.1 bundled applications like Paintbrush and Write, he states that "if you had a bunch of Windows 3.1 applications on your hard disk, this is probably one of them and you'll get a message that the applications can't be run. Considerable time is wasted to no purpose." But Windows 3.1–compatible programs definitely work under OS/2 2.0. Some people misunderstood the phrase and asked me if OS/2 2.0 can't run *any* Windows 3.1–aware applications. I run Windows applications like Atech's AllType font-conversion program without problems.

Fernando Cassia
Buenos Aires, Argentina

Upgrading Made Easier

I appreciated the timeliness of Andy Redfern's article "Make the Right CPU Move" (December 1992). I wanted to upgrade my 386SX/25 to remain more current but was unsure of the best path to take. Since I wanted to realize a major performance improvement but not at an astronomical cost, I had narrowed it down to either the 386DX/40 or the 486DX/33. The article clearly showed that there is not enough difference, performance-wise, to justify the extra cost of the 486 for my applications. I'll upgrade to the 386DX/40 and wait for the P5.

Also, thanks to Jerry for telling the truth about OS/2's installation: If you read the manuals, it's as easy as inserting one disk after another—it is boring, but hardly difficult.

Larry Field
College Station, TX

Static Shock

I was shocked when I saw the November 1992 What's New item "Create a New Ion Field" (page 82), which describes a device called the Perfect-Aire 100.

There is no such thing as an ion field. There is also no such thing as ion radiation (except maybe in particle accelerators, and that's stretching it). There is certainly no such thing as electrostatic radiation: By definition, static electricity is *static* and thus cannot radiate anything.

On top of that, I do not think this kind of device has ever been proved to have any beneficial effect in reducing static. Rather, it often uses high voltages, which tend to produce ozone—a poison if the concentration is too high.

Jean-Pierre Weber, Ph.D. in E.E.
Stockholm, Sweden

WE WANT TO HEAR FROM YOU. *Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, send BIXmail c/o "editors," or send Internet Mail to letters@bytepb.byte.com. Letters may be edited.*

Investment Credit

While many companies may be trading off long-term R&D against short-term financial gain with the new, low-cost personal computers coming out ("Penny-Pinching PCs: How They Did It," November 1992), not all are cutting back on R&D spending. Apple has *increased* spending on R&D (26 percent from 1991). Also, the construction of Apple's new R&D campus (Cupertino, CA) demonstrates that not all companies coming out with low-cost personal computers are taking a short-term view of their future.

Mark Boudreau
Toronto, Ontario, Canada

Windows Rebellion?

It was interesting to contrast the tone of BYTE's *Essential Guide to Windows* (1992) with that of "Penny-Pinching PCs: How They Did It" (November 1992). The former referred to the huge amount of disk storage and RAM required to run Windows applications. The consensus seemed to be a 200-MB hard drive and 8 MB of RAM; a 486 was recommended. In the discussion of the inexpensive PCs (made by Compaq, AST Research, IBM, and so on), the configuration was more like a 40-MB drive, 4 MB of RAM, and a 386SX. Unless there is a wholesale rebellion against Windows applications because of their excessive hardware requirements, I fear that the marketing of low-end PCs by high-end companies will fail.

Henry T. Minden
Concord, MA

Where are all the Windows enthusiasts your PC journalists cite in BYTE's *Essential Guide to Windows*, 1992? The Windows users I see are usually victims of managers trying to entice computer phobics and novices to the system or of their vendor's greedy deals with the Microsoft juggernaut. Enthusiastic PC users gave up on DOS long ago. Most that I know are using OS/2 2.0 and find it a much better platform for their DOS applications than DOS, and especially better than Windows. OS/2's support for Windows applications is a useful bonus.

Joseph C. Hager
San Francisco, CA

FIXES

- In BYTE's *Essential Guide to Portable Computing*, 1992, on page 26 we referred to Mitsuba as a manufacturer of floppy drives as well as notebook computers. Mitsuba does not make floppy drives.
- In "Fast Transit" (October 1992), Henry Quan is identified as president of ATI Technologies. Quan is vice president of marketing. ■

Important News For The Power Hungry: Your Dinner's Ready.

Come and get it.

The new Amiga® 3000T multimedia workstation tower – the most expandable, flexible Amiga ever built.

Now powered by a 25 MHZ Motorola 68040 CPU, the A3000T is faster than ever before. (Current A3000T users can upgrade to a 040-based accelerator card.)

The A3000T features a 200MB hard disk drive. A 3.5" floppy disk drive. 5MB of RAM, expandable to 18MB. And 32-bit bus architecture to transfer mammoth amounts of information at breakneck speed. The truly power famished will be happy to know that the A3000T is stuffed with an abundant selection of expansion slots. There's a co-processor slot. A video slot for internal devices. Up to four PC slots. And up to five Zorro III slots. Every Amiga 3000 series computer comes with Commodore Express™ Gold Service options.* And convenient leasing terms are available.

Now, you'd expect a power feast like this to carry a fat price tag. But now with our new low price, you can sit down to an Amiga 3000T for just $2,875.** Which in itself is a powerful reason for seeing your Commodore dealer today. For a dealer near you, call 1-800-66-AMIGA. *In Canada, call 1-800-661-AMIGA.* Bon appetit.

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- ISO compatible, so it reads & writes to 650MB MO disks.

NEWS

MICROBYTES

HDTV Presages a New Wave of Intelligent Entertainment; Computer Companies Watching

The first HDTV sets, which will offer brighter, wider, and clearer displays than that of today's TVs, will not likely start appearing in U.S. homes before the 1995–1996 time frame. Yet companies ranging from Microsoft to HBO (Home Box Office) are investigating the on-demand delivery of digital TV programs, where the HDTV not only plays the program but actually scans for programming that interests you and delivers it for viewing at your convenience.

Last December, at the HDTV and Future Television conference run by Meckler, Ltd. (+44 071 976 0405) and held in London, Nathan Myhrvold, Microsoft's vice president of advanced technology, said the company plans to help produce entertainment systems that contain computers running a version of Microsoft Windows. Users will preprogram these HDTVs to scan an electronic programming guide and select a particular type of program or movie that appeals to them. Future entertainment centers could also encompass integrated multimedia and movies in which the audience participates with and influences the outcome of a program.

With their 16-to-9 (width-to-height) aspect ratios, HDTV screens are wider than standard TV screens, which traditionally have 4-to-3 aspect ratios. And with display resolution in the range of 1920 by 1035 pixels, HDTV display resolution is much higher than regular TV's and closer to that of a 35mm film.

HDTV is important to an on-demand information delivery, because it offers picture resolution that's sharp enough to clearly display text. Because most of the new HDTV sets will have considerable built-in digital logic, they will take a more active role in entertainment delivery than do today's passive TVs. With standard, smaller picture TV, screen real estate is at a premium. But HDTV screens are rarely less than 32-inches diagonal in size, which should allow enough room for the TV picture, with menus and status indicators at one side of the screen.

Since 1989, Japan has pioneered HDTV broadcasting with daily transmission. Junji Matsuzaki, director of the HDTV division of NHK Broadcasting, Japan, says that "100,000 Japanese households can now receive NHK's HiVision HDTV satellite broadcasts." In Europe, programs from the 1992 Summer Olympics in Spain were transmitted using the HD-MAC (High-Definition Multiplexed Analog Components) standard. In the U.S., four all-digital systems for terrestrial broadcast HDTV have been proposed to the FCC, which is expected to choose its standard before the end of the year.

Myhrvold said cable TV systems will likely be the primary providers of interactive HDTV programming in the U.S. He adds, "If you already have digital transmission with cable TV systems, why not [offer] two-way capability and integrate the service with these enhanced entertainment systems?" Robert M. Zitter, senior vice president of HBO's Technology Operations Division, said that in early 1994, direct satellite-to-home broadcasting will start in the U.S, which should help accelerate HDTV's acceptance.

HDTV is already starting to make inroads into high-end graphics displays. Supermac Technologies (Sunnyvale, CA) and Intelligent Resources (Arlington Heights, IL) have released video cards that let you connect an HDTV monitor to a Mac. HDTV systems are expensive, but Larry Thorpe, vice president, production technologies, Sony Advanced Systems division (Montvale, NJ), expects the price of the monitors to come down as they become more widely used. NHK Broadcasting's Matsuzaki-san believes that the average 32-inch HDTV set will fall in price below 500,000 yen (about US$4000) this year.

—Trevor Marshall

NANOBYTES

Researchers at **Bellcore Labs** (Red Bank, NJ) say they have created experimental prototypes of a rechargeable lithium-ion battery that could result in AA-size batteries that can run about three times longer than current products. Researchers had known that rechargeable batteries could be improved with lithium-based technology, but safety and environmental problems with using pure lithium metal prevented lithium-based batteries from entering the marketplace. Bellcore scientists say they eliminated these problems by replacing the highly reactive lithium metal with lithium compounds and graphite. □

Next Computer hopes to boost sales into the European-finance and public-service markets through an agreement signed with Norwegian server-supplier Dolphin Server Technology. Steve Jobs, Next CEO, announced in London that Dolphin will sell Next workstations as clients for its Unix-based server workstations. Dolphin will license the Database Kit in NextStep 3.0 and the NetInfo administration software. □

At the Technologic Partner's Personal Computer Outlook conference, the following interchange took place between moderator

Richard Shaffer and **Vern Raburn**, chairman of Slate, which develops pen-based applications:

Shaffer: So, Vern. What's happened this year [1992] in pen computing?
Raburn: Nothing happened in pen computing! That's the problem. □

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Autodesk, *Robert Wenig, Manager, AutoCAD for Windows:* "At Autodesk, we're using WATCOM C/386 in the development of strategic new products since it gives us a competitive edge through early access to new technologies. We also highly recommend WATCOM C/386 to third party AutoCAD add-on (ADS and ADI) developers."

Fox Software, *David Fulton, President:* "FoxPro 2.0 itself is written in WATCOM C, and takes advantage of its many superior features. Optimizing for either speed or compactness is not uncommon, but to accomplish both was quite remarkable."

GO, *Robert Carr, Vice President of Software:* "After looking at the 32-bit Intel 80x86 tools available in the industry, WATCOM C was the best choice. Key factors in our decision were performance, functionality, reliability and technical support."

IBM, *John Soyring, Director of OS/2 Software Developer Programs:* "IBM and WATCOM are working together closely to integrate these compilers with the OS/2 2.0 Programmer's Workbench."

Lotus, *David Reed, Chief Scientist and Vice President, Pen-Based Applications:* "In new product development we're working with WATCOM C because of superior code optimization, responsive support, and timely delivery of technologies important to us like p-code and support for GO Corp's. PenPoint."

Novell, *Nancy Woodward, V.P. and G.M., Development Products:* "We searched the industry for the best 386 C compiler technology to incorporate with our developer toolkits. Our choice was WATCOM."

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Circle 163 on Inquiry Card.

Popular 486 Sees High Demand in Europe

LONDON—Europe faces a potential shortage of 486 chips in the first quarter, with vendors saying that Intel has warned that those without a consignment on order should not expect to obtain parts early this year. The processor family is in heavy demand due to a larger-than-expected need for the 486 family and the rush of vendors wanting to deliver low-cost 486-based PCs, said Nick Wood, Intel's technical marketing manager at Intel U.K. Companies that buy 486 chips on the open market—in particular, through the so-called "gray" market from other PC makers—may face a tough time, Wood conceded.

"A significant change in demand for 486s started in Q3 last year, compounded by the market reaching an overall size of 30 million units [for all PC processors worldwide], compared to a Dataquest forecast of 23 million," Wood said. "Q1 will be tough, but we should be able to meet all market requirements." About 60 percent of PCs now shipping are 486-based, Wood added.

Chris Bakolas, Dan Technology's technical director in the U.K., confirmed that Intel was warning vendors about potential 1993 shortages as long ago as October 1992. Michael Spiro, financial director of direct-vendor Elonex, said PC vendors that buy their 486s through the U.K. chip distribution channels may not get enough chips. Chip shortages could recur later this year.

—Dom Pancucci

IBM No Ostrich in Anticipation of NT, Cairo

While Microsoft readies Windows NT, IBM is busily preparing OS/2 2.1. John Patrick, vice president of marketing and sales for IBM's Personal Software Products division, said IBM hopes its 5000-site beta test of OS/2 2.1 will help it avoid mistakes made with version 2.0. The haste with which IBM released OS/2 2.0 resulted in about 200 bugs.

Version 2.1 will have seamless support for Windows 3.1 standard mode (with extra drivers for printers and other hardware), the 32-bit graphics engine, and bug fixes. It will also have 256-color XGA and Super VGA drivers, Advanced Power Management support, PCMCIA-card enabling, pen support, a fax send/receive applet, and for Win-OS/2 users, the Windows File Manager and TrueType fonts. What's missing is seamless support for IBM's 8514 graphics standard. "All in all, it's the best beta I've seen to run with all these features," said Steve Mastrianni, president of Personal Systems Software (Unionville, CT).

IBM's PSP division is not focusing its development efforts solely on the 32-bit Intel version of OS/2, however. Patrick said the company is targeting a "Workplace Shell–like" GUI-based version of PC-DOS—tentatively called Workplace DOS—at users of 286 and lower-end 386 systems. IBM may come out with pen extensions for this PC-DOS and a ROM version of Workplace DOS. IBM also expects to go into beta test this year with a version of OS/2 running on the Mach microkernel.

Also, Taligent spokeswoman Loretta Stagnetto said that the company hopes this year to announce business and product strategies for the microkernel-based, object-oriented operating system it hopes will win out over Microsoft's upcoming Cairo and other systems.

—Ed Perratore

Intel Faces Competition on Low and High End

BURLINGAME, Calif.—Smaller Intel-clone chip makers AMD (Sunnyvale, CA) and Cyrix (Richardson, TX) are upbeat in their assessments about their ability to compete. At the Technologic Partner's Personal Computer Outlook conference, executives from AMD, Cyrix, Sun Microsystems, and AST Research concluded that despite the massive Intel Inside campaign, most users don't care about processor name brand, provided the chip is 100 percent compatible and performs well.

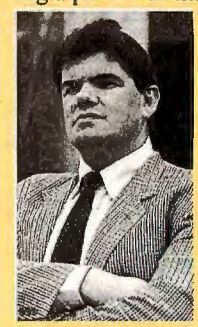
Cyrix's CEO Jerry Rogers said that as a fabless chip maker, Cyrix has concentrated on its strengths and enlisted the aid of Texas Instruments. Subodh Taprani, AMD director of marketing and systems, said AMD has seen strong demand for its 386 chips, noting that it set a record for its 386 unit sales during the third quarter of last year. AMD plans to release a 486-compatible chip later this year.

As Intel prepares to unleash the first Pentium processors and move its user base from the 486 to its next-generation processor, it faces competition from the likes of the Mips R4000 and DEC's Alpha microprocessor.

—Patrick Waurzyniak

NANOBYTES

In an ironic twist of fate, Borland International founder **Philippe Kahn** blames Microsoft for starting a price war that he said forced



Borland to lay off 350 people—15 percent of his company—two weeks before Christmas. "It's painful, it's no fun, but we have to do it," said Kahn. "Microsoft has been extremely aggressive, and we think there will be more price wars in the future." Kahn attacked Microsoft's pricing strategy for Access, a Windows database program introduced last November. Kahn said Microsoft mailed literature that advertised Access at $695 and then slashed the introductory price to $99. Ironically, Borland used a similar strategy a few years ago when introducing Quattro Pro. Observers said that things would not be so bad for Borland had it not been so late in releasing its Paradox for Windows (which should be released by now) and dBase for Windows (slated for mid-1993 release). □

Microsoft (Redmond, WA) denies that its $99 introductory offer for Access was a cruel attempt to squash Borland. Charles Stevens, general manager of Microsoft's Database and Programmability Group, told BYTE that Microsoft was only trying to establish a new database program in an entrenched market. Nevertheless, users report that the first version of Access could have benefited from code optimization. One user complained that Microsoft technical support recommended that he upgrade his 40-MHz 386 machine to at least 8 MB of RAM to achieve acceptable performance. This despite the fact that Microsoft's Access box reads that the program runs on a 386SX with 2 MB of RAM; "4 MB [of RAM] recommended." □

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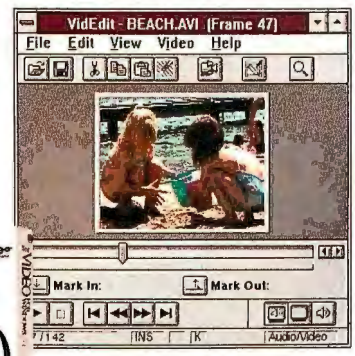

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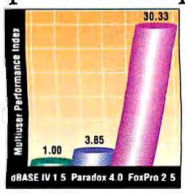

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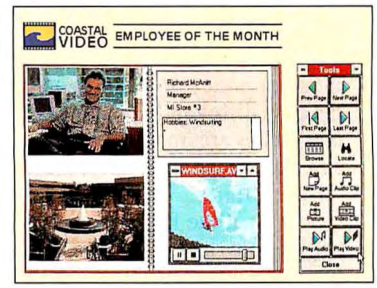

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NEWS

MICROBYTES

First Showing for 64-Mb DRAMs

MUNICH—Attendees of the Electronica trade expo were treated to previews of 64-Mb DRAMs. These memory chips will be a major factor in the hardware implementation of bit-hungry digital image-processing and transmission applications, which look set to dominate the computer, telecommunications, and consumer markets into the next century.

The chips were shown by Korea's Samsung Electronics, which claims to have wrested world leadership in DRAM production from its Japanese competitors, and by the partnership comprising Germany's Siemens Nixdorf and U.S.-based IBM.

The Samsung chip is based on 0.35-micron CMOS technology. Improvements in performance and reliability will be carried out through 1994, when engineering sampling will begin, said the firm. Commercial sampling is scheduled for 1995, and volume production is planned for the same year. Using a price projection of $600 per chip, Samsung cited a Dataquest forecast that the market for 64-Mb DRAMs would be worth $7 million in 1995 and $2.1 billion in 1997 and would then soar to $7.5 billion in 1998.

More low-key was the decision by IBM and Siemens to show, at the latter's Electronica booth, an 8-inch wafer comprising 64-Mb DRAMs that the two firms manufactured jointly at IBM's East Fishkill (New York) facility. Ulrich Schumacher, memory product manager for the German firm since October 1992, told BYTE that "development work on the 64-Mb DRAM in partnership with IBM is proceeding according to plan. In the meantime, work on the 256-Mb DRAM [by Siemens] has commenced with IBM and Toshiba, with preliminary results not expected until the end of 1994."

—Raymond Boult

Europe Struggles with Piracy Definitions

LONDON—Pan-European computer companies are being forced to review their antipiracy procedures across Europe because different EC (European Community) states are implementing the centrally agreed legislation in different ways and at different times.

The deadline for passing the EC directive on copyright protection and building it into national law was January 1, but many countries have missed this target. Despite extensive argument during the drafting of the central directive, each country has since reworked the document to fit their traditional style of statute. "The directive from Brussels was wrought after such heated debate that it was felt it would be wrong for member states to paraphrase it," said Vanessa Marsland, chairwoman of the legal advisory group for the U.K.'s FAST (Federation Against Software Theft). This has already happened, however, leading to slight differences in key definitions such as originality, interoperability, and the restrictions on practices such as decompilation (i.e., reverse engineering).

There are also discrepancies between the directive's and the specific country's definitions of a "computer program" and in the areas of expression versus ideas, which proved such a crucial point in the famous Microsoft/Apple interface battle. These differences will be tempered by the fact that national law has to be interpreted by judges in the spirit of EC law. Nevertheless, the different implementations of the EC legislation will require careful study by companies in the U.S. and Japan wishing to do business in Europe.

According to Marsland, certain amendments in the EC directive could inconvenience suppliers more. "A quirk of the wording [paragraph 5.1 of the directive] may mean [current user] agreement licenses need rewriting. There is a question now over whether things which are not prohibited are permitted," she said. The combination of the EC directive and each country's implementation will likely keep international counsels for companies busy.

The U.K. government has received joint complaints from the Software Publishers Association, the Business Software Alliance, and FAST about the proposed form of the U.K. statute.

Neil Goldman, international counsel for Lotus Development, said, "We are hoping that none of the slight variations will compromise the EC standards. But we have delayed bringing legal action in some countries because some are slower than others at putting the law in place." Currently, the Business Software Alliance is pursuing an active campaign against software piracy worldwide. In Europe, the worst offenders are Spain, Italy, and Portugal, according to industry trade associations. Spain is not expected to amend its copyright laws until mid-1993.

—Louise Cole

NANOBYTES

DEC says that nearly 900 technical and commercial applications from 400 software developers have been announced so far for DEC OSF/1 for AXP, OpenVMS AXP, and Windows NT on Alpha AXP systems. Of the 900 applications, 400 should be released by March, according to **Marion Dancy**, director of the Alpha AXP Applications Program. Sarah Miller, spokeswoman for DEC, said the application breakdown is about 500 for OpenVMS AXP, 300 for the 64-bit OSF/1 for AXP, and 75 or 100 for Windows NT. The numbers do not include DEC's own applications or custom applications being ported to Alpha using DEC's binary translators and compilers. □

Demand for Intel's 486 pushed the company's fourth quarter revenue to a record **$1.86 billion**. Net income for the quarter was $429 million, compared to $189 million for the same quarter in 1991. Vinod Dham, general manager for Intel's microprocessor division, told BYTE that for 1993, Intel's volume processor will be the 486—not the Pentium. □

IBM has recalled two former top executives from retirement to advise the company as it tries to climb out of a slump. **Paul Rizzo** and **Kaspar Cassani**, both formerly vice chairmen of IBM, will advise chairman John F. Akers as counselors and advisers. IBM says it will eliminate 25,000 jobs this year—possibly through its first-ever layoffs. IBM blamed a sharp drop in European sales in recent months for its worsening financial results. □

Computer maker **Everex Systems** (Fremont, CA) has filed for voluntary protection from creditors under Chapter 11 of the Bankruptcy Code. CEO Steve Hui had resigned, and Everex has pared its workforce to less than 900 employees from the 2100 people it employed about a year ago. □

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FTC Ready to Rule on Microsoft

The FTC has completed its antitrust probe into the business practices of Microsoft and concluded that the company engaged in anti-competitive behavior, says a report in *Business Week*; FTC staffers are preparing recommendations that include breaking the company up into smaller pieces and establishing a "wall" between its operating-system and applications divisions.

Microsoft continues to post big profits while other software companies struggle. Although this does not mean that Microsoft's success is due to anticompetitive behavior, competitors say Microsoft can subsidize its applications development with revenues from its operating-system operations, and that its applications people can benefit from early details of an operating system.

"It's always been true the more you knew about the operating system, the better you could make your apps," said Fred Gibbons, CEO of Software Publishing. "There's no way on God's green Earth that I can believe that Microsoft didn't have an unfair competitive advantage by being in the operating-system and the apps business."

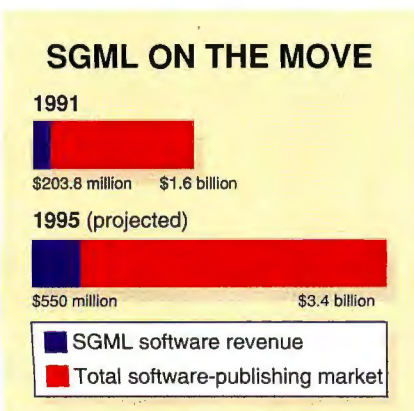
Microsoft argues, however, that a company that is creative and aggressive can succeed in the market and offers companies like Adobe and Intuit (maker of the Quicken personal-finance manager) as examples. "We're competing with Microsoft and doing very well," said Kevin Harvey, president and CEO of Approach Software, makers of a Windows database package.

"Microsoft is a brilliant company run by a brilliant individual. Bill Gates is the Henry Ford of this half century," Gibbons said. But Gibbons added he wished Microsoft would do everything within its power to make sure that its applications division gets the same information at the same time as independent vendors.

—Dave Andrews and Patrick Waurzyniak

Portable Documentation Accelerating SGML

Worldwide revenues for products related to SGML, the Structured Generalized Markup Language established by the ISO in 1986 and adopted by the U.S. Department of Defense, will more than double by 1995, according to InterConsult (Arlington, MA, (617) 646-9600), a market-research firm specializing in the computer-publishing market (see the figure). The study predicts that the steady growth for SGML-based software is due in part to the shift toward electronic delivery of massive amounts of documentation required in manufacturing, military, telecommunications, and service fields.



InterConsult's worldwide SGML-specific software revenue figures include parsing, composition, auto-tagging, and SGML integration programs for workstations and mainframes.

Louis R. Reynolds, president and CEO of Electronic Book Technologies (Providence, RI, (401) 421-9550), said SGML offers an open standard that lets users access hypertext documents under multiple operating systems like Windows, DOS, Unix, and the Mac. With the growing acceptance of CD-ROM, companies can put the equivalent of several large, complicated manuals on a single CD. "The hardware technology [for portable computing and remote access] is becoming cost-effective and available," he said. "It's driving the whole industry to electronic delivery."

Control Data Systems announced it will use EBT's DynaText electronic-book publishing and delivery system to convert its paper documentation to electronic manuals, joining Novell and Silicon Graphics as EBT users. Reynolds predicts that within two to three years, applications will be supporting SGML on a wide scale. For example, a word processor's Save options will include SGML as well as options like ASCII. "Electronic books are potentially bigger than spreadsheets," Reynolds said. "Think of it this way, how many people play with spreadsheets and how many people read books or reference manuals?" ■

—Dave Andrews

NANOBYTES

Novell has signed a letter of intent to acquire **Unix System Laboratories**, the subsidiary of AT&T that provides the Unix operating system and related software and services. The acquisition is expected to be completed by the end of March. Ray Noorda, president and CEO of Novell, said the acquisition is being done at the "urging of customers" who have asked Novell to "support the Unix system directly and integrate it more fully within the NetWare environment." Analysts said the announcement illustrates the importance of Unix systems in downsizing business applications to computer networks and shows how seriously Novell regards the potential challenge of Microsoft's unreleased Windows NT operating system. □

Users depending on Microsoft for "mission-critical" project management were dismayed to learn last year that a bug in **Microsoft Project 3.0** causes file corruption. Microsoft technical support acknowledges that a serious bug will cause file corruption on large projects using shared resources. If users save often, the software doesn't relinquish memory properly. What the company calls a "memory leak" eventually crashes the program with a protection fault. Microsoft says its developers are aware of the bug. A maintenance release that fixes the problem was due in mid-February. □

WordPerfect is finalizing beta testing on a program called **IntelliTag** that converts WordPerfect documents into SGML (Structured Generalized Markup Language). You can use IntelliTag to convert other word processors' files into WordPerfect 5.1 format and then into SGML. A Unix version (expected price is $495 for one user) is slated for release for Sun Sparcstations in the February/March time frame. A DOS version is planned for June release, says a WordPerfect representative. ■

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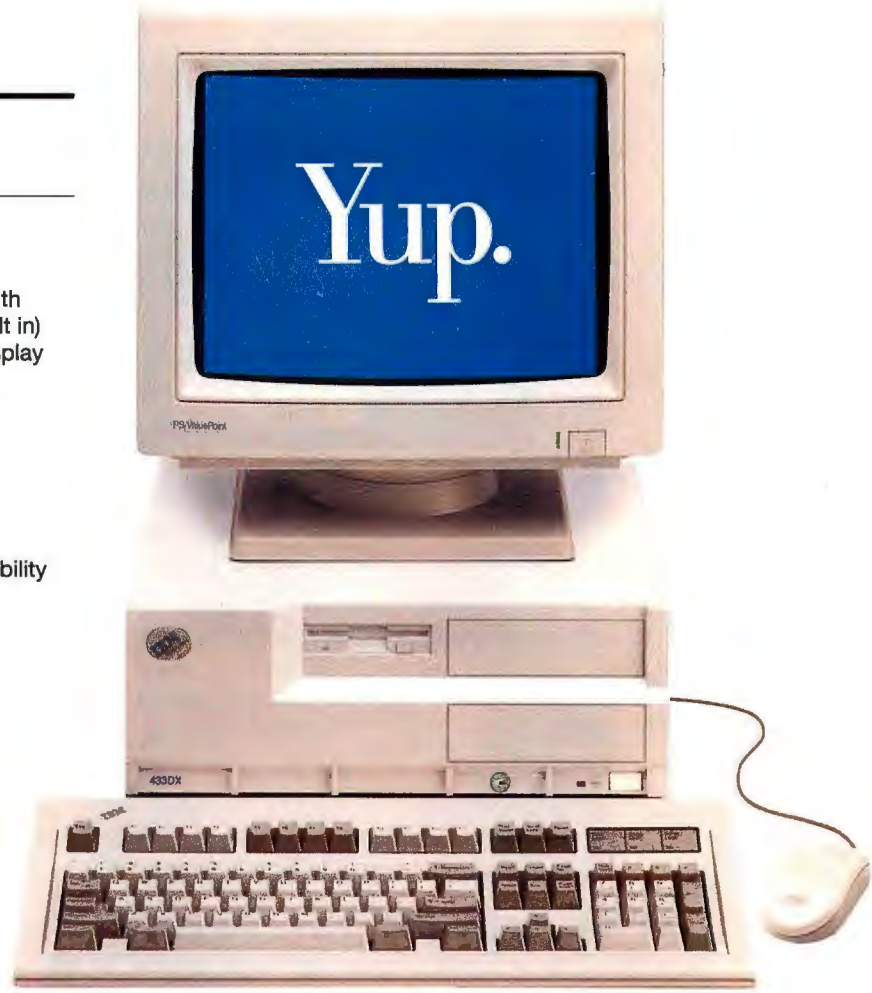

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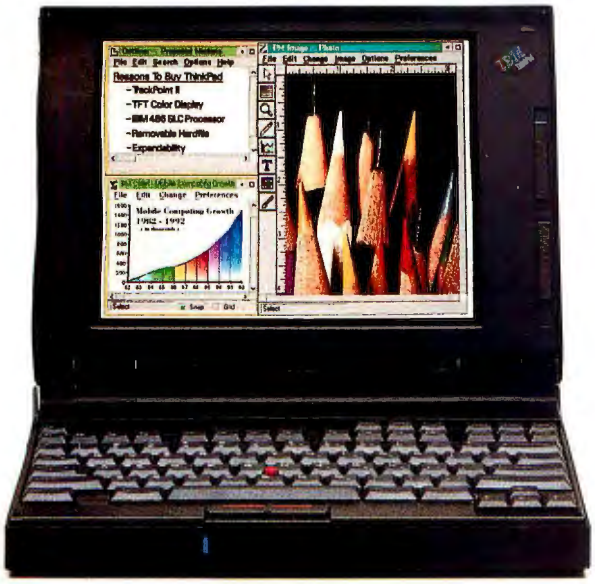

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HIGH-TECH OPPORTUNITIES ABOUND

NEW DELHI—India, the country that introduced the world to the decimal system and the use of the numeral 0, is still far from being a serious player in the computer industry. According to *Dataquest*, an Indian computer magazine, total revenue generated by the Indian computer industry passed the US$1 billion mark for fiscal year 1991–92. This may sound like a staggering figure for a country whose GNP is only $450 billion, but it is a drop in the bucket compared to the global information-technology market.

To encourage growth, the Indian government has recently adopted a more liberal policy that makes it easier for foreign companies to set up high-tech industries in India. The government is emphasizing domestic manufacturing. It is discouraging imports by imposing a crushing import duty of more than 100 percent for hardware and 70 percent for software. According to many sources, hardware manufactured in India is as robust as any available. However, the most popular operating systems are the U.S.-developed DOS and Unix-on-Intel operating systems, with Microsoft Windows catching up rapidly.

India, with a population of 870 million, is the second most densely populated country in the world, and it presents a huge consumer market. An educated middle class of about 300 million is an unexplored market that will become hungry for PCs if the prices are low enough. A cutthroat competition among Indian vendors has already resulted in price-cutting that saw an average PC drop in price by more than 50 percent. Even with that reduction, a 386 system sells for about $3300; a 486 system sells for about $4900.

The Indian government is looking for foreign companies to invest in the capital-hungry computer market and thus create more competition. If U.S. and European hardware vendors are not quick to react to the recently liberalized foreign-investment policy in India, they will lose the opportunity to fill the gap between supply and demand of PCs in India.

A country with more English-speaking people than there are in England, India offers an inexpensive but talented pool of 140,000 software professionals. The South Indian city of Bangalore, also called the Silicon Valley of India, has more than 300 software houses that export software to other countries. Primarily, though, such ventures deal with applications software and turnkey projects only.

Public schools in India follow the "catch them young" philosophy. According to Jaya Narasimhand of the Modern Public School in Delhi, Logo programming is taught in elementary schools beginning with the fourth grade. Students in the ninth and tenth grades learn BASIC, and eleventh- and twelfth-grade students advance to Pascal.

In a few years, this emerging class of affluent and computer-literate students will create a great demand for computers. These future entrepreneurs, whose parents are already well established in business, will do nothing short of launching a massive computerization of their businesses. But the Indian computer industry is not ready to meet this demand. This creates a hotbed of opportunities for U.S. and European companies that are interested in investing in high-tech industries abroad.

India's emerging class of computer users will create a great demand for computers

There are hurdles, however. The telecommunications system is still in a primitive state. It takes anywhere from one to two years to get a telephone connection—if you are lucky. In spite of these obstacles, the National Information Center, a department of the Planning Commission of the Indian government, has installed a satellite-based network connecting 470 districts in India using VSAT (very small aperture terminals) technology. According to Dr. N. Vijayaditya, the deputy director general of NIC, "It is the largest satellite-based network outside the U.S."

Major international hardware and software vendors like Hewlett-Packard, DEC, Olivetti, Intel, Lotus, Honeywell, Unisys, Motorola, and Microsoft already have a presence in India, whether through joint ventures with Indian companies or through local outlets for export purposes. However, India is still largely a market waiting to be discovered. ■

Jay Ranade is the series editor in chief for McGraw-Hill's books on the subjects of IBM, DEC, computer communications, and workstations. He has written more than 10 books and edited more than 100 books in this series.

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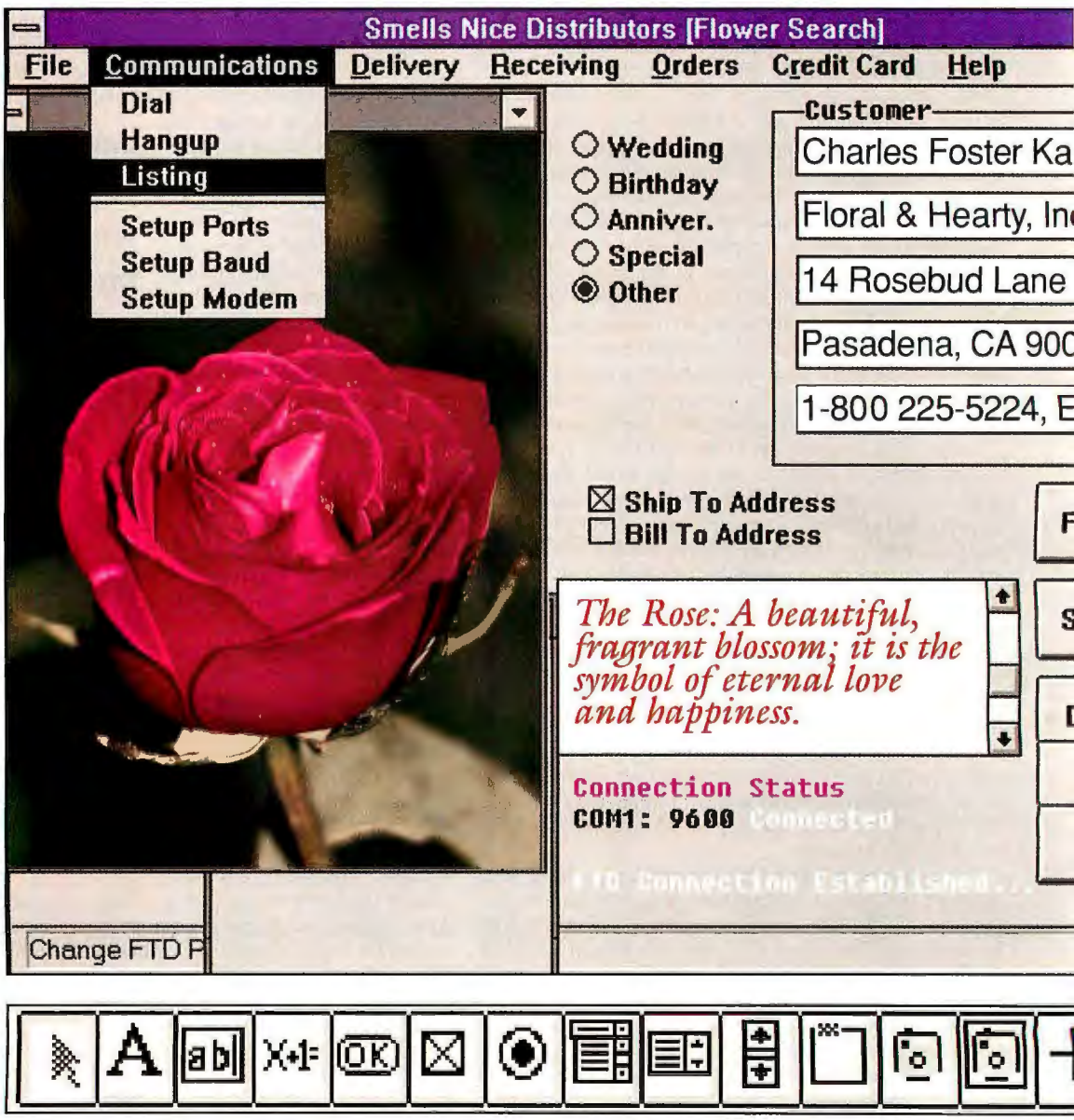

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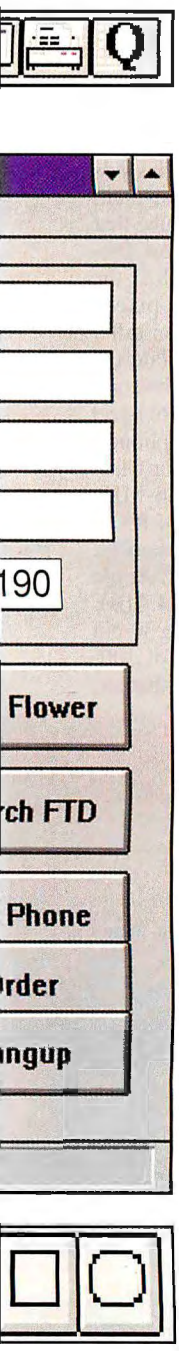

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A Spring Harvest of Apple Macintoshes

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Six new computers redefine the Mac product line

In 1990 Apple began its major assault on the microcomputer market with six new machines. No portion of the market was left untouched: The Mac Classic II, with its black-and-white display, targeted the low-cost segment, while two 68040-based Macs, the Quadra 700 and 900, took the high-end, high-performance territory. For the on-the-go office worker, the PowerBooks—three notebook Macs with black-and-white screens—offered many features that PC notebook computers lacked. Since then, Apple has made enhancements to these product lines, such as a faster Quadra (the Quadra 950) and more powerful notebooks with gray-scale displays (the PowerBook 180 and PowerBook Duo 230).

On February 10, Apple unleashed its second wave in the market-share war. As before, the company introduced six Macs that compose a sweeping revision of its product line. Among the changes is the first compact Mac with a color screen, the first PowerBook with a color screen, and a new Quadra with a shorter mini-tower design. A newly introduced Centris series—a set of 68040-based midrange computers—is intended to replace the Mac II line. Also shown was the Mac LC III, a high-powered successor to the LC II.

With street prices likely to range from $1000 to $4500, these new Macs address the price-conscious segment of the microcomputer market while delivering processing power. Because low-end Macs now account for the vast majority of Apple's unit sales, we'll start at the bottom of the product line and work our way up. We looked at preproduction units of each model. Note that the prices given here are preliminary and may change by press time.

Color Classic

Low-cost computing on the Mac traditionally meant sacrificing color capability. This is no longer true. The Color Classic's built-in monitor uses a 76-dot-per-inch, 10-inch-diagonal Sony Trinitron tube that displays a 512- by 384-pixel screen. Previous compact Mac screens—such as the Classic II—are only 512 by 342 pixels, making the Color Classic's screen taller by 42 pixel lines. To accommodate the larger tube, Apple slightly altered the compact case design, using a larger front bezel that also includes a built-in microphone.

As with the Classic II, the Color Classic's main logic board uses a 16-MHz 68030 processor and has 4 MB of RAM standard (the Classic II initially had only 2 MB of RAM, but since mid-1992, Apple has been shipping the unit with 4 MB). RAM is expandable to 10 MB using 30-pin RAM SIMMs. There is 256 KB of 100-nanosecond VRAM (video RAM) that lets

the computer display 256 colors on-screen. You can expand it to 512 KB by adding a VRAM SIMM; the system can then display 32,768 colors.

The Color Classic still uses a 16-bit-wide bus that reduces system costs, but at the expense of throughput. However, the video-frame buffer now resides in VRAM rather than in main memory and thus eliminates a performance hit that hobbled the Classic's design. In the old design, as the video circuits periodically accessed memory to refresh the screen, they blocked the processor's access to the bus, which degrades overall performance. With the video-frame buffer in separate VRAM on the Color Classic, both video and processor operations run unimpeded. The result should be better performance, and the preliminary BYTE low-level benchmark results (see the figure) support this conclusion. The Color Classic is about as fast as a Mac LC II, or about Mac II caliber.

Normally, the compact Mac design offers limited expansion options, but here's where the Color Classic really breaks with tradition. First, there's a socket for a 68882 FPU. Next, there's a 96-pin PDS (Processor Direct Slot) that's electrically and physically compatible with Mac LC and LC II expansion boards. Finally, you can junk the Torx screwdriver and case-cracking tools required to open older compact Macs. Just tug on two tabs at the bottom rear of the computer to remove a panel, and the main logic board slides out, letting you easily add extra RAM, the FPU, or an LC or LC II expansion board. This arrangement also prevents exposure to the hazardous voltages lurking in the color-video circuitry.

A Color Classic with 4 MB of RAM and a 40-MB hard drive costs $1300. The 68000-based Classic is being discontinued, with the Classic II taking its place as the lowest-cost Mac. No upgrade path from a Classic II to a Color Classic is offered.

Mac LC III

As limited as its expansion options are (a single PDS slot and no FPU), the Mac LC II is Apple's best-selling computer. The company asked users what design improvements they'd like to see in the computer. The answers were, allow more memory, add more display options, and make it faster. The LC III does these things—and more. A new controller chip—an enhanced derivative of a Mac LC ASIC (application-specific IC)—enables you to expand RAM to 36 MB (up from 10 MB). The main logic board has 4 MB of 80-ns RAM soldered to it, and a single SIMM socket provides memory expansion using a high-density SIMM. The LC III uses an industry-standard 72-pin SIMM, rather than the 30-pin SIMMs found in other Macs.

The LC III's built-in video supports a bevy of monitors, from Apple's 12-inch RGB display (512 by 384 pixels) to its 16-inch display (832 by 624 pixels) and VGA monitors. The 512 KB of 80-ns VRAM soldered to the main logic board supports 8-bit pixels (256 colors) on these screens. A single SIMM socket lets you add 256 KB of VRAM (for a total of 768 KB) so that you can view 16-bit images (32,768 colors) on 14-inch monitors (640 by 480 pixels).

The LC III's 68030 processor is clocked at 25 MHz (up from 16 MHz), and there's a socket for a 68882 FPU. More important, the LC III uses a 32-bit-wide bus, whereas the LC II's bus was only 16 bits wide (a cost-cutting move, as in the Classic design). The end result is that the LC III serves up nearly Mac IIci performance, according to the BYTE benchmarks. A notched 114-pin PDS connector accepts existing 96-pin LC II expansion boards, with a maximum power budget of 4 watts. An LC III with 4 MB of RAM and a 40-MB hard drive costs $1300. Mac LC II owners can rest easy: Through a logic-board swap, they can upgrade their computers for $599, although they will have to replace the old RAM. The LC II won't be discontinued; instead, its price will be lowered.

Centris 610

With the market's low end firmly anchored by the Classic II, Color Classic, LC II, LC III, and the Performa line, Apple turned its attention to the aging 68030-based Mac II line. The top performer here has been the 25-MHz Mac IIci, whose design is more than three years old. The new Centris 610 and 650 computers are low-cost 68040-based midrange Macs.

Tight integration of components has reduced the 10 custom ASICs used in the Quadra 950 design to only three, which reduces the cost of the Centris computers and the 33-MHz Quadra 800 (described later). One of these chips, the memory-controller ASIC (MEMC), now lets you mix different-density RAM SIMMs (as long as they are 4 MB or larger) on the main logic board. At boot-up time, the MEMC maps the different-size chunks of RAM into one contiguous memory space.

Throughput wasn't sacrificed while cutting costs. Both Centris computers use the 53C96 SCSI controller, the same one found in the Quadras. This controller has a maximum transfer rate of 5 Mbps, versus the 53C80 found in other Macs that handles only 1.5 Mbps. The I/O bus in the Quadra design has practically disappeared,

with most I/O signals and controls combined into one ASIC (the IOSB). The IOSB is clocked at CPU speeds, so on the Quadra 800 most I/O operations run at 33 MHz. The exception is the Ethernet controller, which runs at 16 MHz.

The Centris 610 is a low-profile desktop computer similar in design to the Mac LC III. It has room for two internal SCSI devices: a 3½-inch drive and a bay at the front for a 5¼-inch half-height device (typically a CD-ROM drive). An 86-W power supply provides ample power for these peripherals. To reduce costs, the Centris 610 uses a 20-MHz 68LC040, which is essentially a 68040 processor without an FPU (sort of like a 486SX). However, it uses the same socket as a 68040, which offers the possibility of an upgrade.

An Ethernet port, using the AUI (Attachment Unit Interface) connector, is an option. This option is actually a main logic board populated with the Ethernet port and electronics. Like the Mac IIsi, the Centris 610 has a single 68040 PDS expansion slot, which can also be a NuBus slot by using an adapter board. To fit within the computer, these boards must be only 7 inches long (current NuBus boards can be up to 12 inches long) and use a maximum of 10 W.

The Centris 610 starts with a base 4 MB of RAM; two 72-pin SIMM sockets let you expand memory to a maximum of 68 MB. Its 512 KB of 100-ns VRAM supports 8-bit colors on monitors from 12 to 21 inches (1152 by 870 pixels). Two SIMM sockets let you increase VRAM to 1 MB, to support 16-bit-deep screens on monitors as large as 16 inches.

A Centris 610 with 4 MB of RAM and an 80-MB hard drive is expected to cost under $2000. You get a lot of bang for your buck here: The BYTE low-level benchmarks peg the 20-MHz Centris 610 at better than Mac IIfx performance (the Mac IIfx uses a 40-MHz 68030 and 68882 FPU.) Even with the 68LC040, the Centris 610 did better than the Mac IIfx on floating-point operations.

Centris 650

If you require more expansion options than are offered by the Centris 610, there's the Centris 650. It uses the same Mac IIvx housing with a bay for a 5¼-inch SCSI device, a 68040 PDS, and three slots that implement a NuBus 90 backplane. The slots accept full-size NuBus boards. A 112-W power supply powers the system, and 15 W is available for each NuBus slot. The processor is a 68LC040 or a 68040 clocked at 25 MHz. As with the Centris 610, the Ethernet interface is an option. The Centris 650's on-board video is identical to the Centris 610's and supports the same monitor sizes and screen depths. But it uses 80-ns VRAM instead of 100-ns hardware.

The Centris 68040-based Macs make up Apple's new midrange computers. Both are shown with an optional CD-ROM drive.

The main logic board has 4 or 8 MB of 80-ns RAM; four 72-pin SIMM sockets let you expand memory to as much as 136 MB (assuming 8 MB on the main board). The memory subsystem in the Centris 650 and the Quadra 800 has been enhanced to support interleaved memory. The MEMC ASIC arranges RAM in logical banks and then provides a hardware assist by rapidly stepping through the banks during burst-mode accesses. This shaves several clock cycles off these memory operations and improves throughput. The memory on the main logic board is interleaved, and the socketed SIMM RAM must be the same density for memory interleaving to occur.

The BYTE benchmarks show that, on average, the Centris 650's memory operations are faster by about 13 percent than the Quadra 700 (Apple claims 10 percent to 15 percent). While not all memory operations can take advantage of burst mode, the test results do indicate that the memory subsystem uses them when it can. The benchmarks show that the 650 edges out the 25-MHz Quadra 700 in performance.

A Centris 650 with 4 MB of RAM and an 80-MB hard drive sets you back $3000. It's expected that the Mac IIsi and IIci will be discontinued, leaving the Mac IIvx as the sole survivor of the Mac II line.

Quadra 800

The Quadra 800 is a short, squat tower similar to the Quadra 950, but it stands only 14¼ inches high (versus the Quadra's 18⅜ inches). It uses a 33-MHz 68040 processor and comes with 8 MB of 70-ns RAM on the main logic board. Four 72-pin SIMM sockets let you expand RAM to 136 MB. Memory on the main logic board is interleaved, and so is the socketed RAM if it is all the same density. Ethernet is standard, and three slots implement a NuBus 90 backplane, which handles full-size NuBus boards.

The tower contains three bays at the front that can hold four SCSI devices: a 5¼-inch half-height device (typically a CD-ROM), a 3½-inch half-height device (a hard drive), and either a 3½-inch full-height device (typically a disk array) or two half-height devices. A ribbon cable with SCSI connectors and four power cables at the ready make adding a SCSI peripheral easy. The 200-W power supply provides ample muscle for these peripherals and 15 W per NuBus board.

Because the Quadra 800 borrows from the same design used by the Centris 610 and 650, it supports the same monitors and screen depths (up to 16 bits deep on a 16-inch monitor). Video performance on all

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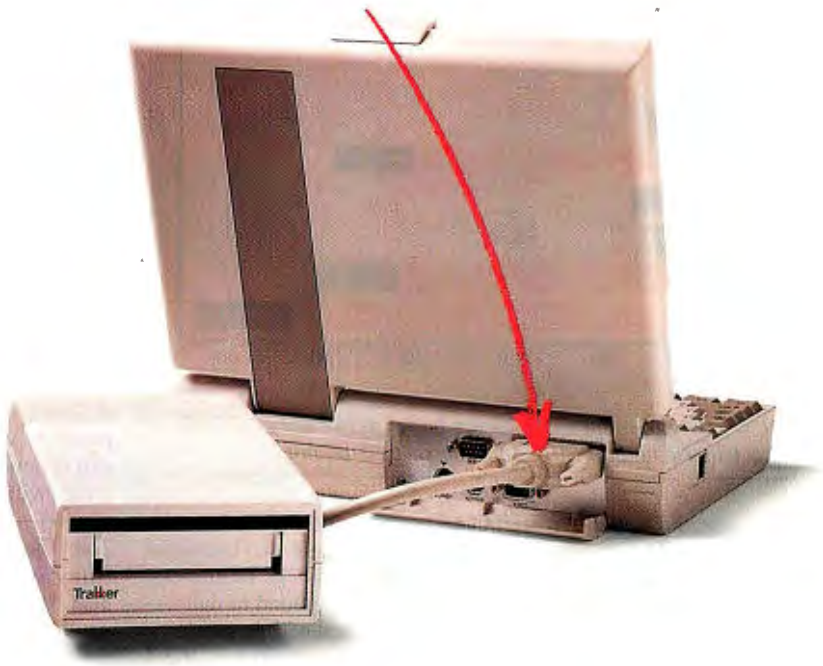

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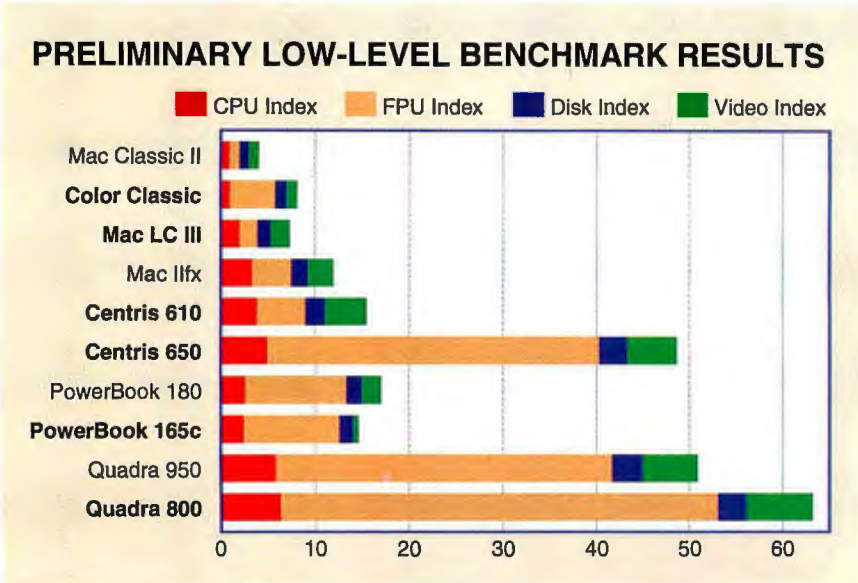

For all tests, a Classic II = 1. Higher numbers indicate better performance. All Macs ran System 7.1. The Color Classic had an FPU; the Centris 610 did not.

three systems is faster because the IOSB eliminates one wait state from VRAM accesses. Also, certain QuickDraw graphics routines have been modified to take advantage of the 68040's MOVE16 instruction (which burst-transfers 16 bytes), improving the speed of scrolling and filling operations.

The BYTE benchmarks show that the Quadra 800 is slightly faster than the 33-MHz Quadra 950. This results from the improvements in the Quadra design: memory interleaving, the I/O functions merged into the IOSB, and the optimized video.

A Quadra 800 with 8 MB of RAM and a 230-MB hard drive costs $4700, a most attractive price when you compare it to a similarly equipped Quadra 950 ($7359). Where the Quadra 800 falls short of its predecessor is in its lack of 24-bit video, fewer slots, and fewer peripheral bays. The features the Quadra 800 packs, however, should attract a flock of buyers.

PowerBook 165c

Last but not least, Apple closes the gap in its notebook line with the PowerBook 165c. Essentially a PowerBook 180 (a 33-MHz 68030 processor, 68882 FPU, external video, and 4 MB of RAM), the 165c differs mainly in its color passive-matrix LCD screen that displays 256 colors. The 9-inch-diagonal display is smaller than the PowerBook 180's 77-dpi, 10-inch-diagonal display, but its 85-dpi density packs in the same 640- by 400-pixel screen. The screen uses special filters and polarizer materials to provide good contrast and a wide viewing angle, while two backlight bulbs and a filter increase its brightness. The screen adds only ½ pound to the system's weight (for a total of 7 pounds).

Internally, the engineers moved the 4 MB of RAM and 1 MB of ROM to a "cousin card" to make room for the color display's controller and DRAM. The display consumes more power (about 6 to 7 W). Thus, the PowerBook 165c uses a beefier 2.9-watt-hour nickel-cadmium battery (the PowerBook 140/170 use a 2.7-Wh battery). Also, the power charger now cranks out 24 W (up from 15 W) to recharge the battery faster.

The 165c's screen is brighter than we expected, with rich colors. Scanned color images are a joy to behold. The BYTE benchmarks indicate that the 165c is slightly slower than the PowerBook 180. The video benchmarks were especially slow because the display's frame buffer doesn't use dual-ported VRAM. Although the PowerBook 165c's passive-matrix screen might not match the brisk colors of an active-matrix screen, the trade-off here is for your wallet. A PowerBook 165c with 4 MB of RAM and an 80-MB hard drive costs $3279. The prices of comparable PC notebooks with active-matrix screens start at about $4300.

A Mac for Every Purpose

This latest generation of Macs spans every part of the microcomputer market. At the low end, there is the affordable Color Classic with a small desktop footprint. If you need more power, the LC III serves up Mac IIci performance.

The 68030-based midrange Mac II line was in desperate need of an overhaul. The Centris line of Macs brings this section up to date with affordable 68040-based computers that deliver ample horsepower.

The Quadra 800 mini-tower offers leading-edge performance while intelligent design compromises make it the most affordable Quadra ever. And for those who need color on the road, the PowerBook 165c is a powerful 33-MHz color notebook that delivers performance while sparing your budget.

As usual, we admire the Apple engineers who have reused proven technologies where they can (e.g., enhanced versions of the Mac LC components for the LC III) and maximized their design efforts (e.g., by integrating the Quadra design into fewer ASICs and using them in the Centris computers as well as the Quadra 800). The result is better performance at lower cost—a win-win situation for the Mac user. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is an associate Apple developer. You can reach him on AppleLink as "T.THOMPSON" or on the Internet at tomt@bytepb.byte.com. Tom R. Halfhill is a BYTE senior news editor based in San Mateo, California. You can reach him on BIX as "thalfhill."

THE FACTS

Color Classic (with 4 MB of RAM/40-MB hard drive): $1300

Mac LC III (with 4 MB of RAM/40-MB hard drive): $1300

Mac Centris 610 (with 4 MB of RAM/80-MB hard drive): under $2000

Mac Centris 650 (with 4 MB of RAM/80-MB hard drive): $3000

Mac Quadra 800 (with 8 MB of RAM/230-MB hard drive): $4700

Mac PowerBook 165c (with 4 MB of RAM/80-MB hard drive): $3279

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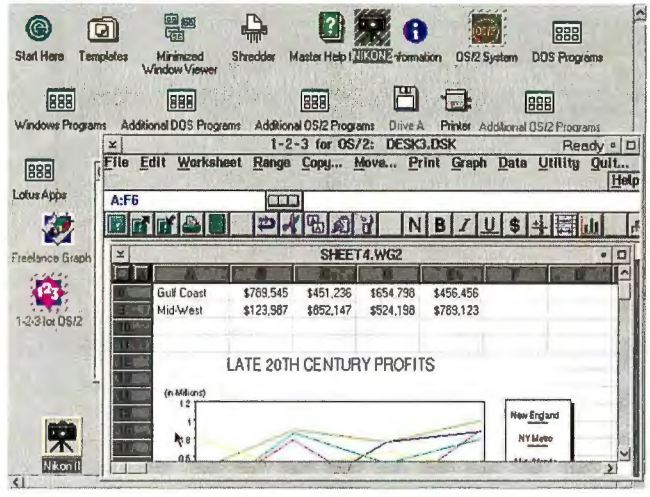
1-2-3, Freelance for OS/2: Major Applications at Last



The lines "something borrowed, something blue" came to mind while I looked at Lotus's first two applications for OS/2 2.0. **Lotus 1-2-3 and Lotus Freelance Graphics for OS/2 2.0** were written for this platform, not ported, yet they borrow from among the best features of their DOS and Windows counterparts while bringing out the best of Big Blue's 32-bit operating system.

Based on the beta versions that I saw, OS/2 2.0 is worth consideration—or reconsideration—as a platform that is supported by major, and native, applications. The attraction of 1-2-3 for OS/2 2.0 and Freelance Graphics for OS/2 2.0, however, is also their tight integration when both are installed—from file operations to the sharing of resources and an OLE-like method of saving all a project's files under a single desktop (.DSK) filename.

Both products should now be available, and Lotus says that OS/2 2.0 versions of cc:Mail and Ami Pro should follow within a couple of months. Lotus will then have OS/2 2.0 products in all four major applications categories. A 32-bit version of Lotus Notes has been held up. Lotus officials indicated at press time that it may not be ready to ship until the end of the year.

Lotus 1-2-3 for OS/2, formerly called Lotus 1-2-3/G, has improved with OS/2 2.0's functionality in mind. Lotus quietly shed the redundant *G* (for graphical) label around the time it released 1-2-3 for Windows. But true to the form of products maintained across multiple platforms, the newer 1-2-3 for OS/2 has gone beyond the current Windows version.

In addition to a more powerful charting engine based on a DLL shared with Freelance Graphics, 1-2-3 for OS/2 includes SmartIcons—one-click shortcuts to operations such as insert or delete row/column, format currency, add, and undo. One handy icon will resize one or more columns to their maximum widths necessary to display all data contained in each respective column. You can also customize the default SmartIcon set to substitute ones you use more frequently.

Among other enhancements, you can select discontiguous sections (called *collections*) for various operations by using the right mouse button, and you can select whole rows and columns by clicking on them in the frame. The next version of 1-2-3 for Windows (expected to ship this spring) will support collections. OS/2's Workplace Shell will now let you drop a filename onto the printer, shredder, or 1-2-3 icon (or the Freelance icon if both are installed). The application icon will launch the application and load the file.

Freelance Graphics, developed for OS/2 before DOS and Windows, uses the same process-oriented approach that Lotus first used in the Windows version 1.0. In other words, the program guides you through each step of building a presentation through a succession of templates.

Version 2.0 for Windows shipped early this year, so the OS/2 version gleaned plenty of functionality from its older sibling. SmartIcons let you click on page layouts, select a text block for input and change the font, start a new page, and page in either direction. Some functions (e.g., outlining and organizational charting) present in the new Windows version are missing from Freelance Graphics for OS/2 2.0. Other functions, particularly those related to the OS/2 Workplace Shell, are not in versions written for other platforms.

Individually, 1-2-3 and Freelance Graphics are worth a look; together they may be irresistible. For starters, you save more than 4 MB on your hard disk thanks to code shared between the two applications; you also save RAM, but usage varies too much to provide a concrete figure.

The common charting engine, which saves about 2 MB in itself, represents one less part of either program for new users to learn. And, if you're working on several files grouped under a single desktop file, all SmartIcons and menus are context-sensitive and change as you move from worksheet to graph to presentation. Lotus expects that if you use cc:Mail for OS/2 when it ships later this year, you'll be able to drag a file icon to the cc:Mail icon to attach a file to an E-mail message.

You've heard the OS/2 trash talk: It has no so-called killer application that will do for Big Blue's platform what the original 1-2-3 did for DOS. No true killer application may surface in a market that is far more segmented and sophisticated today than it was 10 years ago, but Lotus's first two OS/2 2.0 offerings indicate that adopting the OS/2 platform is now an easier choice to make.

—Ed Perratore

THE FACTS

Lotus 1-2-3 for OS/2 2.0
single-user standard edition, $495; network server edition, $595; $395 per concurrent network user (not including documentation) above price of network server edition

Lotus Freelance Graphics for OS/2 2.0
(prices same as for 1-2-3)

System requirements:
386 PC (minimum 20 MHz recommended) with OS/2 2.0 (equipped with Service Pak) or higher; if installing both products, 4 MB of RAM (7 MB recommended) and 11½ MB of free disk space; for 1-2-3 alone, 4 MB of RAM (8 MB recommended) and 9½ MB of free disk space; for Freelance alone, 4 MB of RAM (8 MB recommended) and 6½ MB of free disk space; a mouse.

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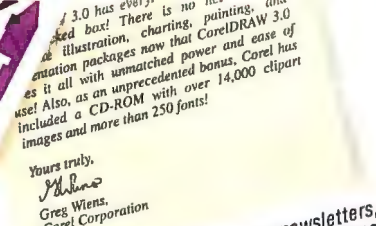

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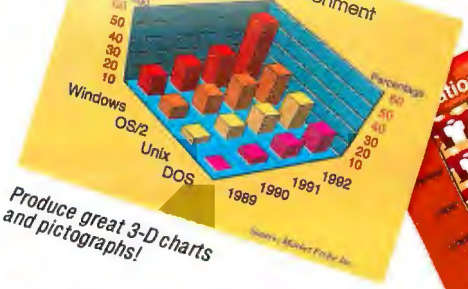

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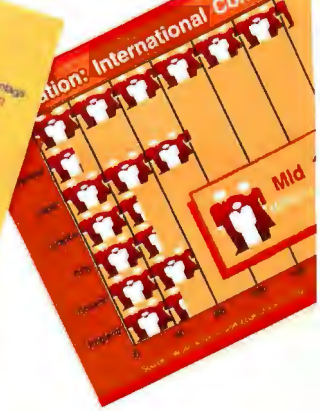

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Sun's New Unix Box: Short and Sweet

With its introduction of the Sparcstation IPC, Sun Microsystems started a new packaging trend: small and inexpensive Unix workstations. With their small footprints and like-size expansion cabinets (for external drive, tape, and CD-ROM), Sun's IPC and its descendants took the bulk out of workstations. But Sun's best-performing desktop systems were still found only in the traditional "pizza-box" case. If you wanted a zippy CPU or drive, you had to invest in something other than Sun's squat boxes.

The **Sparcstation LX** hopes to change all that. As with the IPC, miniaturization abounds, but Sun has found some innovative ways to pack more functions into a case that hasn't gotten any bigger or heavier. The LX addresses many of the wish-list items Sun users have desired.

At the heart of the LX is its MicroSparc CPU, developed by Sun and Texas Instruments and running here at 50 MHz. This CPU rolls the integer, FPU, MMU (memory management unit), and cache into one chip, bringing the chip count down, reducing costs, and making room for more goodies. Those objectives were furthered by Sun's replacement of most of the system's I/O controllers with a pair of ASICs (application-specific ICs). The LX makes fine use of the extra real estate, building in support for basic-rate ISDN, twisted-pair Ethernet, 16-bit digital audio, and accelerated graphics.

Most of the new features built into the LX require outside-world connections, and the back panel of this system is densely packed with connectors. One DB-25 splits out to two serial ports, and another one services a bidirectional parallel port, expanding the range of supported printers. The Ethernet port pops out in two places: a tiny socket into which you plug a thin-wire transceiver or an AUI (Attachment Unit Interface) conversion cable, and a twisted-pair jack that lets you hook directly into a network. You'll also find a jack for connection to an ISDN line and connectors for SCSI and audio I/O.

The LX's standard audio capability is a leap beyond that built into previous Sparcstations. The LX manages 16-bit audio at sampling rates of up to 48 kHz. The system includes a battery-driven condenser microphone with mounting hardware to stick it to the front of your monitor.

The most impressive aspects of this new system relate to performance: CPU, display, and drive performance have all been enhanced. With the 50-MHz MicroSparc CPU, the LX is faster than Sun's Sparcstation 2, previously its fastest uniprocessor desktop system. But it's not *much* faster—the documentation refers to it as being "1.5 times the speed of a 486." My tests against an Altos System 5000 (33-MHz 486) proved that statement to be true, at least for integer performance. In other areas, the LX positively skunked the 486: The LX was three times faster in floating-point and disk I/O. These results are unreliable because the LX I tested was a preproduction unit, but they at least show that Sun isn't inflating its performance claims.

I'll admit I had hoped that by now Sun would have taken a big leap in single-CPU performance, along the lines of 68030 to 68040 or 386 to 486. That didn't happen: My CPU performance tests showed the 50-MHz MicroSparc to be calculating almost exactly twice as fast as the 25-MHz chip in an IPC unit. It's fine for Sun to quote performance numbers against the 486, but the company is losing ground against IBM, Hewlett-Packard, and Silicon Graphics, all of which have reduced-cost RISC workstations with excellent single-processor performance. The LX will also be competing soon against systems built around Intel's Pentium, which, if you take Intel's vaunted performance figures as truth, could also make the MicroSparc look a little sickly.

If the LX's CPU performance isn't stellar, it's at least adequate, and some of the slack is picked up by the system's other turbocharged features. The GXplus graphics accelerator built onto the LX's motherboard boosts the system's text and graphics performance. The first evidence of this is in the LX's text mode. Previous Sun systems were practically unusable without the window system running because text was displayed and scrolled so slowly.

Once you fire up OpenWindows, the GXplus really earns its keep. Sun claims the chip enhances everything from window operations to 3-D wireframe and flat shading; I had no complaints with the system's performance in these areas. The LX comes with a 16-inch color monitor that shows the Sun-standard 1152- by 900-pixel resolution, but you can pick up a 21-inch monitor that handles the GXplus's top resolution.

Overall, the Sparcstation LX strikes me as a solid machine. True, it's not at the top of its class in CPU performance, but it certainly makes a capable platform for the majority of applications you'd want on your desktop. The standard accelerated graphics means that whether you run a program locally or reach across the network to some high-performance computer server, your display won't be a bottleneck. The LX's fast SCSI makes quick work of applications I/O and makes the LX valuable in the peer-to-peer world of TCP/IP and NFS (Network File System)—or even as a low-cost file server.

The Sparcstation LX is priced at $7995 with 16 MB of memory (expandable to 96 MB using 16-MB SIMMs, 24 MB otherwise), a 424-MB hard drive, a 3½-inch 1.44-MB floppy drive, and a 16-inch color monitor. A license for Sun's new Unix System V–based operating system, Solaris 2.1, is included with the system. A CD-ROM drive is not included, but if you plan to buy anything from Sun, you'd better make room for one in your budget. All Sun's software products are shipped exclusively on CD-ROM, and most SPARC applications vendors are following suit.

—Tom Yager

THE FACTS

Sparcstation LX
$7995

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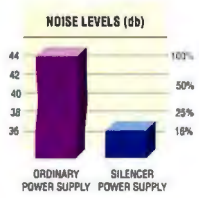

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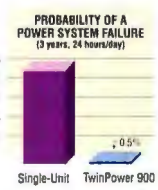

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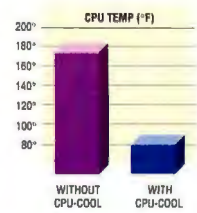

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NO OTHER PEN HAS THIS KIND OF

> The 3.3-pound machine is considerably lighter than many competitors' machines. Its black-and-white screen uses a back light, which will allow customers to use the computer in difficult lighting situations.

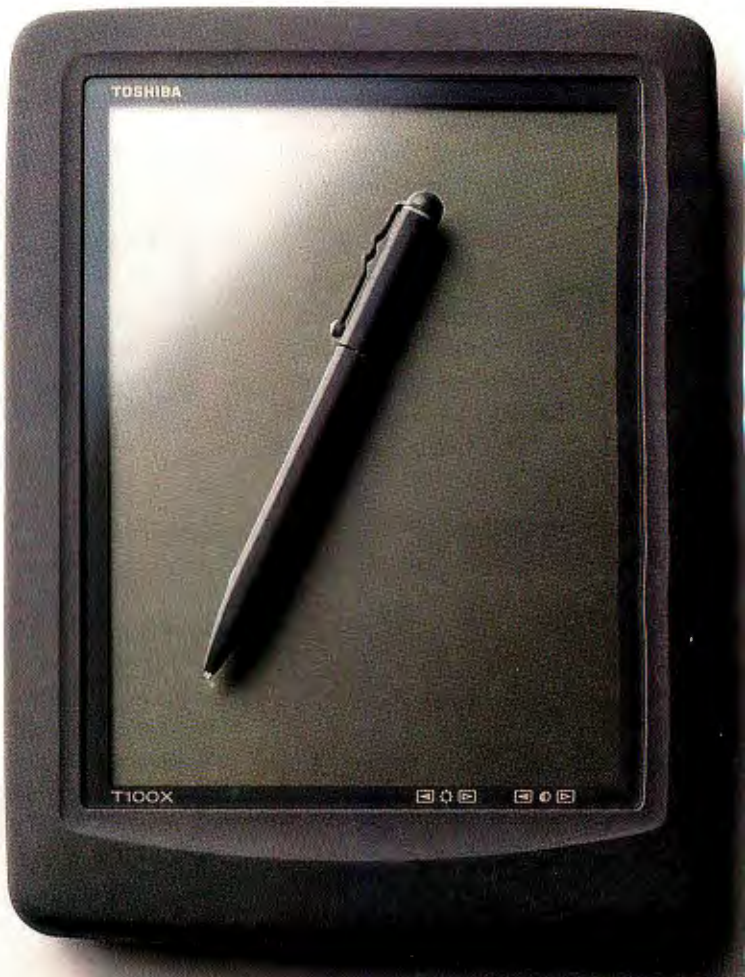
—Los Angeles Times, Nov. 2, 1992

> ...connections, they said.
>
> One problem we've had is seeing the screens [of other pen computers] in various lighting environments...[Toshiba is] using new backlit reflective technology; you can see it in any lighting.

—Reprinted from PC Week, Sept. 14, 1992

> ...porate users said.
>
> [Toshiba has] done an exceptional job in the industrial design of the system, and going beyond that, looking at specific vertical solutions.
>
> **See TOSHIBA page 103**

—Stella Kelly, InfoCorp Senior Analyst
Infoworld, Nov. 2, 1992



The Toshiba Dynapad makes most of its predecessors look clunky by comparison. Packed into this sleek, little 3.3-pound tablet is a 9.5" transreflective-sidelit display, 40MB hard drive and two PCMCIA 2.0 slots. Clearly a 3rd-generation pen computer, the innovative engineering in Dyn pen market has bee

—Portia Isaacson, Dream IT, Inc.

INTRODUCING THE TOSHIBA DYNA

INK.

[Toshiba has] a much better infrastructure for providing support than some other pen computer companies.

—Tim Bajarin, *President/Creative Strategies Research International Inc. Infoworld, Nov. 2, 1992*

[The Dynapad is] a nice system, has a good feel and [Personal Computer Memory Card International Association] cards, and at that low weight, it's much more the kind of thing people are going to need in the field than something like the ThinkPad.

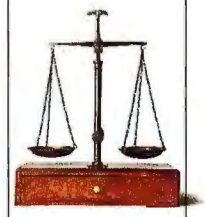
—Janet Cole, *Dataquest Analyst Computerworld, Nov. 2, 1992*

I've been saying that [a pen computer] needs to be small, rugged, and able to run 386 or better.

—Mel Hinton, *Senior Engineer/Public Service Electric and Gas Co. Infoworld, Nov. 2, 1992*

s what the ng for.

Amazingly, we've even been able to incorporate two PCMCIA slots for expandability.



We took pains to ensure our Dynapad is perfectly balanced. Thus making it easy to hold in either arm and in a variety of positions.

At 3.3 pounds, it's truly one of the few pen computers where employees won't get fatigued carrying it.

We gave our pen a transreflective display screen so it can be used in a variety of different locations and lighting conditions (underground, at night, in broad daylight).

Leave it to Toshiba engineers to create a pen computer that has left an indelible impression on the computer world.

Presenting the acclaimed Dynapad™ T100X.

It's almost as if, for the first time, someone actually considered how people would use a pen computer. And designed it from there.

For starters, it's phenomenally light, weighing in at 3.3 pounds. So you can carry it for extended periods in the field without your arm falling off.

But don't be fooled into thinking that it's a lightweight. Because it boasts a 25 MHz Am386™ low-voltage processor. Offers 4MB RAM—expandable to 20MB. And comes with a 40MB hard disk.

The screen is equally impressive. We purposely designed a large 9.5-inch transreflective screen so it's easy to view whether you're in a pitch-black tunnel or out in the field in the blinding sunlight.

We were no less painstaking with the ergonomics. At 10.6" x 8.3" x 1.5", the T100X is very easy to hold. The weight is well balanced. There are no sharp corners. And we've given you both a top-view silo, so you can see if you have your pen, and the option of tethering the pen.

And like every computer we make, our T100X offers a variety of Toshiba innovations. Like our MaxTime™ power management system, which offers such features as AutoResume and AutoSave. So you get the maximum out of every battery charge.

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Because as you can see from the quotes to the left, this is one pen that's already made its mark.

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PAD T100X

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EO's Personal Communicator Ushers In a New Era

Much as the Macintosh represented a conceptual leap forward for personal computers, so too does the **Personal Communicator 440** from start-up EO. EO has changed the definition of a mobile computer, uniting the functions of a handheld organizer with a cellular telephone, both running under an intuitive pen-based user interface (see "Communications Gets Personal," February BYTE).

In BYTE's first hands-on evaluation of the Personal Communicator 440, I looked at a machine that breaks with the past in more than just conception: It is the first system built on the AT&T Hobbit RISC chip, a 3.3-volt CPU that offers fast performance with low power consumption. It also runs Go Corp.'s PenPoint operating system, ported to the Hobbit. EO has guts to eschew compatibility with the Intel/Microsoft and Mac standards, but the company sees communicators as a separate market from portable PCs.

Available this spring, the 440 sports a unique design with no keyboard and a distinctive set of "ears" on either side of the screen. These ears contain I/O ports, a speaker, and a microphone. The 1-inch-thick unit measures 11 by 7 inches without the ears; with one 4-hour nickel-cadmium battery, it weighs 2⅛ pounds.

The system uses a 20-MHz Hobbit chip and ships with 8 MB of ROM (containing PenPoint and 10 bundled applications) and 4 MB of RAM. Using standard 88-pin JEDEC memory modules, you can expand the RAM to 8 or 12 MB through a small door on the front; the preproduction unit I evaluated was loaded with 12 MB. Another door on the front contains a PCMCIA slot (Type 2, Level 2), which you can use for nonvolatile removable storage or other peripherals. My evaluation model also

included the optional fax modem and $800 cellular-phone handset.

The 440 makes a nice pen-based personal organizer with a built-in PIM (personal information manager) and note taker, but the system doesn't come into its own without the phone. The 440 diverges from earlier pen-based systems in its tight integration of communications. The bundled GoFax, GoMail, and address book make it easy to send documents from within any program, and the built-in sound lets you attach voice annotations to documents.

Much of this capability comes from PenPoint, whose notebook metaphor and gesture interface make the 440 remarkably easy to use. The object orientation of PenPoint allows transparent sharing of data between applications.

The software I ran was a beta release, but it had few bugs and the performance was perky. The bundled programs and applets—which include MiniNote (for writing in digital ink), MiniText (for entering text via handwriting recognition), EO Calc (a paper-tape calculator), and Pensoft's Personal Perspective (a scaled-down version of the company's PIM)—were powerful yet amazingly easy to use.

In fact, the 440's intuitiveness demonstrates how far user-interface design has come. I had only a few minutes of training on the basic gestures, yet I barely cracked a manual to use the system. I wasn't able to try the tutorial because it wasn't ready, but I liked being able to get context-sensitive help simply by writing a question mark over the area in question.

The Personal Communicator 440 is well designed and feels solidly built, and I found the nonreflective LCD screen easy to read. Perhaps for the first time in pen computing, a company has got the details right. AT&T has even gotten into the act. As a major investor in EO, AT&T will sell the 440 and 880 under its own name.

EO is only the first player in an expected wave of mobile devices that integrate computing and telephony. Over the next year, you can expect competition for EO and AT&T, but all new arrivals will have to be judged against the high standard set by the Personal Communicator 440.

—Andy Reinhardt

THE FACTS

Personal Communicator 440
(price not available at press time)

EO, Inc.
800A East Middlefield Rd.
Mountain View, CA 94043
(415) 903-8100
fax: (415) 903-8190
Circle 1168 on Inquiry Card.

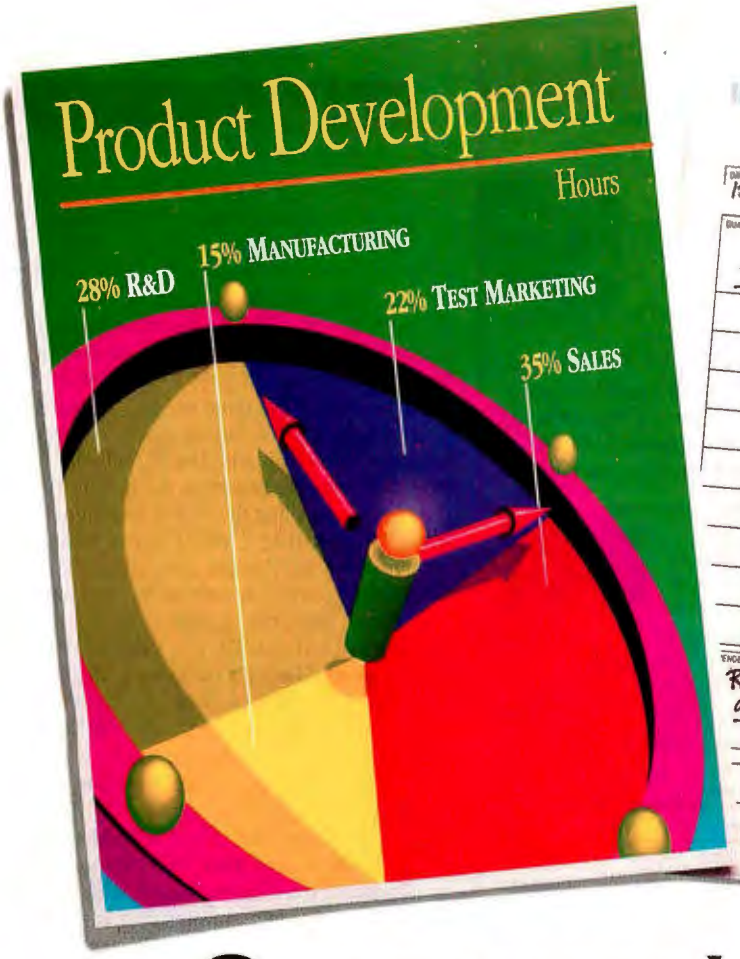
PowerExec EL Notebook: More for Less

If our review of the AST PowerExec notebook ("AST's PowerExec Goes Modular," January BYTE) caught your eye, but you found the price a bit steep, AST has something new for you—the **PowerExec EL**. The *EL* stands for "entry level," and with a list price of $1745, it may appeal to cost-conscious notebook users. That's what AST is hoping for, anyway. Philip Osako, AST portable systems marketing product manager, says that the EL is targeted at small businesses and people who need a notebook to supplement their office system.

AST is not alone in offering attractively priced notebook packages. Compaq and Toshiba, among others, offer modestly priced 386 systems. But for the purely price-sensitive shopper, the EL, at press time at least, leads the pack.

Like the higher-priced PowerExec, the preproduction EL I saw is a roadworthy notebook. It weighs in at almost 6 pounds and uses a nickel-cadmium battery pack. Its base price includes an Intel 25-MHz 386SL processor, a coprocessor socket, a 60-MB hard drive, a 1.44-MB floppy drive, 2 MB of RAM, and one each of serial, parallel, monitor interface, keyboard/keypad connector, Type 2 PCMCIA slot, and expansion bus ports. For a $2295 list price, you can get a 120-MB hard drive, 4 MB of RAM, Windows 3.1, and AST's SmartPoint trackball.

With the list price of the PowerExec at $2395, just what do you give up when you



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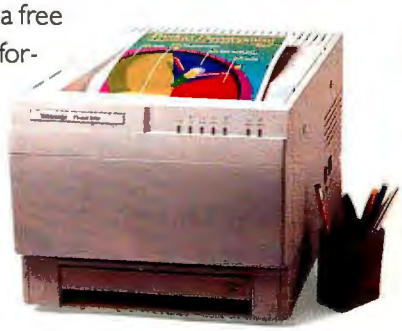

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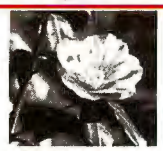

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NEWS

get an "equivalent" EL? First, unlike with the PowerExec, you cannot upgrade the processor and there is no 64-KB cache. Second, there is only one PCMCIA slot with the EL. The 9½-inch-diagonal, 640- by 480-pixel resolution VGA display is different, too. It provides 64 shades of gray, but it's not quite as bright and doesn't offer as much contrast as the one on the PowerExec. Finally, the AC adapter takes a bit longer to recharge the battery pack.

AST says that the nickel-cadmium power pack will last about 3 to 4 hours because the EL has the same heuristic power management system as the PowerExec. In fact, with the exception of the differences noted, this EL *is* a PowerExec. The long list of options includes a nickel-metal-hydride battery pack, RAM modules (the EL expands to 20 MB), PCMCIA-based modems, Ethernet and SCSI adapters, and passive- and active-matrix color displays.

The PowerExec EL is a good example of the more-for-less, Windows-capable hardware trend so prevalent with desktop systems. Other examples of this move toward affordability in notebooks are systems from Toshiba, Compaq, and a few others that are full-featured competing notebooks at similar user-attractive prices. For example, the Compaq Contura 3/25 Model 84/w+ comes with an 84-MB hard drive and 4 MB of RAM. It can be had for a street price of about $1900. Notebooks such as the PowerExec EL show that "entry level" doesn't have to mean starting at the bottom anymore. ■

—Gene Smarte

THE FACTS

PowerExec EL
with 2 MB of RAM, a 60-MB hard drive, and a monochrome display, $1745
with 4 MB of RAM, a 120-MB hard drive, Windows 3.1, and a SmartPoint trackball, $2295
display upgrades (done at factory): passive, $1169; active, price not available at press time

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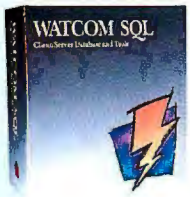

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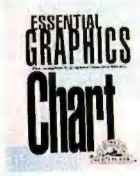

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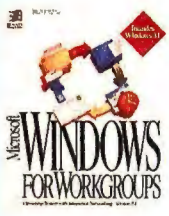

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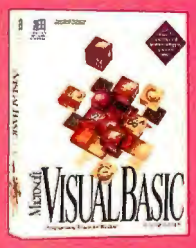

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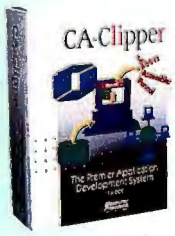

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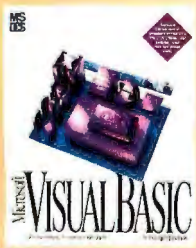

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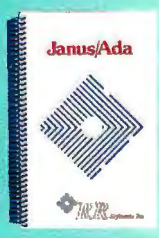

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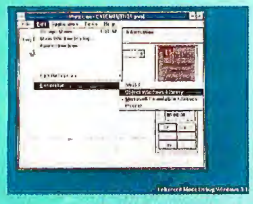

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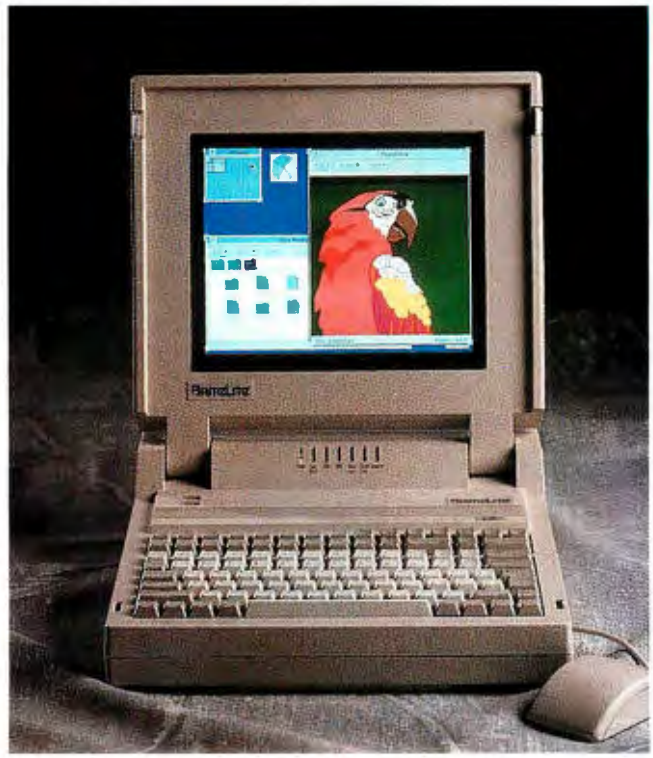
SPARC-Based Portability

A portable workstation based on the 50-MHz Sparcengine LX board from Sun Microsystems, the BriteLite LX is 100 percent compatible with Sun hardware and software, according to RDI Computer. The Solaris 32-bit distributed environment is preinstalled.

Features of the BriteLite LX include a Colorplus active-matrix TFT (thin-film transistor) LCD, which offers 256,000 colors and 64 levels of gray. Standard memory is 16 MB (expandable to 96 MB), and hard disk storage is 450 MB. Ports include a SCSI-2 connector, an audio/attachment unit interface port, and a bidirectional programmable parallel port.
Price: $15,995.
Contact: RDI Computer Corp., San Diego, CA, (619) 558-6985; fax (619) 558-7061.
Circle 1075 on Inquiry Card.



The BriteLite LX puts SPARC power into a portable workstation.

Modular Power Fits in Your Hand

A hand-held PC geared for rugged use, the modular DAT300 features a removable data-cassette hard disk. You can use the cassette—available with from 256 KB to 2 MB of SRAM (static RAM) or flash EPROM and as a 20- or 40-MB micro hard disk—like a floppy disk to exchange data and programs.

Other modules include a removable battery pack, a plug-in radio interface for wireless communications, and a plug-in impact miniprinter. The unit is C-programmable in Windows. You can access the removable data cassettes, as you would a normal hard drive, directly from your desktop PC's parallel port.
Price: $1350 (1,889,325 lira) and up.
Contact: 4P s.r.l., Padova, Italy, +39 498 700474; fax +39 498 700943.
Circle 1076 on Inquiry Card.

Configuration Choice

The expandable DT486 DLC-40 system is available in desktop, minitower, and medium-tower models. The system has a basic configuration of 4 MB of RAM (expandable to 32 MB on the motherboard), dual floppy drives, an 80-MB hard drive, a Super VGA color card and monitor, a keyboard, DOS 5.0, and a serial mouse.

Upgrades for the system include 120-, 170-, 200-, and 340-MB hard drives, a 2.5-MB IDE cache controller, and a Windows accelerator VGA card. You can also add Windows 3.1 and a 256-KB cache-memory module.
Price: Basic system, $1299.
Contact: Diamond Technologies, Inc., Irvine, CA, (800) 989-7253 or (714) 252-1008; fax (714) 252-1508.
Circle 1077 on Inquiry Card.

Desktop Power Packer

The small-footprint Image 466/66i runs at 66 MHz internally and 33 MHz externally. The system has 4 MB of SIMM RAM, expandable to 36 MB on the system board, and 128 KB of ROM.

NEC's implementation of local-bus video technology, ImageVideo, is a dedicated video bus that operates at 33 MHz. ImageSync automatically synchronizes the system to the optimum frequency of one of NEC's MultiSync FG series of monitors. The system has four 8-/16-bit ISA expansion slots and four drive bays.
Price: With a 120-MB IDE hard drive, $2501; with a 240-MB IDE hard drive, $2677.
Contact: NEC Technologies, Inc., Boxborough, MA, (508) 264-8000.
Circle 1078 on Inquiry Card.

Multiuser System

Alpha Microsystems' multiuser AM-1600LC runs on the company's proprietary operating system, AMOS, and is based on a 25-MHz MC68020 processor. Four memory slots accept 1- or 2-MB memory modules for expansion (up to 8 MB).

The system is available with the company's optional Virtual Personal Computer technology, which lets you execute DOS programs without a DOS workstation.
Price: With 2 MB of RAM, four serial ports, one parallel port, a 120-MB SCSI hard drive, and a tape streamer for backup, about $7624 (£4830).
Contact: Alpha Microsystems (GB), Ltd., Maidenhead, Berkshire, U.K., +44 628 822120.
Circle 1079 on Inquiry Card.

The SCSI-2 Advantage

The SiliconAdvantage SCSI-2 host adapter cards provide synchronous data transfer rates as high as 10 MBps and asynchronous rates as high as 7 MBps. Able to perform complex SCSI-2 command sequences without software intervention, the cards automatically handle all command-queue responses from the SCSI devices, in addition to sorting and reordering commands.

Other features of the cards include scatter/gather, enhanced virtual memory performance by off-loading disk I/O tasks from the operating system, connect/reconnect support, and slow cable mode for noisy environments. The cards support up to 49 SCSI devices via use of logical unit numbers. Optional driver support is available for operating systems such as DOS, NetWare, OS/2, Windows, SCO Unix, and Solaris. The software interface is ANSI CAM (common access method) compliant.

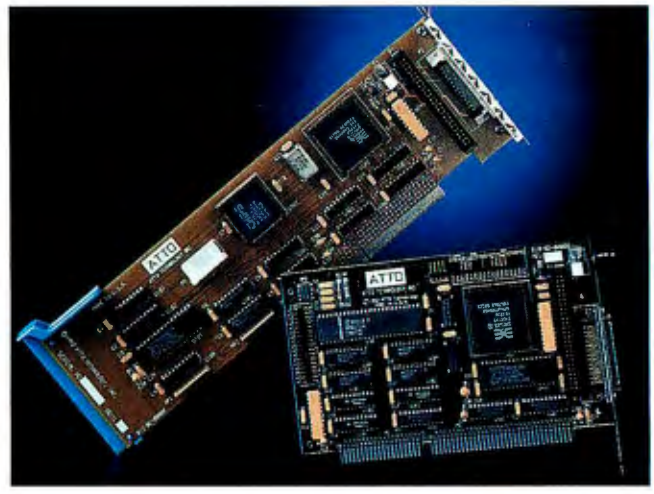
Price: ISA card, $495; Micro Channel card, $795.
Contact: Atto Technology, Inc., Amherst, NY, (716) 688-4259; fax (716) 636-3630.
Circle 1086 on Inquiry Card.

Up the Resolution

The LazerSetter PCL Plus provides 600- by 600-dpi resolution in PCL (Printer Control Language) mode on Hewlett-Packard LaserJet II, IID, III, and IIID printers. The optional LazerTrax PostScript-compatible interpreter can boost resolution to 1200 by 1200 dpi.

A controller card that plugs into the optional I/O slot of the printers, the LazerSetter PCL Plus is based on the 960SB/16 RISC processor. On-board RAM provides fast processing without your having to add additional memory to your printer.

Price: $795 and up.
Contact: Bolder Systems, Inc., Boulder, CO, (800) 967-0973 or (303) 938-9949; fax (303) 449-4005.
Circle 1087 on Inquiry Card.



SiliconAdvantage cards boost data throughput in SCSI-2 systems.

A New View for PowerBooks

Applied Engineering's BookView Imperial pseudostatic RAM and video adapter card plugs into the memory-expansion slot on the motherboard of the Apple PowerBook to let you connect the notebook to large color monitors. The card, which has 6 MB of RAM, provides 8-bit color and levels of gray. It supports standard and full-page VGA, Apple monitors, NTSC, and overhead projectors.

Price: $1116.
Contact: Applied Engineering, Dallas, TX, (800) 554-6227 or (214) 241-6060; fax (214) 484-1365.
Circle 1088 on Inquiry Card.

DSP Boards

Three data acquisition boards use a DSP (digital signal processor) chip to give you the power of signal processing on your desktop system.

A complete DSP subsystem based on AT&T's DSP3210 chip, the Qw3210-SA signal analysis board has 136 KB of high-speed SRAM (static RAM) (expandable to more than 2 MB) and a dual-port RAM interface between the PC and the DSP. The board provides 32 MFLOPS of processing power.

Each of the two channels in the board's analog I/O subsection has a 200,000-sample-per-second 16-bit A/D and D/A converter; a differential-input, programmable-gain instrumentation amplifier; and optional programmable-cutoff analog filters. Software included with the board is a C interface library and Resmon, a memory-resident DSP program that sets up the hardware, reports on errors, and provides task-switching services.

Price: $2995.
Contact: Quantawave, Marlborough, MA, (508) 481-9802; fax (508) 624-0942.
Circle 1089 on Inquiry Card.

The DSP_400 and DSP_MOD boards, based on AT&T's DSP32C chip, provide 25 MFLOPS of processing power and have up to 8 MB of zero-wait-state on-board memory. Each board has a 12.5-MHz, 32-bit parallel port for direct data transfers to the on-board memory without tying up the AT bus on your PC.

Each board comes with a complete software package that provides everything you need to begin developing DSP applications. The DSP_400 uses individual memory chips, and the DSP_MOD uses memory modules.

Price: $950 each.
Contact: Symmetric Research, Kirkland, WA, (206) 828-6560; fax (206) 827-3721.
Circle 1090 on Inquiry Card.

Sound Out Your PC

A sound board that automatically adapts to different voices and accents, the Cyber Audio Card lets you assemble your own vocabulary of voice commands. The card maintains an active 125-word vocabulary.

The board includes digital audio recording and playback on two mono channels or one stereo channel at 11 to 44 kHz and 8- or 16-bit resolution. Other features include compression/decompression as high as 4 to 1 at a 22-kHz sampling rate, a MIDI interface, compatibility with SoundBlaster and Adlib, and an on-board stereo mixer for three stereo channels or six mono channels.

Price: $395.
Contact: Alpha Systems Lab, Irvine, CA, (714) 252-0117; fax (714) 252-0887.
Circle 1091 on Inquiry Card.

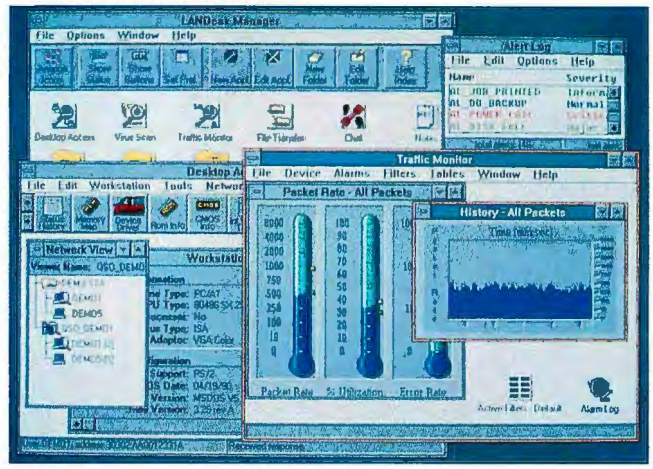
Manage Networked PCs

Intel's LANDesk software tools provide simplified management of desktop PCs and related services on Novell NetWare 3.x LANs. The tools include LANDesk Manager, LANDesk Protect, and LANDesk Inventory Manager.

LANDesk Manager provides a single control point for all local network management solutions. The program lets you remotely view a workstation or file-server screen; query for system information; control the keyboard and mouse; and make changes to the system, such as moving or copying files, rebooting, and executing programs. LANDesk Manager also displays statistics such as packet traffic, error rates, and utilization.

LANDesk Protect continuously scans all network traffic to detect and isolate more than 1900 PC viruses, including common strains, self-encrypting stealth viruses, and polymorphic (i.e., mutation engine) viruses. LANDesk Inventory Manager generates a summary of the hardware and software resources on the network to help you manage upgrades, maintenance, contracts, and licensing compliance.

Price: LANDesk Manager, $1295 per server; LANDesk Protect, $995 per server; LANDesk Inventory Manager, $595 per server.
Contact: Intel Corp., Santa Clara, CA, (408) 765-8080; fax (408) 727-2620.
Circle 1092 on Inquiry Card.



The LANDesk software tools provide LAN administration functions such as node management, network and application monitoring, virus protection, accounting, troubleshooting, capacity planning, remote control, and inventory.

14,400-bps Notebook Modem

The Smart One 1442 PCM-CIA modem from Best Data Products provides notebook PC users with high-speed, error-corrected data transfer and faxing capability. Using built-in CCITT V.42bis and MNP level 5 data compression and V.32bis error correction, the modem lets you achieve effective throughput rates of up to 57,600 bps even on dial-up lines, as well as full send-and-receive fax capability at 14,400 bps. In addition, the Smart One 1442 PCM-CIA operates in full background mode for uninterrupted operation.

The modem's fax features include broadcasting of multiple files to various fax machines; the ability to view, rotate, and print incoming faxes; and time-scheduled transmission. You can keep data and fax numbers in a flexible phone book, and handy logs record fax and even error reports.

Price: $599.
Contact: Best Data Products, Inc., Chatsworth, CA, (818) 773-9600; fax (818) 773-9619.
Circle 1093 on Inquiry Card.

Antivirus Utility for NetWare

Fifth Generation Systems' Untouchable Network NLM (NetWare loadable module) detects and recovers viruses on NetWare 386–based file servers. The package employs integrity checking on the file server to detect viruses without relying on frequent virus signature updates.

A patented virus-removal technique guarantees safe restoration of recoverable infected files, including those hit by new, unknown viruses. The package also features on-line scanning of compressed and archived files and seamless integration of Untouchable Network NLM for detection and recovery of viruses at individual nodes.

Price: $995 per server.
Contact: Fifth Generation Systems, Inc., Baton Rouge, LA, (504) 291-7221; fax (504) 295-3268.
Circle 1094 on Inquiry Card.

Workgroup Connectivity

With Powerfusion for Workgroups, Unix resides as a peer partner in the Windows for Workgroups environment. The package supports Unix, DOS, Windows, and Windows for Workgroups users and provides three connectivity solutions: plug-and-play operation; support for Windows for Workgroups orphans, such as IBM XTs and ATs and Unix; and low memory overhead. Powerfusion for Workgroups allows network users to share resources such as disks, printers, keyboards, screens, and CD-ROMs.

Price: DOS and Windows users, about $100 per workstation; supported Unix clients, $100 each.
Contact: Performance Technology, San Antonio, TX, (210) 349-2000; fax (210) 366-0123.
Circle 1095 on Inquiry Card.

PCMCIA Wireless Adapter

A wireless LAN adapter, the RangeLAN/PCMCIA fits the specifications of the Type II PCMCIA credit-card-type slot. Using spread-spectrum technology over a range of up to 800 feet, the adapter can operate at a data rate of 242 Kbps. The RangeLAN/PCMCIA adapter provides a wireless networking solution to portable users, allowing them to easily set up an "instant" LAN without cables or to extend an existing LAN to hard-to-reach places. The RangeLAN/PCMCIA comes with drivers for popular LAN operating systems.

Price: $595.
Contact: Proxim, Inc., Mountain View, CA, (415) 960-1630; fax (415) 964-5181.
Circle 1096 on Inquiry Card.

Why some software sells more than others.

Success. All software developers strived for it. Now, Don Gall was on top of the world. Software protection made all the difference. Especially in Europe and Asia. Sales were four times better than before. He is the founding father of Sentinel — the guru of software success.

Struggling Software Sales

One day, trekking through the coffee fields of Java, Don ran into his old college buddy Simon Seagull. "Don, my sales are well below expectations." Simon explained his plight. "My software should sell like yours, Don!" Yet despite critical acclaim Simon's company SimonSays Software, teetered on a financial tightrope. "What's your secret, Don?"

They spent hours analyzing potential problems. They looked at everything.

The Key to the Problem

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." 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.

The hours flew by, story after story, Simon learned Don Gall's secret. To succeed is to protect. To protect is to secure with Sentinel.

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Backed by the world leader in software protection, Rainbow Technologies, the Sentinel Family of hardware keys is the most diverse and comprehensive selection available. For DOS,OS/2, Mac, Windows, LAN, UNIX and others. They're simple to install, and are the most reliable and compatible available.

Rainbow offers just-in-time delivery and the largest technical support and engineering staff in the software protection industry.

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The *Evolution* Of P

1984
The Luggables
- 35 pounds
- 8088-class CPU
- 512K RAM
- Floppy drive
- No hard drive
- AC only
- Monochrome display

$4000 to $5000

1987
The Laptops
- 15 to 20 pounds
- 8088 or 80286-class CPU
- 640K RAM
- Floppy drive
- 10 or 20MB hard drive
- AC only or 1.5-hour battery
- CGA display

$3500 to $4500

You've been wrestling with over-sized, over-priced portables for nine long years! Now Gateway 2000 emerges from the struggle and introduces the missing link in the evolution of portable computing. It's the HandBook, a perfect combination of portability and functionality for all on-the-go Homo Sapiens.

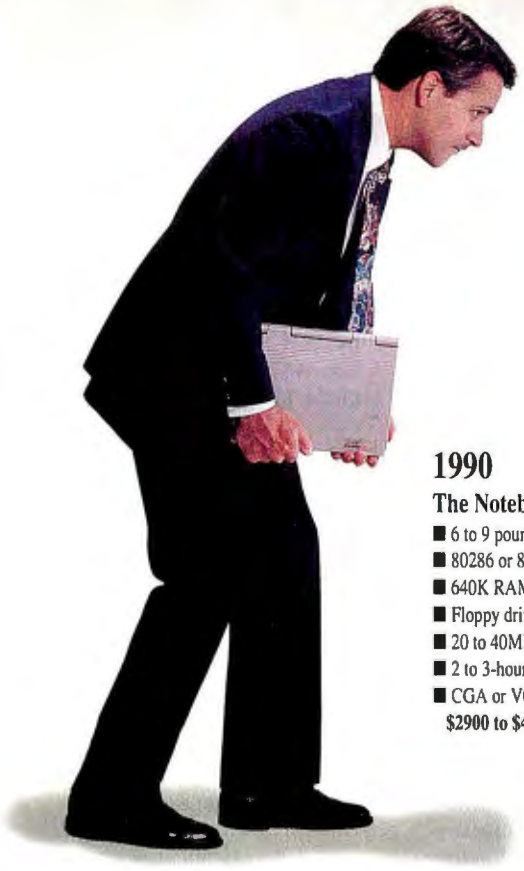
The HandBook is a real PC in a revolutionary new form. Not a notebook, not a palmtop, the HandBook is the first fully-functional PC in a truly portable, handbook-sized form. You can easily take the HandBook anywhere because this new species measures a mere 6 x 10 inches and weighs only 2.75 pounds, yet it runs over 5,000 of your favorite DOS applications. You aren't stuck buying and learning proprietary "card" programs when you have a HandBook.

The exclusive auto-resume feature enables the HandBook to work like no other PC you've ever seen. Auto-resume allows you to suspend the computer's operation for moments or weeks at a time, and then return to your work right where you left off – in seconds, and at the touch of a button.

With the HandBook you get 40MB of hard disk capacity to easily and quickly store all your DOS programs and files.

The quiet and comfortable touch-type keyboard allows you

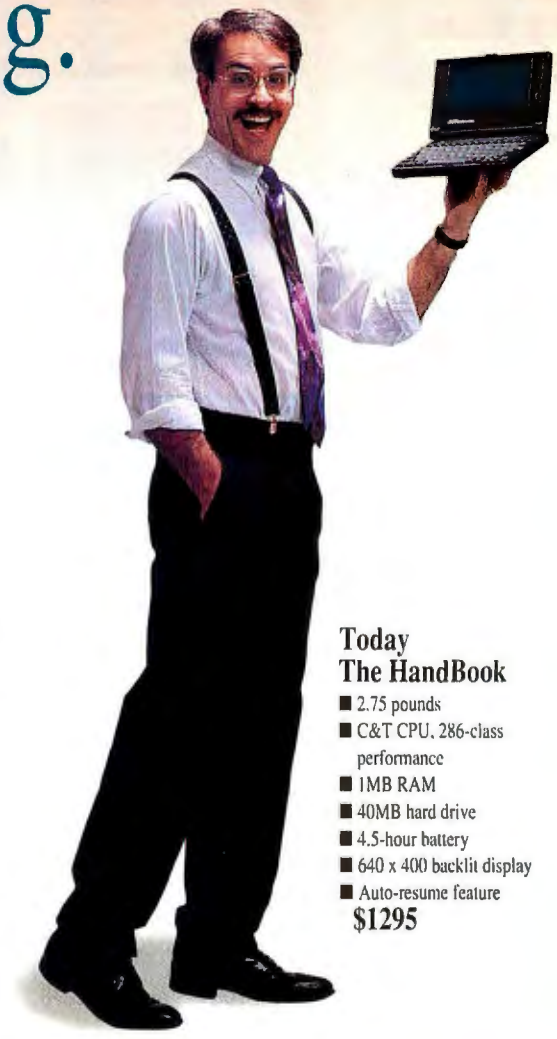
ortable Computing.



1990
The Notebooks

- 6 to 9 pounds
- 80286 or 80386SX-class CPU
- 640K RAM
- Floppy drive
- 20 to 40MB hard drive
- 2 to 3-hour battery
- CGA or VGA display

$2900 to $4500



Today
The HandBook

- 2.75 pounds
- C&T CPU, 286-class performance
- 1MB RAM
- 40MB hard drive
- 4.5-hour battery
- 640 x 400 backlit display
- Auto-resume feature

$1295

to type as fast as you can on your desktop keyboard.

The HandBook's 640 x 400 resolution backlit screen can be read in virtually any light and is large enough to display full 80-column lines of text, so you can use the HandBook whenever and wherever you need to. And the HandBook gives you all this with up to 4.5 hours of life on a replaceable battery.

The Gateway HandBook was designed specifically for you – today's on-the-move computer user. Once you get your hands on a HandBook, you'll struggle no more with a Neanderthal artifact

The HandBook was named one of the year's "Best of What's New" products by Popular Science *magazine and received* BYTE *magazine's Award of Distinction.*

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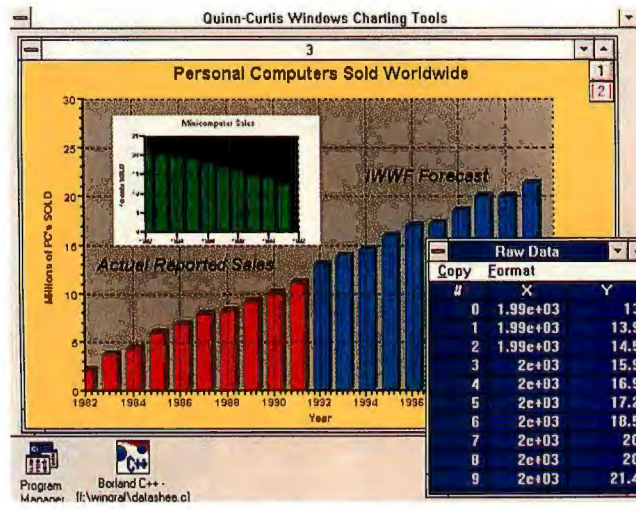
605-232-2000 • Fax 605-232-2023

Windows Charting Tools

A collection of graphics and user-interface routines, the Windows Charting Tools package helps C and C++ programmers add scientific, engineering, and business graphics to their applications. The package for Windows 3.1 provides dialog boxes, high-resolution printer support, and Clipboard and metafile support. It also includes a library of C functions that you can use to create charts such as line, area, scatter, and group plots; horizontal and vertical bar graphs; floating bars; error bars; open-high-low-close plots; and pie charts.

Windows Charting Tools let you combine multiple chart types, data objects, and *x* and *y* axes in the same graph. You can set axes for linear and logarithmic scaling, and you can label axes with numeric values in decimal and scientific notation or with user-defined strings. You can output your charts to Windows-supported printers.
Price: $400; with source code to the Quinn-Curtis Charting DLL, $800.
Contact: Quinn-Curtis, Needham, MA, (617) 449-6155; fax (617) 449-6109.
Circle 1102 on Inquiry Card.



With Windows Charting Tools, you can edit chart characteristics such as graph position, plot attributes, axis parameters, fonts, and data.

Wireless Network Applications

You can add wireless capabilities to your new or existing applications with Motorola's WaveGuide 2.0 connectivity tool. WaveGuide provides a consistent API that lets you build applications for multiple wireless data networks in a DOS or Windows environment with minimal code changes. The WaveGuide API provides a high-level C-language interface that is independent of the underlying wireless network protocols and modem interfaces. WaveGuide 2.0–based applications allow two-way data communications over ARDIS and RAM, two popular wireless networks that transmit data using radio-packet technology.
Price: $1495.
Contact: Motorola, Inc., RadioWare Solutions, Schaumburg, IL, (708) 576-1600; fax (708) 576-0710.
Circle 1106 on Inquiry Card.

Mac Error Detection

StratosWare offers versions of its error detection and prevention product, MemCheck for the Macintosh, for the Think C and MPW C environments. Requiring no source code changes, MemCheck detects errors such as memory overwrites and underwrites, memory leaks (i.e., failure to free allocated memory), and heap corruption. MemCheck operates transparently, appearing only to report errors with exact file and line-number information in the source code.

MemCheck for the Macintosh can detect failures in memory allocation routines, failures in many resource operations, and invalid operations on unlocked and purged handles, as well as the inappropriate use of nonresource handles in Resource Manager traps. You can switch MemCheck on or off at run time, link it out via the Production library, or compile it out with no source code changes.
Price: $179.95 each; bundled, $239.95.
Contact: StratosWare Corp., Ann Arbor, MI, (313) 996-2944; fax (313) 747-8519.
Circle 1103 on Inquiry Card.

Windows Program Generation

Microlex says that its GUIDE (GUI Development Environment) tool provides all the Windows program-generation facilities you need in one system. The package lets you create compiled programs in a fourth-generation-language environment, and it can handle future Windows developments such as Windows for Pen Computing, Windows NT, and multimedia.

Offering Novell NetWare compatibility, GUIDE provides features such as entity-relationship database design tools, a menu designer, and form- and screen-design tools. Other features include interactive multidimensional graphics, comprehensive font and color-palette controls, bit-map sequencing, an integrated table and spreadsheet tool, and report generation and project management facilities.
Price: Four-user version, about $18,300 (£12,000).
Contact: Microlex plc., Derby, U.K., +44 332 290630; fax +44 332 290624.
Circle 1104 on Inquiry Card.

Unix Productivity Tool

With iXBuild 2.1, you can build, prototype, and test OSF/Motif-based GUIs for software applications, independent of the underlying application. Interfaces that you build with iXBuild are run-time independent and can run on most Unix platforms. The package includes a graphical WYSIWYG editor; a set of Motif widgets; automatic interfacing to existing databases; graphical editing functions, which include a Search Editor for positioning, sizing, cutting, pasting, copying, inserting, and deleting elements of your work; context-sensitive on-line help; and dynamic testing facilities. You can also extend iXBuild 2.1 with user-defined widgets and resources (i.e., attributes).
Price: First user license, $4500.
Contact: UniPress Software, Inc., Edison, NJ, (908) 287-2100; fax (908) 287-4929.
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Since when is Raima first in Corporate Database Development?

Since April 7, 1992

Raima Database Manager was the database of choice in the First Annual Windows World Open. The competition featured innovative custom applications built with Windows development tools. Three of the seven winners, and two of the finalists, used *Raima Database Manager* to solve their critical application needs.

For professional developers like yourself, Raima products offer:

- *High performance:* unmatched application speed.
- *Portability:* runs on DOS, Windows, OS/2, UNIX, VMS, QNX.
- *Royalty-free distribution:* increase your profits.
- *Source-code availability:* total programming flexibility.
- *Affordable pricing:* starting at just $395.
- *Language support:* ANSI C, C++, and Visual Basic.

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"No other products matched Raima for the price."
James Lisiak, developer, Chevron

"Raima provided us with speed, flexibility, and royalty-free distribution which allowed us to meet and exceed our customers' needs."
Dave Cooper, developer, Atlantic Research Corp.
(subcontractor, Naval Electronic Systems Engineering Activity)

"Database Manager gave us the edge we needed to handle large amounts of data quickly and efficiently within Microsoft Windows."
Kelly Patrick, developer, PHH Fantus

If you're looking for an award-winning application development tool, give us a call. And discover the Raima advantage.

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Raima Object Manager *The object storage class library*

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Fax 617-449-2674 or mail to: The Interface Group, 300 First Avenue, Needham, MA 02194-2722 USA.

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Scientific Graphics

Grapher for Windows creates presentation-quality *x,y* graphs for scientific and engineering applications. Graph types include line, symbol, bar, and open-high-low-close graphs. You can add vertical and horizontal error bars, with complete control over their line style, width, and color.

The program provides automatic or user-defined axis scaling, tick marks, labels, and legends. You can choose from linear, logarithmic, exponential, power, spline, polynomial, and running-average curve fits, with an unlimited number of curves and fits on each graph. The program supports multiple axes per graph, and you can plot several graphs on a page.

Built-in drawing tools let you place rectangles, circles, areas, or points anywhere on your graphs. You can use the text editor to create text blocks with superscripts, subscripts, and mathematical formulas and symbols.
Price: $199.
Contact: Golden Software, Inc., Golden, CO, (303) 279-1021; fax (303) 279-0909.
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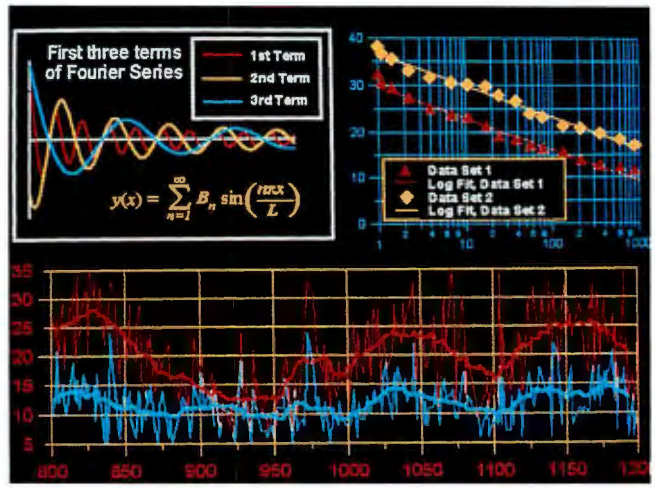
Project Visualization

The CVpvs project visualization system for Sun, DEC, and Hewlett-Packard systems provides a virtual walk-through of large-scale 3-D CAD projects so you can see the structure and appearance of the project from every angle. Spatial orientation features let you move forward, backward, left, right, up, and down, as well as turn and orbit. They also control zooming, the point from which a view originates, and the direction of your gaze.



A 2-D scientific graphics package, Grapher for Windows supports up to 32,000 data points per curve.

In mechanical and manufacturing environments, the CVpvs software lets you inspect complete assemblies, subassemblies, and individual components by manipulating, communicating, and animating a large-scale design. The CVpvs program lets you interrupt display graphics, verify or query nongraphics model attributes from an external database, add notes and labels, and measure dimensions and distances.
Price: $8925.
Contact: Computervision Corp., Bedford, MA, (617) 275-1800; fax (617) 275-2670.
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Exploratory Data Analysis

The latest version of Data Desk, exploratory data-analysis and graphics software for the Mac, works with an unlimited number of cases and adds multivariate general linear models, nonlinear smoothers, automated slider tools, summaries by categories, derived variables, and random subset sampling. Fast calculations let you quickly pursue several analysis paths, and Data Desk 4.0 links all plots and analyses, so you can move from one to another to visualize your data in different ways.

A Linear Model Outline organizes the decisions you need to make to perform linear model analysis, as well as the results that linear models compute. An Overview table gives a summary of results from the analysis, so it is easy to identify factors with strong effects, factors with little or no effect, and factors whose effects are not consistent.
Price: $595.
Contact: Data Description, Inc., Ithaca, NY, (607) 257-1000; fax (607) 257-4146.
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Mathematical Modeling

Ideal for technical specialists, VisSim is an interactive program for mathematical modeling, animated simulation, real-time control, and analysis of dynamic systems. The Windows software offers more than 70 linear and nonlinear mathematical function blocks and six integration methods.

To visually solve complex differential equations, you select the blocks representing the standard procedures required, wire them together, and run the simulation. VisSim's function blocks cover most arithmetic, Boolean, transcendental, linear and nonlinear, integration, and signal-processing operations.
Price: About $755 (£495).
Contact: Adept Scientific Micro Systems, Ltd., Letchworth, Hertfordshire, U.K., +44 462 480055; fax +44 462 480213.
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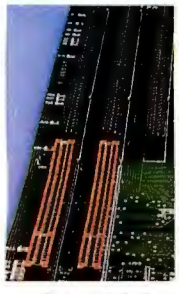

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—PC Magazine, January 26, 1993

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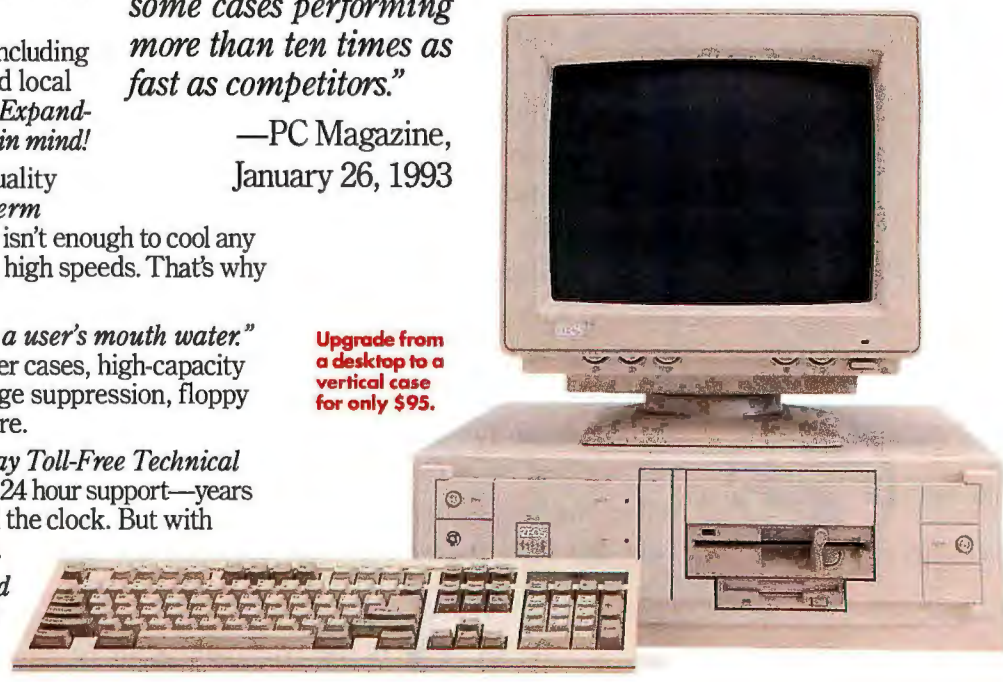

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Automate MIDI Devices

Mark of the Unicorn offers Unisyn, a universal MIDI system editor/librarian program for the Mac. Unisyn gives you control over popular MIDI synthesizers and devices with integrated editing, librarian, and database functions to create, store, and manage synthesizer sounds and other MIDI device configurations. A graphical interface lets you edit patches and sounds, and Unisyn's on-screen sliders, buttons, and other controls facilitate programming even complex synthesizers.

The Performance function memorizes and restores the settings for an entire MIDI studio. You can build libraries of complete studio configurations as well as separate libraries for individual synthesizers and MIDI devices. Database functions let you tag sounds with multiple user-definable keywords. In addition, Unisyn lets you freely move patches among libraries, banks, and devices' internal memory.

Price: $395.

Contact: Mark of the Unicorn, Inc., Cambridge, MA, (617) 576-2760; fax (617) 576-3609.

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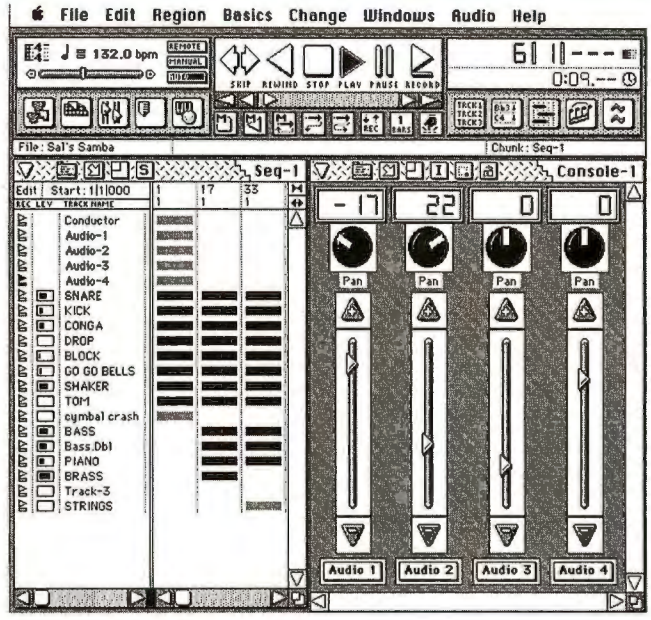

Unisyn lets you create performance snapshots of an entire MIDI studio, including individual patches and entire banks, and control patches, setups, and sounds for all the devices in your MIDI system.

Retrieve SQL Data

IQ Access can selectively retrieve and automatically reformat data for use with popular desktop applications such as Lotus 1-2-3, Microsoft Excel, WordPerfect, dBase, and Microsoft Word for Windows, as well as Btrieve, ASCII, and DIF files. The program for Unix SQL RDBMSes (relational database management systems) from Oracle, Sybase, Ingres, and Informix allows authorized users in an organization to access corporate data and, with just a few keystrokes, move it into their spreadsheets, word processing documents, or mail/merge files. There are no import routines or cleanup procedures because IQ Access handles the data conversions automatically.

The program is designed to take advantage of vendor-specific optimizing features, such as Sybase's dynamic SQL capability and Ingres's histogram-based query optimizer. In addition to the four Unix SQL RDBMSes, IQ Access will also be available for about 60 other databases and ISAM (indexed sequential-access method) file systems on DOS, VAX/VMS, and Data General's AOS/VS, as well as 35 Unix hardware platforms. In client/server environments, the DOS version of IQ Access will work with software such as Oracle's SQL Net, Informix's I-Net, and IngresNet.

Price: $1000 to $42,500, depending on the CPU; client/server, $2500 for a five-pack; network versions, $1500 and up.

Contact: IQ Software Corp., Norcross, GA, (404) 446-8880; fax (404) 448-4088.

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SPREAD THE WORD

Please address new products information to New Products Editors, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. The press release should contain the product description, price, ship date, and an address and telephone number where readers can get more information.

Documents to Data

Now ListReader dbR lets you convert printed or typed documents to data records without keyboard entry. The Windows product scans document pages, recognizes the text, and automatically places it into the correct data field. You can convert many kinds of documents, including lists, forms, or tables, and output data for DBMSes or spreadsheets at speeds of up to 2500 records per hour.

You can combine the lists, forms, or tables in any combination for complex documents. The program also supports one-to-many relationships for documents that have a master/detail arrangement. You create templates that tell ListReader dbR what to expect from individual pages—from simple mailing lists to complex insurance forms.

Price: $895.

Contact: Solea Systems, Inc., Laguna Hills, CA, (714) 768-7736; fax (714) 380-8950.

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Voice Annotation for WordPerfect

With VoiceOver, you can annotate your WordPerfect 5.1 documents with comments in your own voice. The program lets you record sounds, which it then stores within the WordPerfect document. Voice annotations appear on the screen as standard WordPerfect comments, and they include each annotation's author, date, time of creation, and length. In addition, you can cut and paste voice annotations like standard WordPerfect comments.

VoiceOver also works over a network. You can access VoiceOver documents on a file server or send them as an attachment via E-mail.

Price: Single-user license, $129.

Contact: Rational Data Systems, San Rafael, CA, (415) 499-3354; fax (415) 499-8115.

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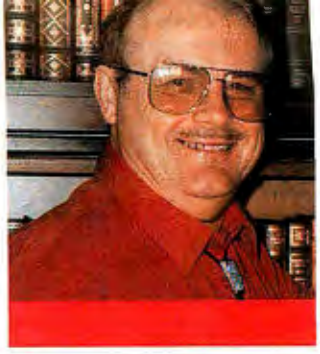


JERRY POURNELLE

CD-ROM SECRETS

It has been a frantically interesting month. I finished *Prince of Sparta, A Novel of Falkenberg's Legion* by Jerry Pournelle and S. M. Stirling (Baen Books) two days ago. By the time you read this, you will be able to buy copies, which is astounding. Jim Baen takes my Word for Windows text, translates it to XyWrite for prepping, pours it into Ventura Publisher, and prints out page proofs. Copyediting corrections are fed in. The book is then formatted, printed out with the LaserJet in Baskerville typeface, and photoreduced to proper page size. Go buy a copy and compare: I'll bet you the print quality will be as good as that of any other paperback original you'll find.

I did *Prince of Sparta* in Microsoft Word for Windows (W4W for short). Steve Stirling did a partial WordPerfect draft from my outline. Then I used Mastersoft's Word for Word to convert his files to Q&A Write format, which is what I use for creative writing; but this time the first job was extensive editing of Stirling's draft, which is a great deal more easily done in W4W. I piped everything through Word for Word again, converting files to the Word for DOS format because Word for Word doesn't recognize W4W files. However, W4W reads Word for DOS files.

Amazingly, everything went fine. On a 486/33, W4W is very fast. While I get frustrated by some of its arcane command structure, I am getting used to it; and it is very powerful. I can keep an entire book in W4W, use bookmarks at each chapter beginning or critical scene, and jump around like nobody's business. If I want to be sure of a character's name or make global changes, search and replace is very fast over the whole novel.

Jim Baen is a publisher, but he is also one of the best editors I've worked with. I'd PKZip each newly finished chapter and use ZMODEM protocol to squirt it up to BIX at 9600 bps with the USRobotics Courier HST V.32bis modem in about a minute; the whole book took under 5 minutes. Jim would download the latest version from BIX and upload editorial comments. I could then make editorial changes, such as expanding a scene to explain an apparent plot glitch or character inconsistency, and use search and replace to find the exact spot where a change was needed. Sometimes we'd work by telephone.

Toward the end, I was creating a new chapter de novo every two days. I would not have finished the book on time without W4W; and it wouldn't be typeset and in bookstores in such a short time without desktop publishing capability. Little computers are wonderful.

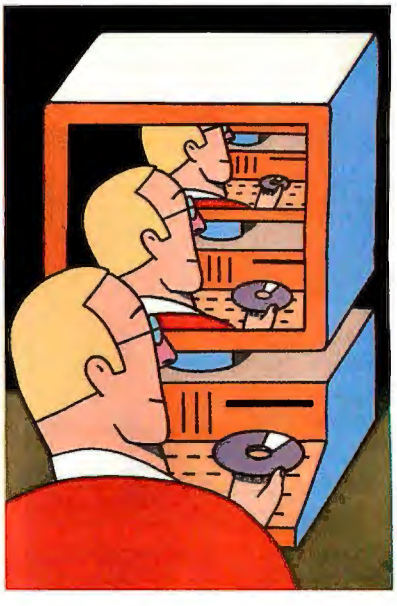
CD-ROM and Workgroups

I say I've been using Windows, but actually I am using Windows for Workgroups, henceforth W4WG; and it's not quite the same thing.

The primary difference is network capability. With W4WG going, I can periodically squirt off a copy of my work to another machine, which makes for great peace of mind. Writers tend to be paranoid about losing text, and I don't really feel that work is saved until there are multiple copies on multiple machines; W4WG makes that easy to do.

Integrating a CD-ROM drive with Windows for Workgroups can be tricky

On the other hand, I nearly went nuts getting the CD-ROM drive to work with W4WG. The good news is that I did succeed.



My CD-ROM system ran fine with Windows 3.1. I was using a Corel driver card and software and a Toshiba CD-ROM drive, and all was well; but when I shifted to Windows so I could use W4WG, any attempt to access the CD-ROM while I was in Windows would lock up the machine. The infuriating part was that everything worked just *fine* as long as I was in DOS; but as soon as I got into Windows, accessing the CD-ROM drive locked things tight. I could recover from the lockup by doing Ctrl-Alt-Del, which would get me back to the program manager; but it certainly wasn't acceptable not to have a CD-ROM drive.

Then things got worse. I did something, I forget what, to CONFIG.SYS, and this time I was able to get the CD-ROM going in Windows. Joy. I told File Manager to share that CD-ROM drive on the network and went over to another machine on the network and accessed the CD-ROM. More joy. And then came disaster.

I got an error message I had never seen: SERIOUS DISK ERROR. Other mysterious things happened, and not even hardware reset worked. I had to turn the machine stone-cold off, and when I rebooted, CHKDSK

said my disk was a mess. That was cured by my rebooting with a floppy disk—if you haven't made a bare-bones (no CONFIG.SYS and no AUTOEXEC.BAT) boot floppy disk for your system, go do it right now! Then I let Norton Disk Doctor do its thing. I could boot up again, but now, any attempt to access Windows failed. Up would come the Windows logo, then my wallpaper (I like EGYPT.BMP), and then that hourglass would sit there, and nothing would happen. Not good.

I went back into CONFIG.SYS and REMARKed out every reference to the CD-ROM drive, rebooted, and tried again. This time Windows told me that my swap file was corrupt, and did I want to erase it? Certainly, said I. It then said that it was impossible to share the E (CD-ROM) drive, and did I want that shared on start-up in future? No, no, a thousand times no; and that fixed things so that I could access Windows again. Of course, it still didn't get me a CD-ROM drive.

By this time I was talking to half a dozen Microsoft people who were eager to help, but nothing helped. The problem was passed upstairs to a senior Microsoft technical-support official, who said, "Ah, we know about that one. He's got to use the new MSCDEX.EXE that comes with W4WG, and it must have the /S switch in the command line that loads it." Alas, while those are both important points, I was already using the new MSCDEX and W4WG Setup had automatically added the /S option in the AUTOEXEC.BAT file.

Be Relentless

I got a lot of advice from other technical-support people, but nothing worked. Time for my never-failing remedy, the relentless application of logic.

Start with when it last worked. That was under Windows 3.1, and I had carefully made no needless changes while converting to W4WG; so what changes had I made? One of them was obvious: I had added the Intel EtherExpress board that comes with the W4WG Starter Kit. Before I did that, I'd used Dariana's WinSleuth Gold to determine what port addresses and interrupts were in use and print out a report. This is one of those programs that you don't use often, but when you need it, you need it bad.

This time, though, I hadn't needed WinSleuth: the Intel Softset program looks for any conflicts and then reprograms the network board to an unused address and interrupts. It's very painless. I used WinSleuth Gold to have another look, and yep, it could see the EtherExpress board just fine, and it was indeed located in what WinSleuth reported previously as unused locations.

It didn't *look* as if there were hardware conflicts; still, the first step in relentless logic is to remove all possible conflicts, so I removed the Sound Blaster card. No joy. CD-ROM worked in DOS, but it locked up in W4WG.

Next step: edit CONFIG.SYS to REMARK out all references to network driver software and run Softset again. When you do that, Softset sees the existing card and assumes that its current interrupt and address are in use; so it finds new ones and reprograms the board accordingly. Thus, if I were accidentally stepping on something already in use because Softset hadn't seen that the first time, this procedure, by relocating the board, should have cured that problem.

No joy. Symptoms unchanged. In fact, it made no difference whether I let CONFIG.SYS load the network drivers or I left them REMARKed out; meaning that it might not be the network that was causing the problem.

OK, it wasn't hardware. Microsoft technical support told me thousands of people were successfully using W4WG with CD-ROM, so it wasn't inherently impossible. Simplify the software, then. First thing, remove QEMM-386, the Quarterdeck memory manager, and stop loading things into high memory, and see if that works; and in fact it did.

The only trouble was that I now had about 400 KB of memory. While that's no problem for people who use Windows applications exclusively, about half the programs I run are DOS applications, and most of them want a lot more than 400 KB. Games, in particular, want upwards of 570 KB to run properly. Some Windows users get around that by rebooting the machine using a separate bare-bones CONFIG.SYS that doesn't load any TSR programs; then they play games and run other memory-hog programs in DOS. That doesn't appeal to me. I want big DOS sessions under Windows.

I reloaded QEMM and did more experimenting. I won't report all the tedious work that was involved. The result was that I found the secrets, some as a result of tips from Stafford Williamson of Quarterdeck's technical-support group and some by working on my own. Here, published for the first time anywhere, is the secret for CD-ROM under W4WG while retaining 600 KB of memory for DOS sessions under Windows.

The Secret

The secret of success is that in W4WG you can load MSCDEX into extended

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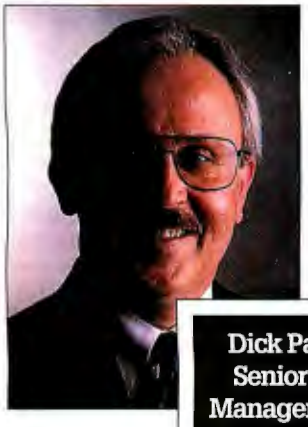

Dick Patefield, Senior Project Manager for Store Systems Support, JCPenney

Recently JCPenney Co., Inc. changed its operations from the old POS systems to the new PC-based technology, relying on PC platforms for point-of-sale and in-store support. And they back each one up with help from MINUTEMAN.

"There was a violent surge in one of our stores," says Patefield. *"If we didn't have the MINUTEMAN unit, it probably would have seriously damaged all of our point-of-sale equipment.*

"The key was the switch-over time from AC to battery," says Patefield. *"It really has the best continuity of the UPS systems we evaluated. Also, the price was very favorable. When you're installing them in as many locations as we are, the pricing was very attractive."*

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memory (the /E switch works fine), but you must *not* let QEMM load MSCDEX high. I know that won't be clear to everyone, so I'll give details.

Set up your system without QEMM and get it running properly with the CD-ROM in DOS. Now install W4WG (if it wasn't already installed). When all that's done, you'll have about 400 KB of memory. Now, working in DOS, install QEMM and let its Optimize program do its thing. You may or may not need to do some memory exclusions. In particular, nearly every system will need the line `X=B000-B7FF` to exclude some video areas from being used by QEMM; and if you have a caching disk drive controller or other SCSI device, you will need to exclude its address area as well.

The next time you boot up your system, you'll probably get some loud complaints. Microsoft Windows Setup generally automatically installs its SMARTDRV caching program with double buffering. Double-buffered SMARTDRV comes in two parts: a chunk that's loaded by CONFIG.SYS and another that's loaded by AUTOEXEC.BAT. It's the CONFIG.SYS part that's causing the problem; that can't be loaded high, but Optimize will have a try at it.

The remedy is simple. Look into CONFIG.SYS (I use the little editor that's built into Norton Commander for this sort of thing). If you see a line that begins DEVICE=:\QEMM\LOADHI.SYS, gives a couple of parameters, and continues :\WINDOWS\SMARTDRV.EXE /DOUBLE_BUFFER, delete parts of that line so that it reads DEVICE=:\WINDOWS\SMARTDRV.EXE /DOUBLE_BUFFER. You can also move the altered line up above the line that loads QEMM in case you need to use Optimize again.

Once that's done, it doesn't hurt to put the statement `DBF=2` into the QEMM command line.

Now reboot. You shouldn't receive any more complaints, and your CD-ROM ought to work fine in DOS. Test to be sure it does. However, if you enter W4WG and try to access the CD-ROM drive, it will probably lock up (although it would work just fine in Windows 3.1). Even if it does not, don't take chances: exit Windows and edit AUTOEXEC.BAT.

In there you will find a command that begins :\QEMM\LOADHI and then has some parameters, continues with :\WINDOWS\MSCDEX.EXE /S /V, and then has some more stuff. There may or may not be a /E in there after the MSCDEX. If there isn't one, put one in there. Now edit the line so that all traces of the QEMM attempt to load high are gone; that is, delete until the line begins :\WINDOWS\MSCDEX.EXE and *do not* change anything after the MSCDEX except to add /E if needed. The /S is also needed, but I presume that W4WG's Setup will have added it automatically.

Now reboot. Your system should have something over 590 KB of DOS memory, and your CD-ROM will work fine in both DOS and Windows.

I don't want to take up the whole column with this, so I'll explain what's going on another time.

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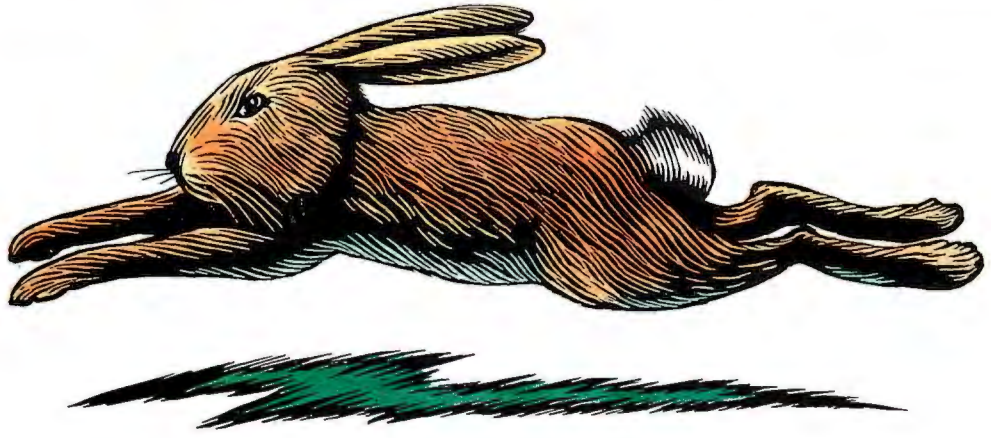

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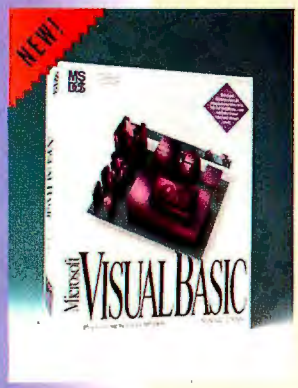

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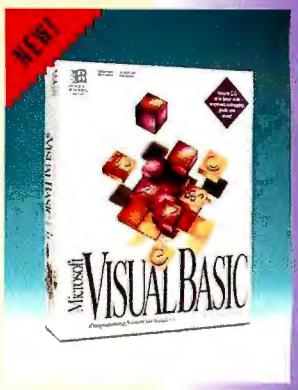

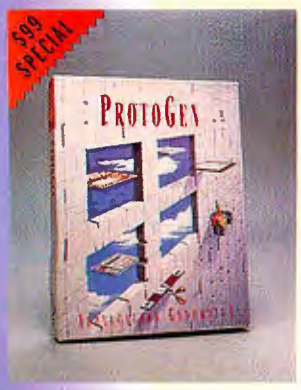

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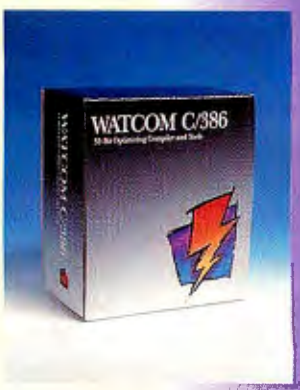

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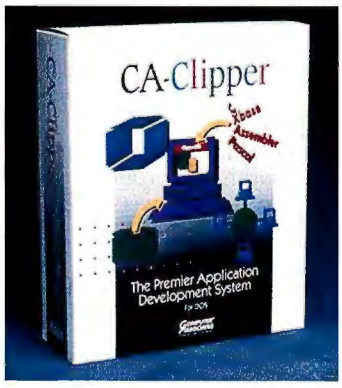

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System Requirements

CA-Clipper 5.2 requires an IBM PS/2, AT, XT, PC or its compatibles; 640K RAM; expanded memory requires LIM 3.2 or higher; hard disk required for development; DOS 3.1 or higher; works with all networks compatible with DOS 3.1 or higher.

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and the Pioneer six-pack CD-ROM Minichanger.

I had the Pioneer R/W optical drive and the Minichanger in a SCSI daisy chain run by a Corel interface card. They were running fine, but as a test, I had, with some help from Alan Rogers ("arog" on BIX), converted that machine to run under DR DOS 6.0. It worked fine, and I so reported, but networking a DR DOS machine into my Windows system was not something I would get done in time for this column.

Converting back turned out to be harder than you'd think, because DOS 5.0 generally comes as an upgrade, not as a standalone product. Somewhere I suppose there are floppy disks of the original DOS that came with that 486 machine, but this is Chaos Manor: the chances of finding them are about nil.

The solution was to boot with a barebones DOS floppy disk that contains SYS.COM, use Norton Commander to find and delete all the hidden system files in the machine's root directory, and use the SYS command to install the system from the boot floppy disk. I could then reboot from the hard disk and use the Microsoft DOS 5.0 and Windows upgrade package to complete the job.

Next I restored the original CONFIG .SYS and AUTOEXEC.BAT so that the machine would access the optical and CD-ROM drives. That turned out to be a tedious job, but eventually I had it done. Moreover, when I brought up Windows and opened File Manager, there were drives D (the optical drive), and E, F, G, H, I, and J, the six CD-ROM drives on the Minichanger. Joy.

At this point I confess a lapse of faith. Remembering the problems I had with converting my main system with one CD-ROM to W4WG, I was so certain I was going to have real problems connecting up to a system with six CD-ROMs and an optical drive that I sent off E-mail to the long-suffering Microsoft PR people, who must pretend to like putting up with my problems, and a copy to the Corel people in case I needed help from them. Incidentally, when it comes to systems integration, Corel has always proved to be a tower of strength. They really understand SCSI and other peripheral devices and how to make them work with both DOS and Windows.

Having confessed my breach of faith, I proceeded to open the machine and insert the EtherExpress board, run Softset and let it choose where to set the board, connect the Ethernet cable and terminator to the new machine, and install W4WG.

When that was done, I tested nothing: I entered Windows, opened File Manager—and Lo!, there were all my assets, and they all worked. When I told the system to share them (CD-ROM as read only, the Pioneer drive as read and write), it made no complaint. I then put Microsoft Bookshelf into one of the six CD-ROM slots, went over to my main machine, and proceeded to install Bookshelf across the network.

It works wonderfully. It's a little slower than what I can get with the Bookshelf disk in the CD-ROM drive connected to my local machine, but that's probably because my local drive is faster than the Pioneer Minichanger. That, incidentally, is about to change. At Comdex, Pioneer showed me a new Minichanger that is so blazingly fast I can hardly believe it, and I'm supposed to have one about the time you read this.

And in any event, what I've got now is Good Enough, and the installation was harder to describe than to do. Once you

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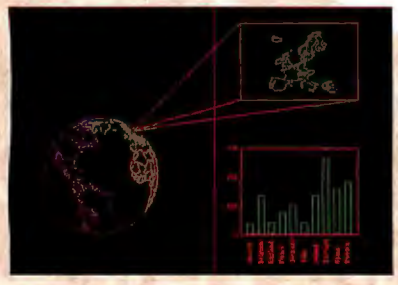

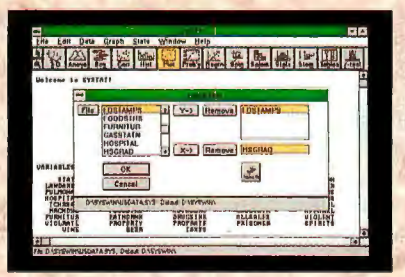

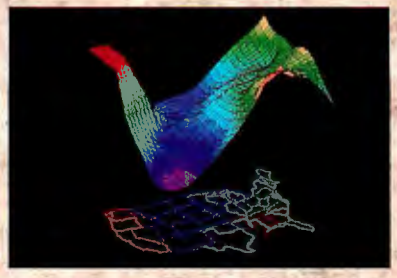

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have a W4WG network running, adding assets to it really is simple.

LAN Alternatives

The major advantage to W4WG is the simplicity. You can set it up quickly, and you don't have to know about network management to use it. However, there are limits to what W4WG can do (it won't, for example, run on a 286 machine). Much more on that another time, but you should be aware of alternatives.

One is to install Novell NetWare and run W4WG on top of it. That works, but there are disadvantages, two chief ones being that it costs money and you end up with limited DOS memory.

The other is not to use W4WG, but use regular Windows and Artisoft's LANtastic for Windows. This has the added advantage that you can network in Artisoft's Central Station, which is a network hub without computer to which you can plug in your laptop and other assets for sharing across the network. Another advantage is that you can hook up LANtastic for Windows and LANtastic for the Mac, thus networking the different platforms with something a lot faster and better than AppleTalk.

I have all the Artisoft products, and I'll set up a LANtastic network as soon as I have a bit of time. This is indeed the Year of the LAN, and I expect to be doing a lot of LAN development and testing before it's over.

Creative's Multimedia Upgrade

There hasn't been a lot of multimedia software, but I think the flood is about to begin. Even if it doesn't, there are a lot of good reasons to upgrade your system by adding a CD-ROM drive, and if you don't have a sound board, you're missing something.

Of course, you can add a CD-ROM drive to any SCSI device string, and there are a dozen sound boards ranging from expensive professional systems down to swap-meet el cheapos. For that matter, Microsoft has come out with a new Windows sound system. Interestingly, the Microsoft sound board has no joystick port: the product manager claims they consulted businesspeople, and the overwhelming opinion was that business purchasers would pay extra *not* to have a game port. One wonders what that means; after all, you can control most games quite nicely with a mouse....

Anyway, one simple way to add multimedia capability is to get the Creative Labs Sound Blaster Multimedia Upgrade Kit. This comes with a CD-ROM controller on a Sound Blaster Pro card, an internally mountable CD-ROM drive, a MIDI adapter kit, all kinds of software, lots of books about the software, and a bunch of CD-ROMs, including Windows 3.1, various sound stuff, Microsoft Works, Microsoft Bookshelf, and Sherlock Holmes, Consulting Detective. The software includes Macromedia's Authorware Star and Action programs, and they're actually pretty nifty for ginning up multimedia presentations.

The instructions for installing the Sound Blaster Pro are complete. The board comes set to IRQ (interrupt request) 7 but tells how to set it for other possibilities, including IRQ 10. Since nothing I know uses IRQ 10, and I might one day want to add something that uses 7, I set mine for 10. Otherwise, I used the default settings. Sound Blaster Pro comes with an installation disk that includes a test of whether or not the board is working: just click, and music plays. No problem, so now it was time to install the CD-ROM drive.

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drive, and you have seen what I had gone through trying to get it working with W4WG, so I was a bit reluctant to change; but what the heck, it was only a couple of hours' work, and whatever happened I'd get a story for the column, so I yanked the Corel card and started in.

There were two problems: the instructions said, "refer to the instructions that came with your CD-ROM drive." There was another instruction sheet, but that got lost in the chaos. That turned out not to be a problem: it was obvious where the cables connected, and they were keyed so that it was impossible to attach them the wrong way.

The second problem was a bit more serious: there is no mounting hardware with the drive. It does come with four tiny drive screws, but there are no mounting rails, nothing to hold the drive in the drive bay. Some computers come with lots of extra mounting hardware, but my Cheetah 486 didn't. I managed a kludge that permitted me to install the drive, but be warned, if you get Creative's kit, be sure you have hardware to mount an internal drive in your computer.

That done, I ran the CD-ROM installation program. That is, there is a program on the Creative disk entitled INST-CD.EXE, and having lost the instructions, that seemed reasonable. It wouldn't work: the program would get ready to install and then suddenly announce that it couldn't find SBPCD.SYS.

This was odd, because I could see that SBPCD.SYS was on the installation floppy disk. Then I noticed a file called CD-DRIVE.BAT, and sure enough, running that did the job. The CD-ROM was installed. I rebooted, and I could read the E drive.

Since Sherlock Holmes comes with the Creative package, that looked like a good test program. So I put in the CD-ROM, logged on to E, got a directory to be sure I was properly reading the CD-ROM, and ran SHERLOCK.EXE. The system trundled for a moment and announced that I had no compatible sound card. Then it dumped me back to DOS.

It seemed very odd that a program bundled with the Sound Blaster Pro card, and running on a CD-ROM drive controlled by a Sound Blaster Pro card, would be unable to find the Sound Blaster Pro card. I tested the card, both with its test program and with a couple of games, and there was no problem.

Eventually, I wondered if changing the IRQ from 7 to 10 had anything to do with it. I pulled the sound card and moved the jumper; and Lo!, up came the Sherlock Holmes game. Apparently the game designers hard-coded the interrupt, and no one at Creative has tested Sherlock Holmes with a Sound Blaster Pro set to IRQ 10. Sigh. I left mine set to the default IRQ 7 so that I could fool around with the Sherlock Holmes game, but that's not really very satisfactory.

Once I was sure that the CD-ROM was working in DOS, I let Optimize do its thing and then fixed AUTOEXEC.BAT so that MSCDEX.EXE wasn't trying to load high. That gives me 598-KB DOS sessions under Windows; and the CD-ROM works just fine, both on my local machine and shared across the network. It's a good, fast drive, and having the CD-ROM drive mounted internally certainly saves space. My friend Rich Heimlich, who does game testing, says that the Creative CD-ROM and Sound Blaster Pro boards are compatible with more games than any other. If you want to upgrade to multimedia, this

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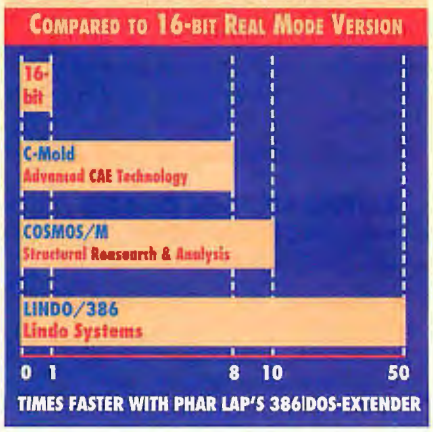

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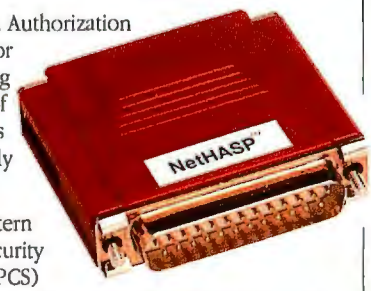

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* CT Magazine, May 1990.

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is a good way to do it, and in fact the installation is simpler than describing it has been. Recommended.

Power Japanese

Want to learn Japanese? If so, Power Japanese looks like what you need. You get some flash cards, a dictionary, 15 high-density 3½-inch disks of software, a sound-converter gizmo to attach to your printer port, a set of headphones, some exercise books, a dictionary, and instructions.

I don't know Japanese, and at my age I'm not likely to learn a new language, so I'm not sure I'm competent to judge the effectiveness of this as a learning tool. It seems to do what you'd want it to: it shows you how to draw and pronounce different Japanese characters, both katakana and hiragana, and has workbooks for you to practice doing those in. It will also show you on-screen other styles of Japanese, including classical Ming. Meanwhile, the program talks to you. Hear the words, and see it written out on-screen.

The speech adapter is small enough that you would have no trouble with it on a portable machine, so instead of watching bad movies and drinking too much on your next flight, you could be learning Japanese.

Learning a new language is more dependent on the determination of the learner than on the instruction method, and I'm not at all sure that if you're serious about learning Japanese, you won't be better off getting human instruction; but if you'd like to try it on your own first, this looks to be the way to do it. With those caveats, recommended.

From Space to Dinosaurs

If you ever wonder what's the point of multimedia, get one of the Knowledge Adventure products. I've previously written about two of their products, Knowledge Adventure and Science Adventure; now they've got two more, Space Adventure and Dinosaur Adventure. Both are wonderful, combining beautiful VGA images, interactive maps and diagrams, and all kinds of other great stuff. I cannot imagine any kid in the world who wouldn't want to spend hours playing with either of these programs. Heck, *I* like playing with them.

You don't need a CD-ROM drive for Dinosaur Adventure. You do need a good bit of hard disk space and a sound board; Sound Blaster Pro works just fine. If you don't have a sound board, these programs alone justify installing one. Knowledge Adventure is a candidate for a big Orchid and a Chaos Manor User's Choice Award, and it gets a highly recommended rating. This is what educational software ought to be.

The Compleat AI

This is a CD-ROM in ISO-9660 format (meaning it is readable by PCs, Macs, Amigas, Unix systems, and almost anything not coal-powered) with hundreds of AI and related programs. Want source code to a dozen versions of the Eliza program, including one you can put on your BBS to talk to people? An artificial-life program? Expert-system builder? Neural-network builder, including source code to simulate a cockroach brain? It's all here, and more, in FORTRAN, Prolog, Lisp, and even BASIC. There are also hundreds of articles about AI and related matters and tutorials on using many of these programs. It's the most complete collection you're likely to see anywhere.

Steve and Susan Chance Rainwater, the principals of Network Cybernetics, told me about this as they drove me to the airport from a speaking engagement a few months ago; this project is more a labor of love than a profit-making venture. Incidentally, they're OS/2 and Ami Pro enthusiasts. Clearly, you can get CD-ROM systems running with OS/2, even if I've had rather bad luck with it myself.

If you have any interest whatever in AI, natural-language processing, neural networks, artificial life, or related subjects, get this disk, for either yourself or your users group; you won't be disappointed. Recommended.

Trantor MiniSCSI

This product, the T348 MiniSCSI Plus, is darned near perfect. It consists of a cable to connect your parallel port to any SCSI device, such as an external hard drive or CD-ROM; software to install the MiniSCSI; and a needless cable to connect your printer to the MiniSCSI cable so that you can print when you're not using the parallel port for SCSI. That last cable is needless because any old Centronics printer cable will do; but the FCC requires them to furnish this expensive thing because using your own cable might result in some radio noise detectable 10 feet away. Your tax dollars at work.

Installing the software is absurdly simple. In my case, I wanted to put the T348 MiniSCSI Plus on my Gateway HandBook: this wonderful little portable computer can access its floppy drive only through the parallel port, so it would be an interesting test. It turned out to be simple: I created a directory called FOO, copied the floppy disk to it, replaced the floppy drive with the MiniSCSI cable connected to a Toshiba CD-ROM, logged on to FOO, and did an automatic installation. That's it. In seconds, I was reading the CD-ROM drive.

What else can I say? It works, it's easy to install, and it's another candidate for a Chaos Manor User's Choice Award. Recommended.

continued

Winding Down

The computer books of the month are both from Sams. First, Gary Entsminger's *Secrets of the Visual Basic Masters* (Sams, 1992). An understanding of Visual Basic is important to everyone working much with Windows, since more and more Windows programs have hooks to interface with it. This is an excellent intermediate-level book on writing, debugging, and error-proofing Visual Basic programs.

Second, John M. Goodman's *Memory Management for All of Us* (Sams, 1992). The most complete exposition on memory management I know of is in Quarterdeck's manuals for QEMM and Desqview. Unfortunately, they are great for reference but unreadable for learning. Goodman's book takes a difficult subject and gives you considerable understanding of it. Reading this wouldn't have solved my CD-ROM/W4WG problem, but knowing what's in this book gave me the approach I needed. If you wonder what the differences between 386Max and QEMM are, this is the book that will tell you, and a lot more.

The book of the month is Graham Fuller's *The Democracy Trap: Perils of the Post Cold War World* (Dutton, 1991). Fuller is a former diplomat and intelligence officer, and he has some of the clearest views on the subject of foreign policy I've seen since Stefan Possony stopped publishing.

The game of the month is Quantum Quality Productions' Battles of Destiny. Think of this as Empire died and, if not gone to heaven, then at least to heaven's anteroom. The perfect improvement to Empire hasn't come, but this one is a valiant attempt. There are some frustrations in the user interface, but if you want to handle enormous armies and try your hand at air/land battle planning, this will do it. A second game of the month is MicroProse's Ancient Art of War in the Skies, and while you can play arcade sequences if you like, the fun part to me is strategic.

As is usually the case, I've still got a huge pile of really good stuff here and no space to write about it. I love it. Next month, a pile of new CD-ROMs and more about networking, including alternatives to W4WG. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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Battles of Destiny.....$59.95
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The Compleat AI CD-ROM.....$129
Network Cybernetics Corp.
4201 Wingren Rd., Suite 202
Irving, TX 75062
(214) 650-2002
fax: (214) 650-1929
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Dinosaur Adventure.....$49.95
Space Adventure.....$99.95
Knowledge Adventure, Inc.
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QEMM-386 6.0.....$99.95
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Sound Blaster Multimedia Upgrade Kit.....$799.95
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FEATURE

Smarter E-Mail Is Coming

Rebuilding your business processes to take advantage of E-mail promises dramatic productivity gains

ANDY REINHARDT

Forget for a moment the confusing alphabet soup of E-mail acronyms. Look past the gateways, switches, and battles over APIs. Despite these hurdles, it's only a matter of time before E-mail is as pervasive and easy to use as the telephone system.

Once E-mail nirvana arrives, huge changes will occur. Organizations that have already implemented enterprise-wide E-mail find that it flattens the management hierarchy, improves project tracking, and speeds time to market for new products or services. E-mail's greatest benefit, however, goes beyond ad hoc exchange of information among employees: Messaging is the foundation for a new wave of workgroup software packages that will alter traditional work structures and could dramatically boost productivity.

"Mail should not be thought of as an application," says Eugene Lee, director of product planning for mail software vendor Beyond (Cambridge, MA). "It's an enabling technology."

After years of wrangling with complicated client/server technologies such as RPCs (remote-procedure calls), users and developers are discovering that E-mail's store-and-forward, network-independent messaging provides many of the same capabilities for a fraction of the cost and complexity (see the text box "The Messaging Model" on page 92). In effect, messaging enables a type of do-it-yourself distributed computing.

"People tend to think of mail today as messages sent between people, but that's just the tip of the iceberg," says John Rymer, an analyst with the Patricia Seybold Office Computing Group (Boston, MA) and the editor of the *Distributed Computing Monitor*. E-mail can also be used for communication between people and processes—known as virtual users—or even among processes themselves; in fact, Rymer says, most communication between applications will ultimately use E-mail transports.

Applications that will build on the messaging infrastructure include multimedia mail, fax routing, database access, scheduling, and document sharing (see figure 1). Perhaps the most promising avenue is the broad category known as work flow, which encompasses information routing, task automation, and decision support. "We've spent millions of dollars on E-mail," says Larry Quinlan, the manager of LAN services for the accounting firm of Deloitte & Touche (Atlanta, GA), "and you can't get a good return on investment from simple messaging alone." Organizations

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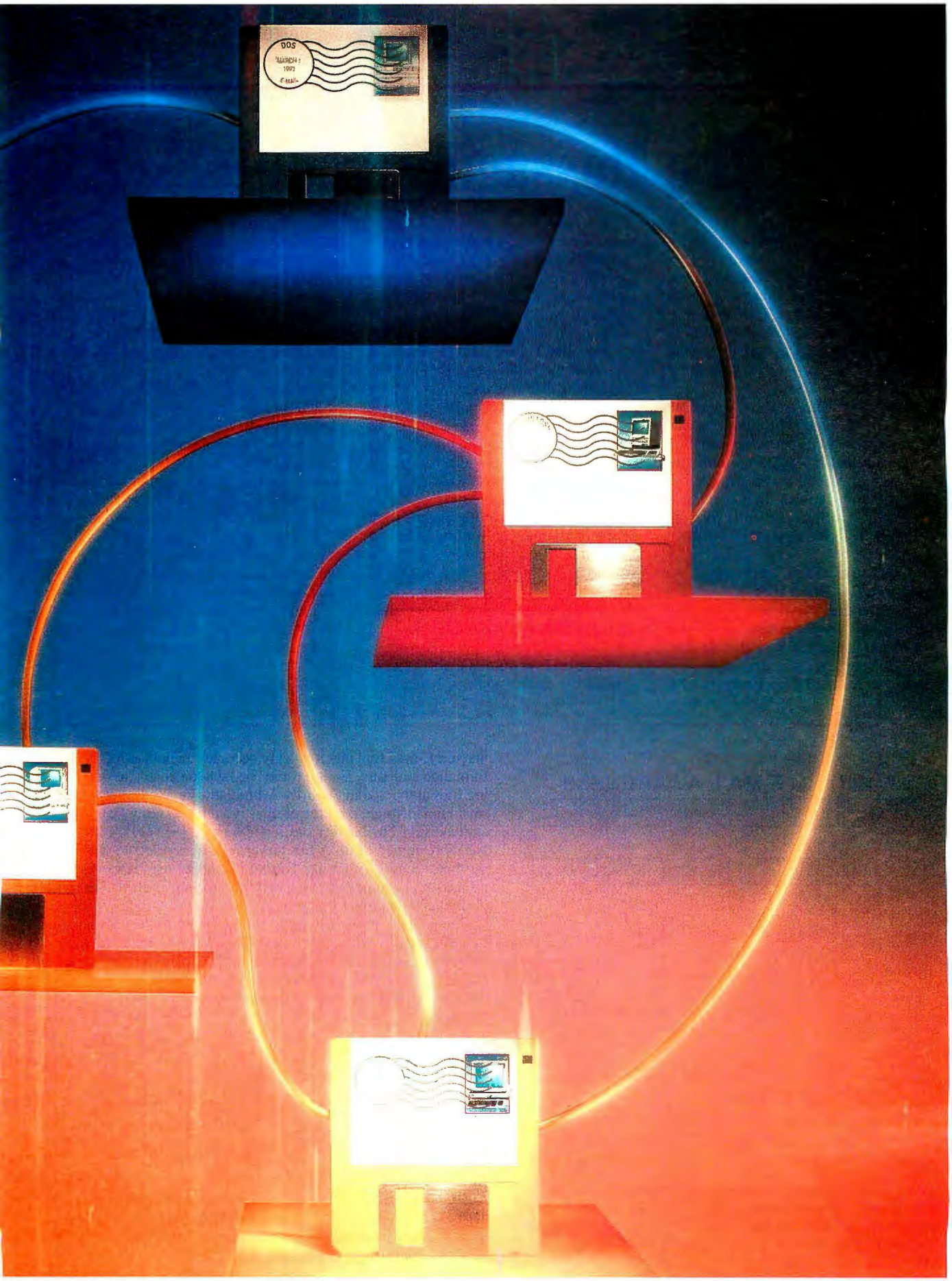
DOS

The Messaging Model

To facilitate interoperability among mail systems, vendors are decoupling the front-end mail client from the back-end mail server. Most packages today, such as cc:Mail and Microsoft Mail, supply both the client and the server in a single box and use their own proprietary message transports.

The exception is Novell (Provo, UT), whose MHS (Message Handling Service) has used a client/server architecture with a published API for more than five years; Novell doesn't market an MHS client, leaving that instead to companies such as Da Vinci Systems (Raleigh, NC) and Beyond (Cambridge, MA).

The implications of this shift are twofold. First, breaking the link between the client and server lets customers use whatever combination of front and back ends they choose. Second, an open interface exposes the mail transport for use by applications other than a mail client; conventional productivity packages (e.g., word processors and spreadsheets) will be able to talk directly to mail engines, and new types of workgroup applications can be built on top of the mail transport.

It is often cheaper and easier to implement distributed computing with messaging than with client/server RPCs (remote procedure calls). RPCs use live "virtual circuits" between applications and require expensive equipment such as high-speed routers and private T1 phone links for WAN (wide-area network) implementations.

"The bottom line is that people want a simple method of routing information," says Rick Bohdanowicz, director of messaging for Novell. E-mail is cost-effective, he says, because users can implement their own schemes using off-the-shelf software, modems, and dial-up phone lines.

Store-and-forward is a good mechanism for remote access, because it places less of a burden on field systems and communications links than does a client/server architecture. LAN managers concerned about network bandwidth also appreciate that using messaging instead of virtual circuits frees up network resources for time-critical tasks.

Messaging can also play a role in connecting desktop systems to host programs, says John Rymer of the Patricia Seybold Office Computing Group (Boston, MA). For example, you could communicate with a system not designed for the distributed world by giving it an interface for messaging.

Compared to the hard-wired design of client/server programs, Rymer says, the more generic messaging interface can prove to be a vital asset in today's climate of corporate mergers and divestitures. "If you're a corporate developer, you need to build applications that can interface easily to new systems," he adds.

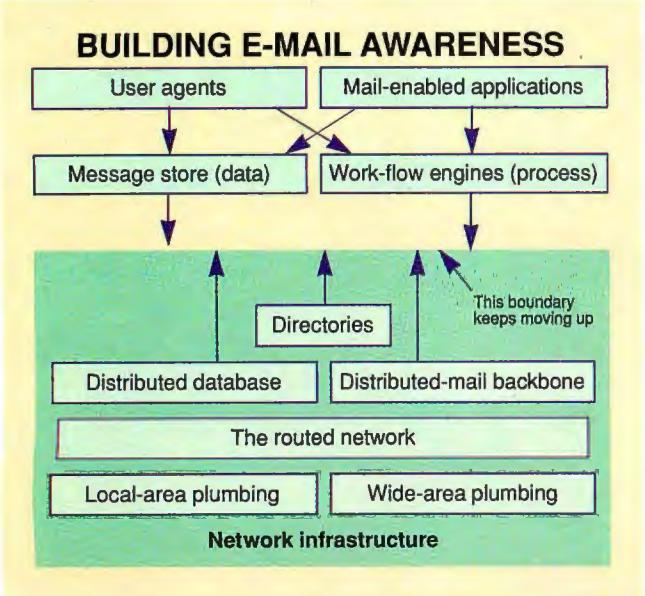

Figure 1: *The messaging architecture of the future will let mail-enabled applications and messaging agents communicate interchangeably with message stores and work-flow engines. This layered design permits users to use the networks, mail services, and front ends of their choice.*

that use E-mail find that it quickly becomes a vital part of their information structure. E-mail is the "de facto mechanism" for moving files at the Social Security Administration (Baltimore, MD), says Jan Hoffman, director of intelligent workstations and LAN engineering. The agency has a network of 15,000 PCs running NetWare and cc:Mail. A fax server routes incoming and outgoing faxes, and staffers use E-mail to update databases. Future projects may include tracking and monitoring letters and the use of digital signatures for approving documents.

Companies such as Beyond, Action Technologies (Alameda, CA), and Reach Software (Sunnyvale, CA) are creating tools to electronically control the flow of data and forms around organizations. These "rules engines" capture existing business processes or stimulate users to pioneer new, more efficient procedures.

The results can be staggering. Most business processes have built up over the years without the advantage of modern technology. By applying both workgroup technology and modern organizational theories, says Walter Ulrich, a director of the consulting firm Arthur D. Little (Cambridge, MA), "businesses can move decision making down to the people who have immediate contact with customers and cut cycle times by up to one-third."

Building on E-Mail

Analysts expect LAN-based E-mail use to grow explosively over the next few years. Market-research firm The Yankee Group (Boston, MA) estimates that the number of LAN E-mail users in the U.S. rose 60 percent last year, from 5.9 million to 9.4 million, and will climb another 60 percent this year to 15.1 million users

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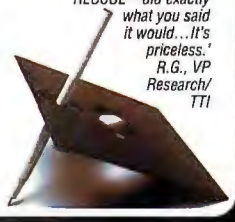

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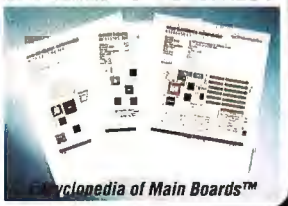

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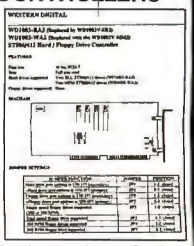

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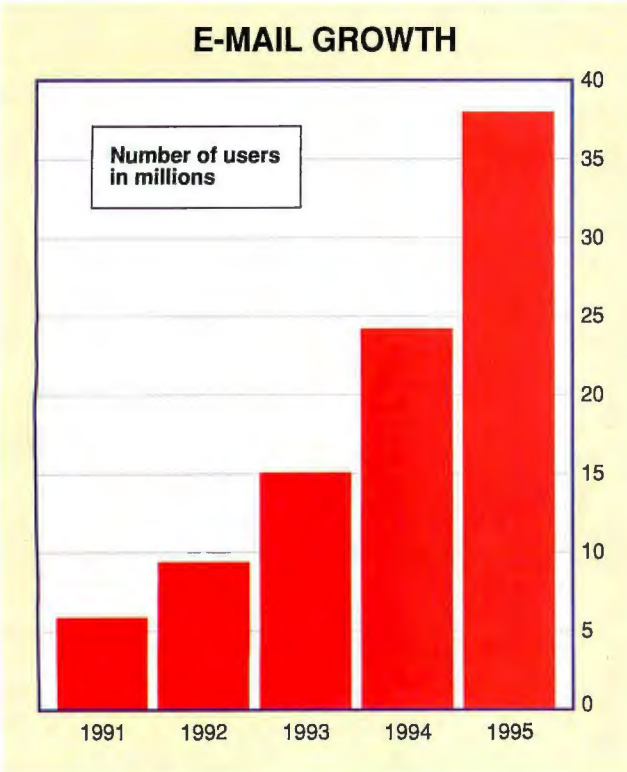

Figure 2: *The number of E-mail users in the U.S. is expected to climb 60 percent this year over last year's levels; by 1995, the user base could reach 38 million. Accurate worldwide figures for E-mail are not available. (Source: The Yankee Group)*

(see figure 2). By 1995, the figure could climb to 38 million. Meanwhile, the number of messages transmitted within Fortune 2000 firms in North America will surge from 6.1 billion in 1993 to 14.3 billion in 1995 (including both private E-mail and public services, such as MCI Mail and EasyLink), says the trade group the Electronic Mail Association (Arlington, VA).

The size of the potential network E-mail market is limited by the penetration of LANs. Only 42 percent of the estimated 47 million personal computers in the U.S. are connected by LANs, says market researcher Dataquest. That figure is projected to grow to 52 percent by 1996.

In the short term, the greatest problem facing enterprise-wide mail is that most of today's mail packages won't talk to one another (see "Mixed Messaging" on page 136). User woes include the inability to link different packages across heterogeneous networks and the thorny problem of how to synchronize distributed directories of network and mail users. For many, the best solutions are gateways from companies such as SoftSwitch (Wayne, PA) and Retix (Santa Monica, CA) that interconnect different mail platforms. In the long term, the emergence of mail standards (i.e., APIs, file formats, transports, and directory services) will ease the need for gateways (see the text box "Standards Coming, But Slowly" on page 96).

Aetna Life and Casualty Insurance (Hartford, CT), for example, has 36,000 employees on five E-mail systems—IBM PROFS, DEC All-In-1, cc:Mail, and Microsoft Mail for DOS and for the Mac—down from nine systems a few years ago. Kevin Ryan, director of E-mail services, says the firm uses a SoftSwitch messaging backbone to connect the different systems internally and X.400 gateways to talk with outside companies, primarily large policyholders. But managing the system isn't easy. "E-mail directories are still cumbersome, overly complex, and not well understood by users," Ryan says. A company as large as Aetna has a lot of people coming and going. "You've got to propagate [directories] out to all post offices and keep all those changes in sync," he says. It's a labor-intensive process.

Until standards are in place, MIS managers must struggle to patch together disparate systems or force all employees to use the same software. The latter is nearly impossible for many organizations. Workgroups have already settled on different mail packages, and the MIS department must also support public services, such as MCI Mail or CompuServe, and legacy host-based mail packages, such as PROFS or All-In-1.

Integrating different software and services is technically possible. "It's just that some things are difficult or expensive," says consultant Amy Wohl of Wohl Associates (Bala Cynwyd, PA). "The real hurdles are administrative."

E-Mail Applications

The types of applications that can capitalize on the E-mail infrastructure fall into two groups: mail-enabled (or mail-aware) programs (e.g., spreadsheets or word processors that also access mail services) and messaging-centric programs built specifically around E-mail transports and store-and-forward messaging.

A few packages, such as Software Publishing's Professional Write Plus, can already talk directly to mail services through custom interfaces. Now, by virtue of standards, such as Microsoft's MAPI (Messaging API) and the VIM (Vendor-Independent Messaging) interface from a rival group headed by Lotus Development (Cambridge, MA), developers can add mail access to any program. In the near term, the most common mail-enabled programs are likely to be versions of shrink-wrapped packages such as WordPerfect, Lotus 1-2-3, Excel, and Freelance Graphics. "It sounds simple," says analyst Mike Heylin of market researcher Creative Strategies Research International (Santa Clara, CA), "but [mail-enabled versions of familiar software] are what users want right now."

When Windows applications support mail APIs, for example, you will be able to select Mail from the File menu in the same way you choose Print. A compose-mail dialog box will pop up in the application, along with fields for addressing, priority, and other options. When you send the message, the spreadsheet or word processing file is automatically attached. In Windows and Mac systems (and with some DOS packages), the recipient can then launch the creating application directly from the mail attachment; if the application isn't available, many mail clients provide a means to view the file.

By tapping into messaging transports, mail-enabled programs will also be able to communicate with each other, much as they do now through virtual-circuit mechanisms such as DDE, OLE, and Apple Events. "We're very keen on doing mail-enabled applications," says Deloitte & Touche's Quinlan. The real reward, he says, comes from the ability to move data among applications. For example, Deloitte & Touche provides electronic meeting registration. Built using cc:Mail's import/export facility, the application lets auditors sign up for company seminars via E-mail. The company also provides automated audit software to its field staff, which uses E-mail to exchange audit workpapers. By hiding the mail capability within the application, Quinlan says, auditors can exchange data without being computer jocks.

Building on the foundations of VIM, cc:Mail, and Notes, Lotus plans to enhance its applications suite with workgroup capabilities, says Irene Greif, director of workgroup technologies. For example, the mail-enabled 1-2-3 for Windows 2.0, expected to ship early this year, will include technology called Version

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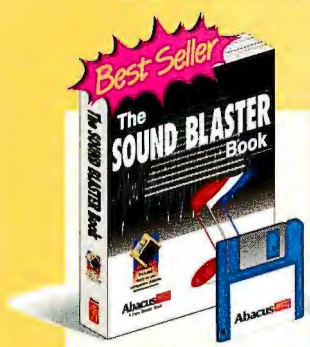

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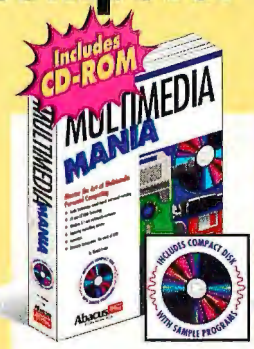

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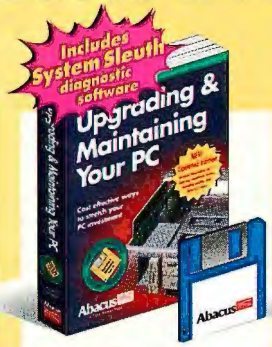

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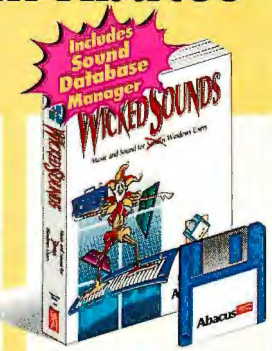

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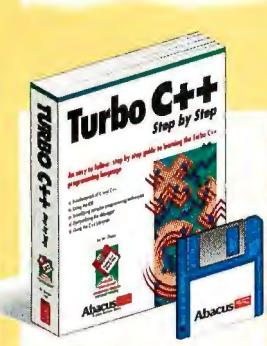

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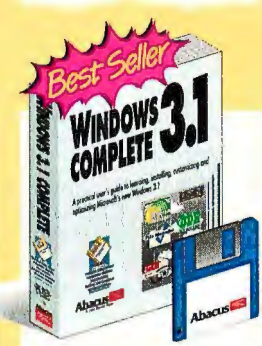

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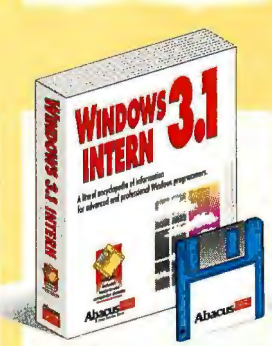

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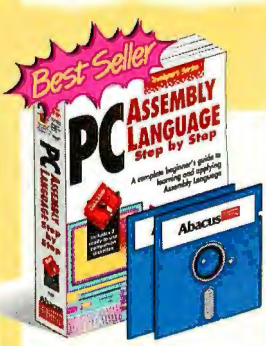

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Standards Coming, But Slowly

An industry executive once quipped that there was no clearer sign of the failure of E-mail than the success of the fax. People needed a fast, standardized way to exchange data and were willing to sacrifice the benefits of editable documents for the one-touch convenience of a fax.

Today the situation has improved, but it will be years before standards are established that make E-mail as easy to use as the phone or the fax. The charge toward standards is being fought on three fronts: mail APIs, transports, and file formats. A fourth category—directory services—is so complex that proprietary solutions may continue to dominate for the rest of this decade.

Easy Access

The fight over mail APIs has garnered the most attention, perhaps out of proportion to its long-term importance. Microsoft touts the Windows-based MAPI (Messaging API), parts of which have already been added to Windows for Workgroups, while Lotus (Cambridge, MA) and others are promoting the cross-platform VIM (Vendor-Independent Messaging) API. Apple offers OCE (Open Collaborative Environment), but it also intends to support VIM. Novell (Provo, UT), IBM, and Borland (Scotts Valley, CA) back VIM, too.

The mail API battle has generated open hostility among the camps, but many observers view it as a red herring. "It doesn't matter what the mail API does," says Eugene Lee of Beyond (Cambridge, MA), "as long as I can run my application on your mail server."

The premise of MAPI is similar to that of the Windows printer architecture: It's an intervening layer that abstracts the behavior of the device on the other side of the interface (see figure A). MAPI specifies a series of 60 operating-system calls that invoke common mail actions such as send, receive, and mailbox management. A DLL performs the client mail services and interfaces to mail engines through what Microsoft calls the SPI (Service Provider Interface). Consequently, any MAPI-compliant Windows application can talk through the DLL to any SPI-compliant mail engine. Hewlett-Packard, WordPerfect, DEC, SoftSwitch, Novell, Banyan, and AT&T have already committed to MAPI-enabling their mail engines.

Microsoft is shipping a subset of MAPI, known as Simple MAPI, in Windows for Workgroups, but it works only with the Microsoft Mail engine. The complete MAPI subsystem, known as Full MAPI, will operate only in Windows for DOS and Windows NT, and it won't be bundled with any operating system until late this year.

VIM takes a different approach. Instead of a set of routines that ship with the operating system, VIM is a specification for directly accessing mail engines from various client environments. Lotus will offer implementations for Windows and OS/2 clients talking to the cc:Mail engine, but other parties will have to provide VIM hooks for their respective engines or client environments. For example, Apple is expected to support OCE for Mac-only users but enable VIM access from the Mac for users who want to address other mail engines on other platforms.

Lotus promises to provide a subsystem to remap VIM calls to a MAPI back end, thus allowing VIM-compliant applications to talk to MAPI mail engines. Also, Microsoft and VIM supporters joined forces in a group called the XAPIA (X.400 API Association), which is creating a set of multiplatform Common Mail Calls that offer capabilities analogous to Simple MAPI.

But Suzan Fine, the MAPI product manager at Microsoft, argues that when standards are made generic enough to work across platforms, they forfeit richness and specificity. She says that developers writing complex messaging-based applications such as BBSes or work-flow systems will probably choose to work within a single environment, such as Windows with Extended MAPI. This offers them advanced features, such as folder management, while still allowing access from non-Windows systems via XAPIA.

Microsoft's main criticism of VIM, that it is too firmly tied into the cc:Mail engine, rings hollow as long as MAPI works only with Microsoft Mail. For the balance of 1993, software developers will rewrite their applications to one or both of the mail APIs, and users will eventually be able to invoke mail capabilities from within their programs without giving a thought to what engine lies in the background.

Free E-Mail

The inclusion of Simple MAPI in Windows for Workgroups points to a controversial result of separating mail clients and servers. To an increasing extent, the client will become a standard part of the operating system. Microsoft and Apple are moving in this direction. "What this means is that basic E-mail is free in the long run," says Beyond's Lee. In the future, he says, vendors will have to compete based on advanced features such as Beyond's rules engine, which helps users route E-mail and cope with message overload.

Not everybody agrees that the operating system is the best place for the mail client, however. Novell argues that, as a network function, mail needs to be cross-platform. Analyst Mike Heylin of Creative Strategies Research International (Santa Clara, CA) says that integrating E-mail into the operating system could discourage innovation by third parties. "Personal computing is not a monolithic structure," he says, "and Windows is starting to look more and more monolithic."

Servers and Formats

VIM and MAPI do not address the issue of mail engines talking to one another. The solution is likely to come from international standards, specifically X.400, which defines a universal mail-transport protocol. Until now, X.400 hasn't been widely adopted for PC LAN–based mail systems, because it is complex and vendors were already committed to proprietary transports. The protocol is more widely applied outside the U.S., where there is greater demand for international standards.

People use X.400 mostly for mail backbones. Through a gateway such as

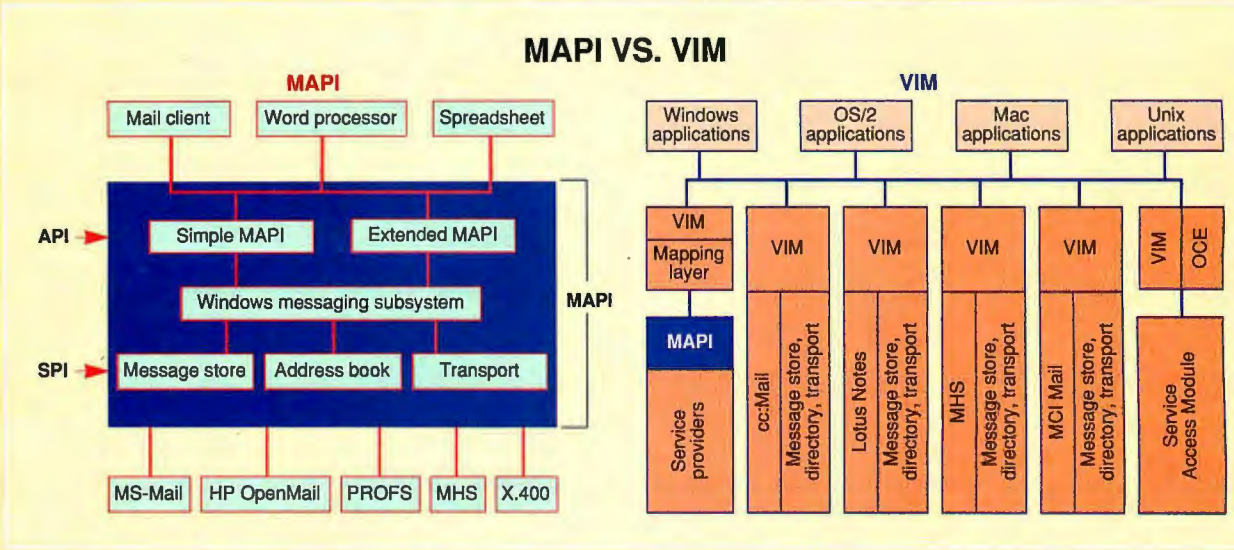

Figure A: *Microsoft's MAPI and Lotus's VIM specifications offer top-level APIs that let applications talk to mail back ends. In the Windows-only MAPI, the layer interfaces to mail engines via drivers, while in the cross-platform VIM, the layer is actually part of the engine itself.*

the Retix OpenServer 400, mail messages are translated from their native format into X.400 and then back to the same or a different format on the other side. But native X.400 mail servers are growing in popularity; for example, Microsoft is developing an X.400-based mail server for Windows NT.

Not everybody agrees that X.400 is the ultimate solution. Consultant David Ferris calls it the "lowest common denominator" and projects that it will be three to four years before X.400 becomes attractive. In today's market, he says, customers often decide that they are better off using proprietary mail switches from SoftSwitch (Wayne, PA) or DEC (Maynard, MA).

Even if you use X.400 natively or as a backbone, you face yet another problem for which no clear solution is in sight. "If the protocol situation is OK, and you've carefully unified the APIs and mail services, you still have to deal with incompatible file formats," says Nina Lytton, president of the consulting firm Open Systems Advisors (Boston, MA). "This is the big smoking gun."

For example, Lytton says, efforts are under way to standardize Windows and Mac calendar formats in group scheduling programs. But these efforts aren't cross-platform, nor do they address access to Unix- and host-based calendaring systems. However, some vendors offer point-to-point file conversions, such as between Microsoft Schedule+ and IBM PROFS calendars.

One technology that may ease the file-format problem is Adobe's (Mountain View, CA) Acrobat, a portable document format that renders WYSIWYG documents correctly across platforms. Acrobat will make it possible to distribute complex documents via E-mail to users on an incompatible system. But while it provides accurate document display, its files won't be editable in initial releases of the software. You will still need file converters to collaborate on projects across platforms.

Directory Assistance

Most mail systems use incompatible naming conventions and addressing schemes. Naming inconsistencies mean that sometimes messages crossing gateways get lost and aren't delivered. To make matters worse, many LANs can't share their user directories with the mail systems that ride on top of them, which means that lists of LAN and mail users must be separately maintained and propagated throughout the network.

Help is on the way. NetWare 4.0 will replace the server-based Bindary user directory, which requires manual propagation from one server to another, with NetWare Directory Services, an open, networkwide, self-propagating user directory. For users of earlier versions of NetWare, Novell will also offer NetWare Global Messaging, an NLM (NetWare Loadable Module) implementation of MHS (Message Handling Service) that taps into the Bindary. Banyan will also target pre–NetWare 4.0 customers with a port of its directory services, StreetTalk, to the NetWare environment.

The long-term solution to directory services is another international standard, called X.500, that codifies directory structures and provides a way for directories on linked systems to find and query each other. X.500 is even further from wide-scale implementation than X.400 because it is complex and poses unresolved problems, such as how to limit the extent of a distributed search. Most analysts don't expect X.500 to be widely adopted until the late 1990s. Microsoft plans to use X.500 natively in its Windows NT–based messaging server, but many other mail and network software companies are taking a wait-and-see attitude.

The Vines Advantage

JON UDELL

Vines users view the chaotic mail situation that prevails on most PC networks with Olympian detachment. They have enjoyed seamless global E-mail for eight years, thanks to Banyan's (Westboro, MA) legendary distributed name service, StreetTalk. As a result, Vines' modest 8 percent share of the PC network market includes several of the world's most sophisticated wide-area installations. "We see a lot of Fortune 1000 customers who use Vines as a backbone, with pockets of NetWare at the department level," says Robert Hankin, director of marketing for CCOM Information Systems (Iselin, NJ). CCOM's HelpLine is a mail-enabled help desk application that supports Vines mail, cc:Mail, and Microsoft Mail.

When an operator logs a call, HelpLine automatically mails the user a call reference number and then follows up with additional messages as the operator researches the problem. Running on Vines, HelpDesk exploits the fact that a user's StreetTalk ID is both a network address and an E-mail address. That identity eliminates the directory synchronization woes so vexing to administrators of other PC networks. Moreover, Vines' mail system exhibits a simplicity and robustness that so far eludes the Unix mail systems to which it is distantly related. "The mail engine and transports just work, without any fuss, on local- and wide-area networks," says Ted Kull, project manager for systems engineering at the Educational Testing Service (Princeton, NJ).

Has Vines, with its superb mail services, fostered a rich set of mail-enabled applications? Ironically, not yet. In part, that's because Banyan only recently released its Intelligent Messaging module, which offers message compression, restartable transmission, multithreaded processing, and network management. These features make Vines mail an efficient handler of not only interpersonal message traffic but also the huge file transfer load that companies like Compaq were placing on it. Mostly, though, Vines users, like their Novell counterparts, are tire-kicking Reach Software's Workman, Beyond's BeyondMail, and Lotus's Notes, looking for ways to model organizational paper flow and transform it into mail-enabled software.

Some Vines developers have built custom forms-routing applications using the Vines gateway API, which, unlike the mail client API, can access all users' mailboxes. LANshark Systems (Reynoldsburg, OH), a developer of Vines utilities, has exploited the gateway API to build simple information servers that receive mailed requests for information and mail back files or the results of database queries. Because the data repository (e.g., a Paradox database) is not typically mail-enabled, this kind of application requires homegrown protocols and polling of shared directories. When mail awareness is as common as DDE support, says Scott Sharkey, president of LANshark Systems, you will see several more systems of communicating applications built on a mail substrate.

Sharkey is skeptical that Banyan's promised support for VIM (Vendor Independent Messaging) and MAPI (Messaging API) will smooth the way for Vines developers. "It would be like looking at the world through a periscope," he says. Neither API accommodates the richness of StreetTalk. Users of Vines 5.5, for example, can attach a wealth of attributes to each item in the StreetTalk database. That means an application that encodes the rule "send a copy to Joe's supervisor" can look up the boss's name at run time. Until the APIs and directory services catch up with Vines, Sharkey plans to continue developing two versions of his software: one that fully exploits Vines and one for the rest of the world.

Sharkey may not have to wait long. The Vines ENS (Enterprise Network Services), which shipped last December, brings StreetTalk and the Vines mail APIs to NetWare 2.x and 3.x. Implemented as a dedicated Vines server, a NetWare VAP (value-added process) or NLM (NetWare loadable module) and a small DOS TSR program, Vines ENS threatens to steal the thunder of Novell's (Provo, UT) forthcoming NetWare 4.0. Automatically synchronizing StreetTalk with the NetWare bindery, ENS gives existing NetWare 2.x and 3.x installations the unified network view that would otherwise require an upgrade to NetWare 4.0.

Some Vines services may even run better on NetWare than on Vines. For example, the optional Intelligent Messaging module can use high-performance NetWare threads for its multithreaded message processing. Moreover, while mail-aware applications will need to be rewritten to exploit 4.0's new API, Sharkey says that his Vines applications run on ENS today as is. It's a smart move on Banyan's part, and one that brightens the future of mail-enabled software on NetWare LANs.

Jon Udell is a BYTE senior technical editor at large. You can contact him on BIX as "judell."

Manager, formerly code-named Chronicle, that facilitates sharing worksheet data.

Version Manager provides a new format for spreadsheet cell ranges that lets users import and export them as objects with attached properties such as version number, author name, and assumptions. For example, a colleague could mail a range object, not to your personal in-box, but to 1-2-3's in-box, from which the application would fetch it and incorporate it into a worksheet.

For workgroups, Version Manager lets you publish cell ranges into the Lotus Notes database, where they become separate entries. Greif says this will let groups work in parallel on spreadsheet projects while taking advantage of Lotus Notes features—data replication across servers, security, and the ability to sort and view messages by criteria such as author or region. The payoff comes for projects that require consolidating spreadsheets. Greif says, "Instead of waiting for everybody to finish and then doing

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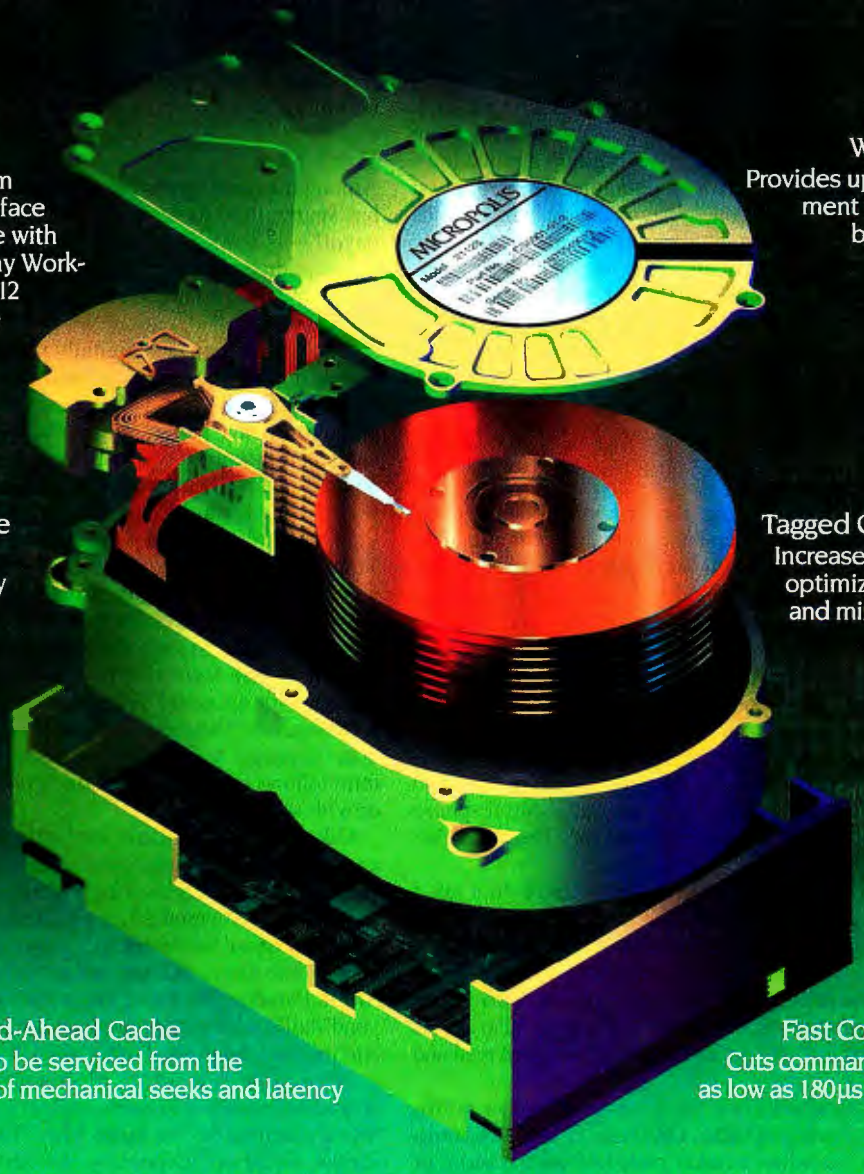

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The same model could be applied to Ami Pro documents or Freelance Graphics slide shows, but Lotus hasn't committed to delivery dates for workgroup-enabled versions of these packages. "Our goal is to do more than just mail-enable our products," says Greif. "We want to build on the communications infrastructure by using both mail and databases."

Borland (Scotts Valley, CA) is keeping quiet about its E-mail strategy, but it is known to be developing a software architecture that will support an upcoming line of workgroup applications. Called Object Exchange, or OBEX, the architecture is built on BOCA (Borland's Object Component Architecture), which builds on the company's InterBase database engine. Borland will likely use VIM as the interface between applications and mail services.

As with other vendors' products, Borland's mail-enabled applications will let users send messages without exiting to a separate mail client. But the company's ultimate ambition is to harness mail as a medium for IAC (Interapplication Communication). The link to InterBase suggests that Borland has set its sights on work flow.

Meetings, Meetings

The leading category of messaging-centric applications is group scheduling and calendaring, which lets you plan meetings and allocate the use of resources such as conference rooms or audiovisual equipment. Microsoft's Schedule+, shipped as a part of Windows for Workgroups, may help grow the market, which is already addressed by PowerCore's Network Scheduler, Da Vinci's Coordinator, Futurus's Team, On Technology's ScheduleMaker, and Attachmate's ZipOffice.

While scheduling seems an ideal application for store-and-forward messaging, not everyone sees it that way. Campbell Services' (Southfield, MI) OnTime for Networks relies on Banyan (Westboro, MA) Vines RPCs to ensure the real-time response needed to reach quick consensus (see the text box "The Vines Advantage" on page 98).

"Message-based scheduling systems today don't do a good job of handling conflicts," says Anik Ganguly, vice president of product development at Campbell Services. However, OnTime does support a store-and-forward transport, because many Vines users can't afford the full-time WAN (wide-area network) links necessary for a true client/server system. Messaging also serves remote users who dial in to collect and send mail and then read and respond off-line.

Another promising application for messaging is user notification; for example, Texaco (Tulsa, OK) uses E-mail to coordinate employee activities when a tanker pulls into port. A series of synchronized actions must occur among oil terminal workers, ship crew, salespeople, and headquarters; the company uses the mail system to send automatic assignments and updates to employees. The goal is to reduce the potential for costly mistakes and seaport overtime charges of $10,000 per hour, says consultant David Ferris of Ferris Networks (San Francisco, CA). User notification can also advertise job openings, company events, or changes in personnel policy.

Fort Howard (Green Bay, WI) has instituted an application that uses messaging to remotely manage the laptops that its field sales force uses. Rob Williams, a personal computer analyst for the firm, says that by using BeyondMail rules scripts and DOS batch files, he can upgrade software in the field, change menu screens, and distribute new E-mail directories. Williams broadcasts mail containing codes that trigger BeyondMail rules running on the laptops. The rules uncompress the attached batch file, execute it while piping the screen to a DOS file, and send a message back with the screen-capture file attached. Williams can verify that the update has succeeded, or he can diagnose and fix any failures.

Work Flow

Among the many potential applications for E-mail, the one that has sparked the most interest—and could provide the biggest payoff—is work-flow automation. Datapro Research (Delran, NJ) says that work-flow software will be a $250 million market this year, while related hardware and software sales will amount to $1.6 billion.

Work-flow packages digitally replicate existing business processes that involve routing paper or forms among employees (see figure 3). By using electronic forms riding on E-mail transports, users save paper, boost efficiency, and add intelligence to data distribution. But equally important, according to a Datapro report, organizations look to work flow as a means to reinvent the way they do business and create new structures.

"The whole way we work and manage will change," agrees Tom White, president of Action Technologies. "Work flow lets your work become more decision-related and less paper-related."

A frequently cited example of work flow is in processing travel expense reports. In such a system, an employee fills out an electronic expense form that is automatically routed to his or her manager for approval. After that, the form goes directly to accounting, or if the expense level is high enough to require additional approval, it is sent to the manager's boss. The routing of the form follows preprogrammed rules, typically described graphically or with scripts or both.

Other basic work-flow applications include purchase-order and invoice processing, vacation and leave requests, creation of sales proposals, engineering change orders, and editorial production flow. Beyond's Lee says that the company uses its own software for an automated sales-lead routing system. Names are entered into forms and sent to a virtual user acting on behalf of the firm's Paradox database. From the "application mailbox," BeyondMail's rules engine retrieves a message, extracts data values, and imports them into Paradox.

Work flow is a subset of groupware, which also includes shared-information systems such as Lotus Notes (see "Collaborative Computing" on page 112). The difference, says Esther Dyson, editor of the industry newsletter *Release 1.0*, is that Lotus Notes is a fundamentally passive system that makes no effort to track who gets what information or what they do with it, whereas work-flow systems play an active role in disseminating data to the people who need it. She adds that intelligent routing is based on a combination of rules, events, and time.

Dyson divides the universe of work-flow applications into two categories: scripted work flows (also known as forms-based or E-mail-based routing) and work-flow tools that enforce process integrity. Into the first category she places BeyondMail and Reach Software's Workman; in the latter category, she calls Action "the conceptual leader." Says Dyson, "Action alone understands the relationships that underlie the flow

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of work and provide the framework for completion of tasks, as opposed to stepping through actions."

Dyson identifies three basic architectures for work-flow systems. BeyondMail typifies the first type: user- or client-based. Systems such as Beyond's, she says, are tools for individuals to automate their interactions with other people and applications (see screen 1). While Beyond doesn't use a centralized model, you can create virtual users in the mail system (e.g., Beyond's use of Paradox) that receive messages and act on them according to rules.

Beyond's work-flow capabilities spring from the rules engine it provides for filtering and sorting mail. Company president and CEO Chuck Digate says that BeyondMail offers a bottom-up, ad hoc approach to automation: Using the BeyondRules scripting language and BeyondMail Forms Designer, users set up their own rules for tasks ranging from personal mail management to complex forms routing. The package is available for DOS and Windows clients, and it supports Novell MHS and Banyan Vines mail engines. The company also sells a version of BeyondMail that acts as a front end for Lotus Notes.

BeyondMail lacks graphical tools for diagraming work flow, such as those supported by Reach Software's Workman. But Workman requires a more top-down approach, in which processes are targeted for automation and then work flows are engineered. With BeyondMail, "users get mail first, and then they can add incremental functions," says Digate.

The second type of work-flow system is object- or agent-based, exemplified by Workman. Forms in Workman carry the intelligence that each client needs to process the form correctly (see screen 2). Workman treats data as objects, letting you view the underlying values through a variety of forms. Each form has active fields that can invoke specific actions, such as calling an external database; the form design decides which fields are active or even visible to each user.

As with user-based systems, agent-based systems usually use E-mail transports. But Hewlett-Packard's NewWave, for example, uses an object repository and proprietary internal circuits to pass agents around the Windows environment. While Workman doesn't use a central database to manage the work flow, information about the status of each form is reported back to a database for tracking and reporting. Workman runs under Windows and supports MHS, NetWare Global Messaging, and Vines mail systems.

The routing engine, which lives on client systems, is programmed through a combination of graphics tools and scripts; objects can flow on paths through the organization—serial, parallel, or looped, depending on actions taken at each step. The status of objects is stored in a Btrieve database (Reach Software plans to support a SQL engine this year as well), and a Query/Select tool lets you define management views of work-flow status.

continued

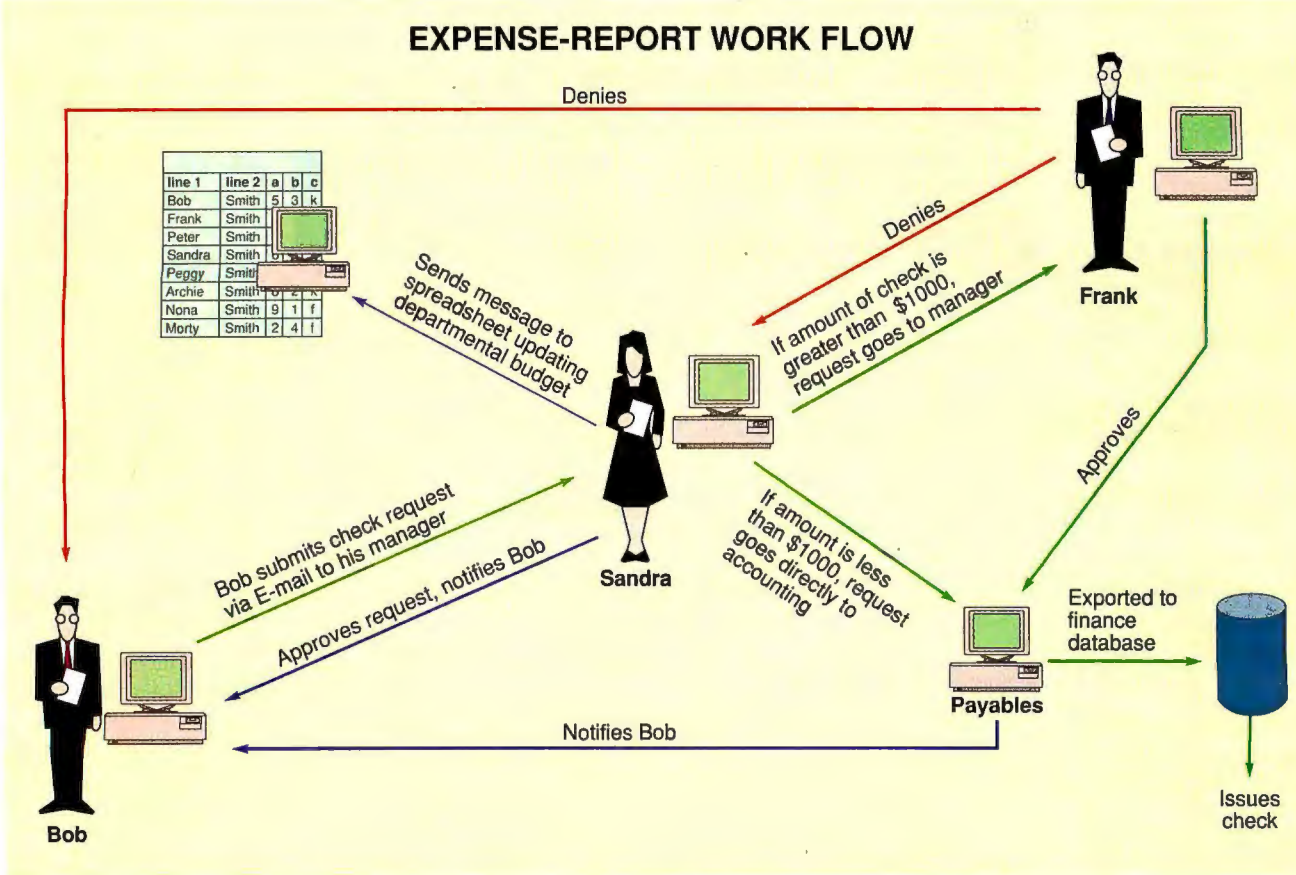

Figure 3: *A prototypical work flow is processing check requisitions. In this example, Bob submits a request by filling out an electronic form, which is automatically routed to his manager, Sandra, who can approve or deny the request. If the amount is greater than $1000, Sandra's boss Frank must also add his digital signature. The approved form is forwarded automatically to accounts payables. At several steps along the way, information about the transaction is sent to other software packages, such as a spreadsheet and the finance department's database.*

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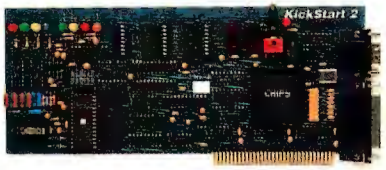

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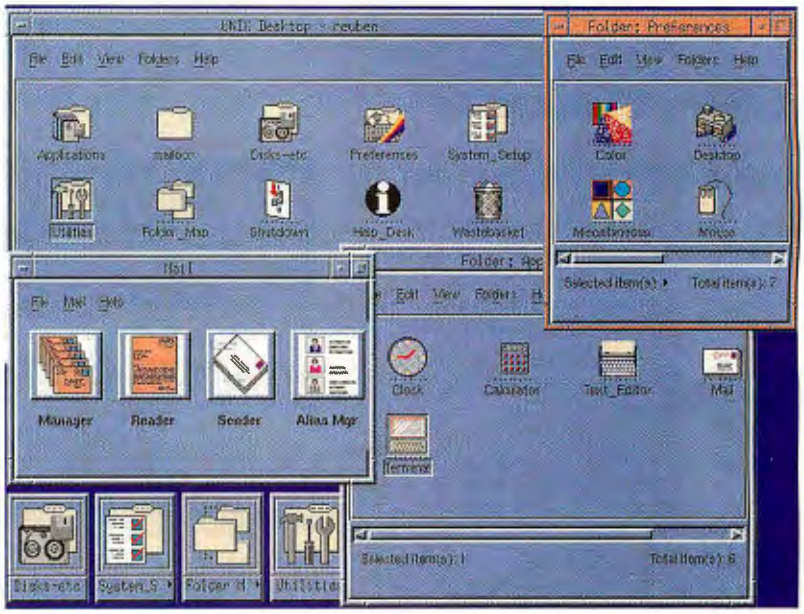

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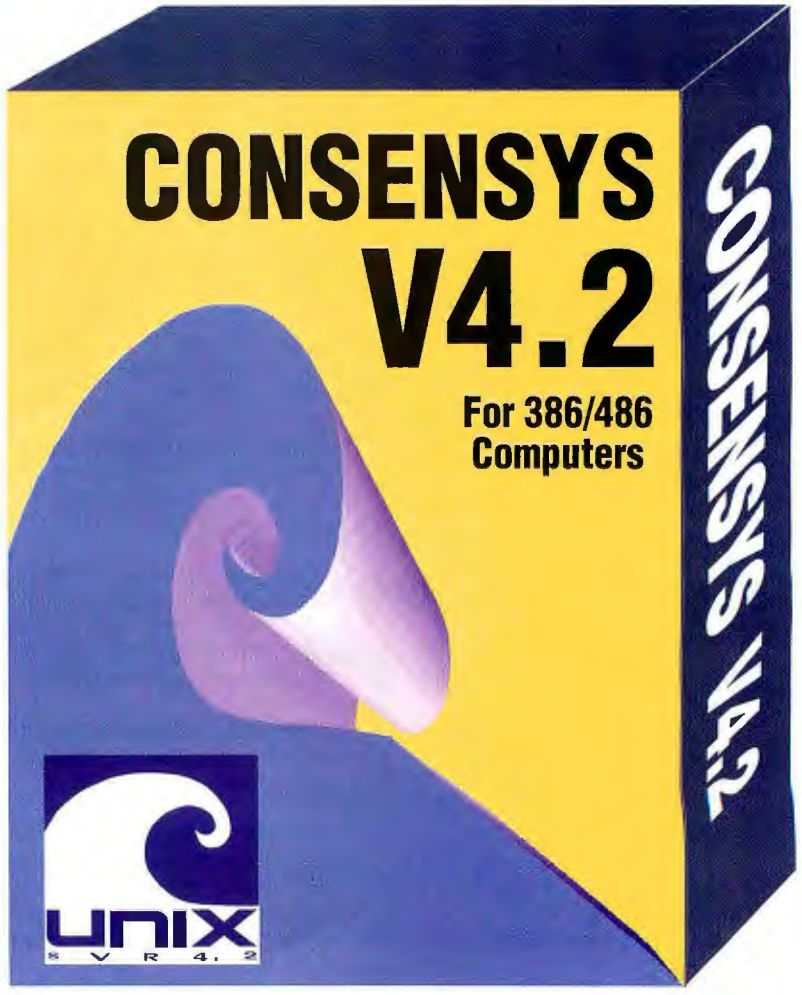

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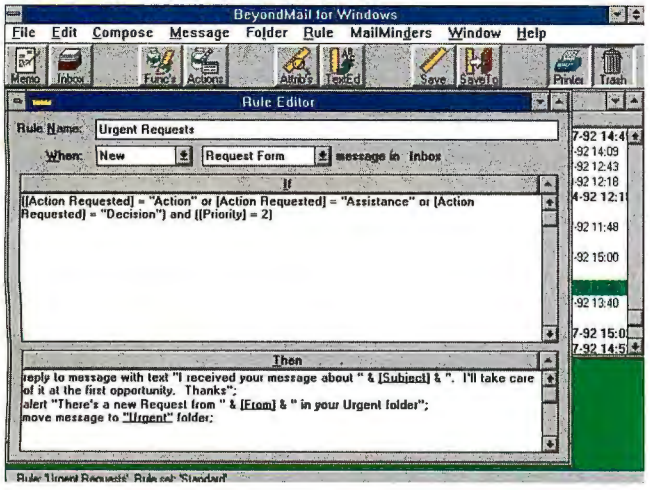

Screen 1: *BeyondMail's Urgent Request rule takes advantage of the product's forms capability. If a form is marked urgent, the Urgent Request rule informs the sender that the form was received, alerts the recipient that an urgent request has arrived, and moves the request message to the recipient's urgent folder.*

Workman also supports easy connections to other programs, through DDE scripts, calls to SQL databases, and support for DLLs. Mike Spies, vice president of marketing for Reach Software, says, "It's not enough just to move things around; you have to provide a means to process information through integration with other applications."

Spies says that one major difference between Workman and Action's work-flow tools is that Workman is client-based. "Server-based technology is limited to those who can gain access to the server," he says. Store-and-forward allows easier implementation and administration, relieves bandwidth crunch on LANs, and makes it easier for remote users to use the system.

Inventa (Cupertino, CA), a consulting firm specializing in software development, uses Workman to help implement work-flow systems for clients. "Most people aren't thinking 'I'm going to buy a work-flow engine,'" says Ken Santoro, vice president of the firm. "They want to automate purchase orders or sales leads." To make work flow successful, he adds, "you have to build applications that automate processes, not just tasks."

Action represents the third type of work-flow architecture—server-based systems. These systems build around a single logical center, although the database itself can be physically distributed. By actively monitoring the status of tasks throughout a system, Dyson says, a server-based system makes it easier for a central administrator to track work flow (see screen 3). Systems built this way also enjoy benefits from piggybacking on a relational database engine, including the availability of tools for managing transaction processing.

Best known for developing MHS and The Coordinator, Action is concentrating its efforts solely on work-flow software. An implementation of the company's Workflow Management System tools will be sold by Lotus as an add-on for Lotus Notes 3.0. Action's software is available only on an OEM basis.

Action's Workflow Management System includes a work-flow designer and an applications builder for connecting work flows into external applications, such as E-mail or databases. The work-flow server stores information about the status of work flows in a relational database, and the reporting tool lets you manage work flows and inspect your performance.

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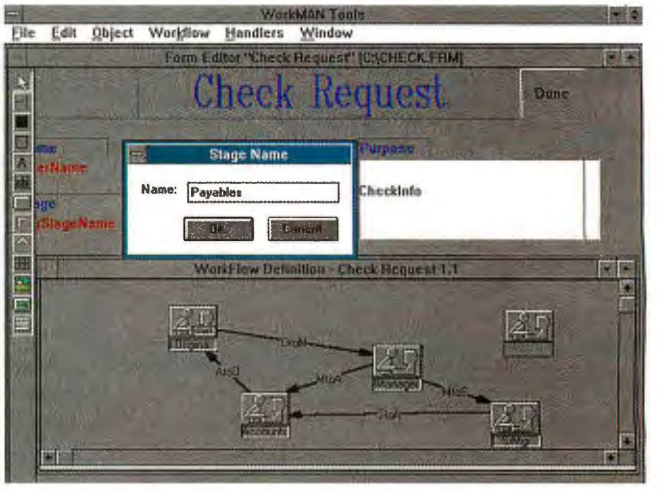
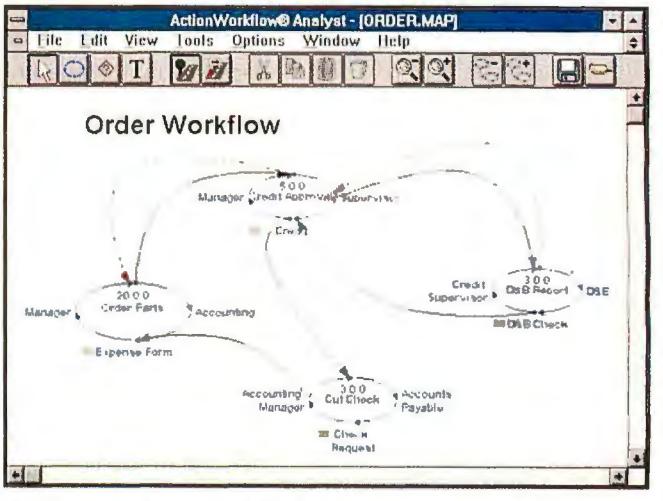


Screen 2: *Workman adds to forms the intelligence needed to process them correctly. Active fields can invoke specific actions, such as calling an external database. The form editor, shown here, lets the form designer decide which fields are active or even visible to each user.*



Screen 3: *Action's Workflow Management System is server-based, which allows easier tracking of work flow. It includes a work-flow designer and an applications builder for connecting work flows into external applications, such as E-mail or databases.*

for PC LANs, LaserData (Tyngsboro, MA) plans to resell Action's tools starting in the second half of this year, and it is also incorporating work-flow technology into a document management system set for release by the third quarter. Rodney Rogers, vice president of engineering for LaserData, says Action's advantage is that the work flow and task status are monitored and controlled by a central database. "Coded into its design is the knowledge of what is to be done," he says. By comparison, client-based products offer less control. "Nothing [in client-based systems] tracks the state of completion of tasks," he says. "This can be built, but it's part of the application, not the underlying work-flow engine."

Another Action customer is Verimation AB, a Swedish maker of PC LAN and host-based E-mail systems and a pioneer in developing intelligent electronic forms and routing systems for

"Recommended."
Jerry Pournelle, Byte, July 1992

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mainframes. Adam Sroczynski, president of Verimation's U.S. subsidiary, says that his company chose Action because its features met customer demand for process management capabilities. "I don't think you can take BeyondMail very far in terms of reengineering your business," he says. "How can you manage and improve a process that's controlled by the user? You need a more top-down approach."

Sroczynski says that work-flow customers typically have two demands. First, they want a tool that helps to improve processes, find bottlenecks, and reduce cycle times. Second, "they want to remove the definition of routing from the form application itself and put it into a server process so that they can replicate those functions elsewhere." Verimation is shipping an E-mail package called Memo LAN that incorporates Action tools for creating ad hoc work flows; in the third or fourth quarter of this year, new releases will add Action's front-end work-flow design and management tools, as well as the ability to access the Action work-flow server from a mainframe.

In addition to Beyond, Reach Software, and Action, other players in the work-flow software market include HP, Recognition Equipment/Plexus (Dallas, TX) (which supplies the Unix-based technology used in NCR's ProcessIt work-flow system), and Workhorse (Dublin, Ireland). Keyfile (Nashua, NH) and FileNet (Costa Mesa, CA) market work-flow-oriented document-image-processing systems, while JetForm (Ottawa, Ont.), Da Vinci Systems, and Delrina (Toronto, Ont.) offer forms-routing packages. The recently merged PowerCore (Manteno, IL) and Finansa (London, U.K.) plan to deliver a work-flow package in the third quarter, and Microsoft is rumored to be developing a work-flow capability for Windows, code-named Calvin and Hobbes. In the host world, IBM's OfficeVision/VM and DEC's All-In-1 offer mail management and forms-routing capabilities.

Users Lead the Way

At many firms, says consultant Ferris, the people installing E-mail are technical-support staff more focused on making the hardware and software work than on its potential for reducing costs or enabling new applications. Without the involvement of senior information executives, he says, the investment in E-mail infrastructure may not be fully harvested.

Fortunately, says Reach Software's Spies, a growing number of customers are realizing that messaging applications afford an opportunity to reengineer their businesses. "This whole thing is being driven by users who have needs and are looking for solutions," he says. "Instead of having something foisted on them by vendors, this is a rare instance where users are way ahead." Messaging is becoming the foundation of a new information infrastructure, because it's simple and cheap compared to other techniques for IAC and distributed computing. The pending arrival of mail-enabled applications will expose users as never before to E-mail's power as a data distribution medium. The next step is to implement work-flow automation.

Best of all, messaging and work flow build naturally on the most important resource of all—human capital—by giving employees tools to do their jobs better. "You don't even have to explain this stuff to people," says Nick Rudd, the chief information officer for advertising agency Young & Rubicam (New York). "It mirrors the reality of what they deal with every day." ■

Editor's note: *Also contributing to this story were BYTE senior news editor Tom Halfhill, senior technical editor Jon Udell, and news editors Dave Andrews and Ed Perratore.*

Andy Reinhardt is BYTE's West Coast bureau chief. You can reach him on BIX as "areinhardt."

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COLLABORATIVE COMPUTING

Computer-aided teamwork will change your office culture forever

JEFFREY HSU AND TONY LOCKWOOD

Collaborative computing is a catchphrase for a new body of software and hardware that helps people work better together. A collaborative system creates an environment in which people can share information without the constraints of time and space.

Network groupware applications link workgroups across a room or across the globe. The software gives the group a common, on-line venue for meetings, and it lets all members labor on the same data simultaneously.

Collaborative applications include calendar management, video teleconferencing, computer teleconferencing, integrated team support, and support for business meetings and group authoring. Messaging and E-mail systems represent the most basic type of groupware.

"I hear of new groupware products every day," says David Coleman, conference chair of Groupware '93, a trade show to be held this August in Palo Alto, California. Coleman expects to list more than 400 products from over 250 companies in a catalog scheduled to be published later this year.

Sales of workgroup software are soaring, according to WorkGroup Technologies (Hampton, NH). Sales for 1992 were $1.3 billion worldwide; this year, projections call for $1.93 billion in worldwide sales.

No Commander Datas

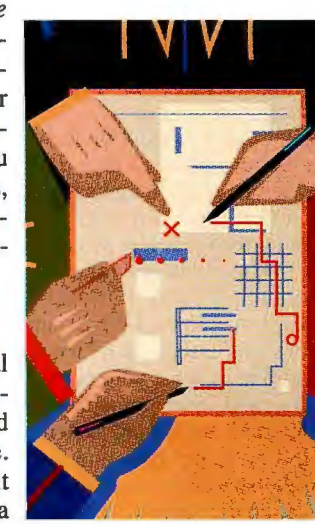
The best that any of these products can do is to put text, data, and graphics together in an integrated groupware package, creating what's known as *comprehensive workgroup support*. For example, Instant Update from On Technologies (Cambridge, MA) is a product for the Mac that lets you create and manipulate tabular data as well as import graphics into your documents. Some packages, such as GroupSystems from Ventana (Tucson, AZ), provide transparent access to other applications residing on your server.

Although an integrated groupware system allows you to bring supporting applications and information into your collaborative environment, some researchers, such as Robert Johansen from the Institute for the Future and Mark Stefik from Xerox's PARC (Palo Alto Research Center), hope to extend this support by bringing in artificial team members that can interact with a workgroup. These expert-system and AI technologies provide you with software entities called *agents* that constantly rummage through information warehouses, seeking the data that you need. These info-houses are part of your collaborative work environment and are continually fed new information from the workgroup and other data streams that you develop. Like parts constantly arriving at a busy factory, data flows nonstop into your info-house. The agents serve as receiving clerks, routing data to you and your workgroup.

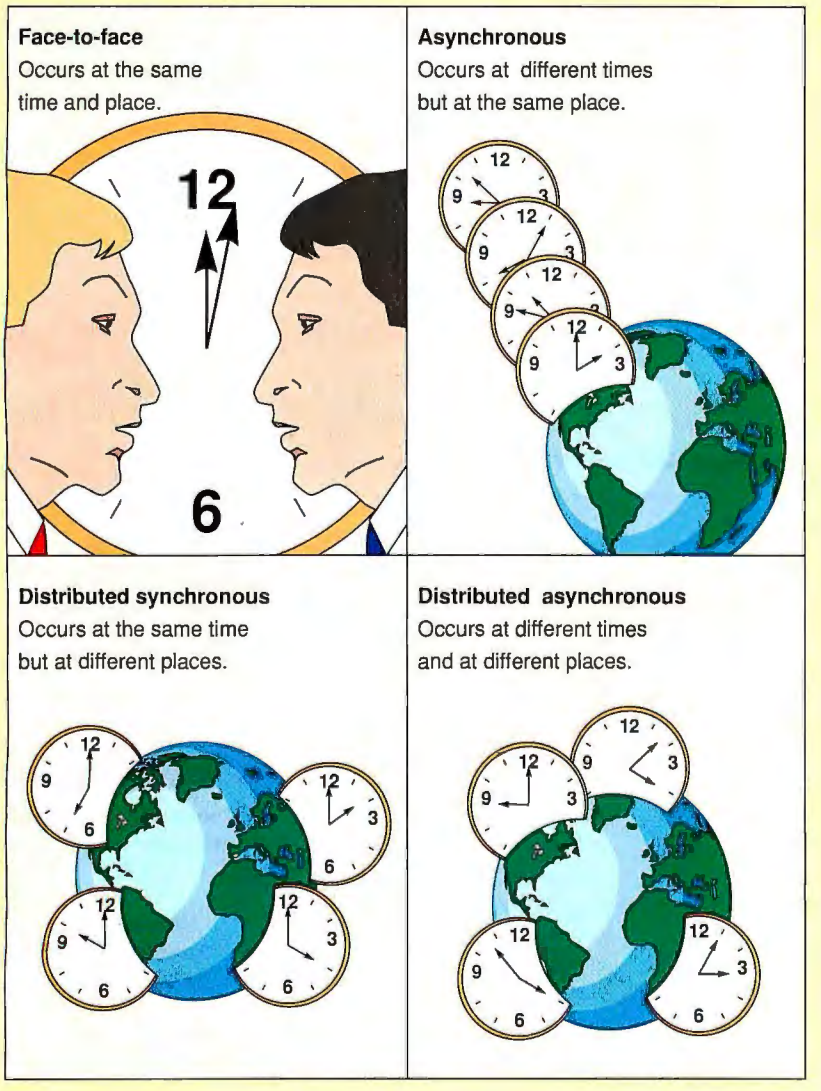
"In the short run, it's more likely that, instead of a Commander Data [the android on the TV show *Star Trek: The Next Generation*], you're going to have an information refinery that will be a part of your collaborative work environment," says Johansen. "You would have individual agents, programmed by team members, pulling out that information they want."

Designed to Help

There are three fundamental aspects of collaborative systems: common task, shared environment, and time/space. The first measures the extent to which the members of a



TYPES OF COLLABORATIVE INTERACTION



Workgroup interaction can occur in the following dimensions of time and space: face-to-face, same place at different times, same time at different places, and different times and places.

workgroup can work on the same task. If the system allows many people to work on the same task, it ranks high on the common-task spectrum (e.g., a software design system that lets programmers interact frequently in real time on a module of code).

A strong shared-environment system keeps you informed of what a project's condition is, what your coparticipants are doing, and what atmosphere or setting is supported. An E-mail system that simply sends messages back and forth isn't high on the shared-environment scale. However, an electronic classroom—with its emulation of traditional classroom settings, including blackboard windows, lists of students, and questions/responses—rates much higher.

Time/space collaborative systems focus on the time and place of the interaction (see the figure). Face-to-face, or *synchronous*, interaction is at the same time and place. *Asynchronous* interaction occurs at one place at different times. If the interaction is at the same time but at different places, it's *distributed synchronous* interaction. And interaction at different places and times is *distributed asynchronous* interaction.

System Types

E-mail, computer-teleconferencing, real-time-teleconferencing, and video-teleconferencing systems all help to create or to support electronic meetings. Meeting environments are created through text and graphics on computer terminals or via audio and video transmitted from one location to another. Computer-teleconferencing systems (e.g., BIX and CompuServe) represent an extension of the messaging and E-mail system models.

Real-time teleconferencing—such as Team WorkStation, a research system designed by Hiroshi Ishii of the Nippon Telegraph & Telephone's Human Interface Laboratories (Kanagawa, Japan)—is an example of distributed synchronous interaction. It allows participants in different locations to interact.

Another approach to real-time teleconferencing places a single-user application in a computer-teleconferencing environment. Information is exchanged among multiple users using a protocol that determines who has the floor at any given time.

Unlike computer teleconferencing, in video teleconferencing, video and audio connections link meeting rooms or networked workgroups. Participants can see and hear other members of the dispersed group (see "Better Than Being There" on page 129).

Electronic whiteboards, or live boards, electronically mimic the whiteboard that you find in many conference rooms. In this working environment, each member of a workgroup has a terminal on which to work and can broadcast results to everyone else's screen.

Xerox PARC developed an advanced electronic whiteboard that uses a projected LCD. Each participant in a meeting gets a stylus that allows him or her to write on the whiteboard from anywhere in the room. Xerox has connected the system to a network and has even used it to connect remote sites (see "The Electronic Whiteboard," July 1992 BYTE, page 166). At this writing, Xerox is in the process of setting up a commercial unit to sell the system.

Notable Technologies (Foster City, CA) recently announced Shared Whiteboard, communications software for Go Corp.'s PenPoint operating system that creates a real-time connection between two pen systems. It uses a phone line to transmit graphics and text between remote locations. A second phone line is needed for voice communications. David Larson, Notable Technologies' vice president of sales and marketing, says the company is working on a version that will allow more than two users to participate.

continued

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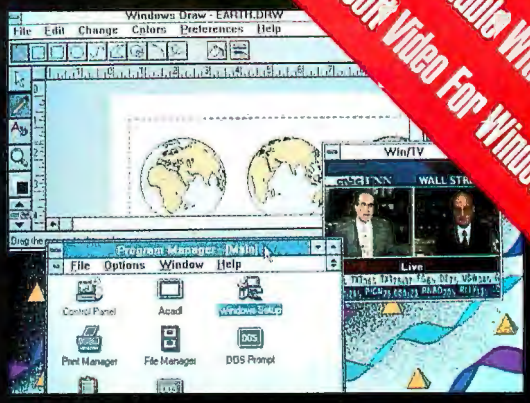

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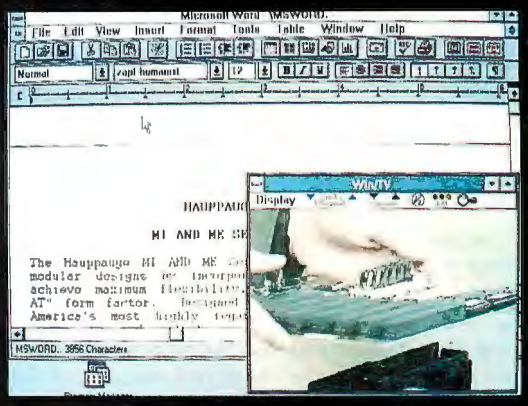

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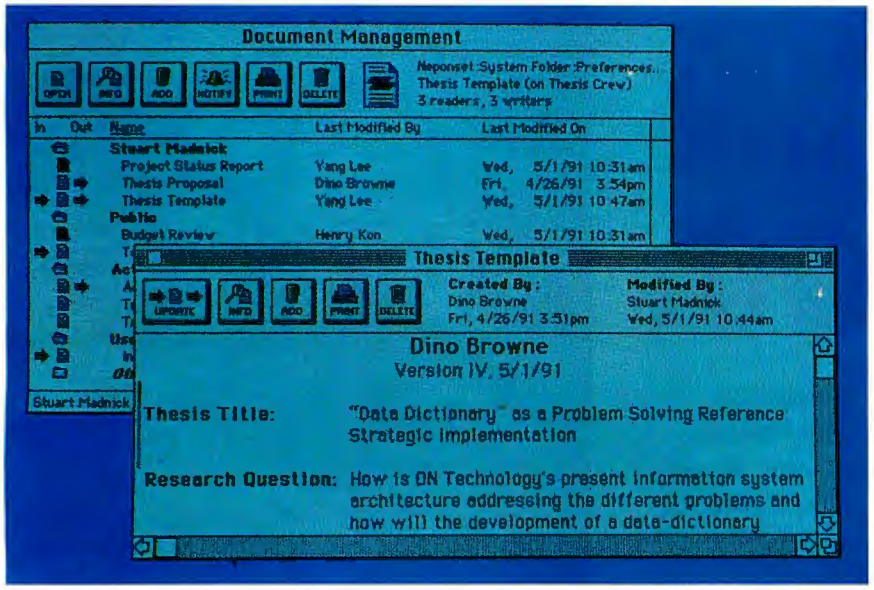

Instant Update uses arrows to indicate updated documents. In the foreground, you see who made changes and when. (Screen courtesy of On Technology)

Collaborative Writing

Multiuser editors and group-authoring systems are able to bring a workgroup's collective input to bear during the creation and editing of a document. Such collaborative systems can be either real-time or asynchronous.

If the authoring system is real-time, it lets several participants edit a document at the same time by parceling out logical segments of the document to members of the group. The system controls the read/write access to the various segments (e.g., the Group Writer facility in GroupSystems).

Asynchronous editors, such as Instant Update, store both the original text and the reviewers' comments. This allows a document manager to evaluate all comments before making final changes (see the screen).

Thomas W. Malone, director of the MIT Center for Coordination Science (Cambridge, MA) and developer of the research collaborative systems Information Lense and Oval, sees group-authoring systems evolving beyond document creation/editing systems. Malone envisions workgroups collectively creating knowledge networks that describe real-world objects or ideas. The networks would connect those ideas and objects and use hypertext-like links to represent the relationships and dependencies among the items. "These knowledge networks will be viewable through a variety of displaying and summarizing tools," says Malone. "They will be shareable across global networks and readable, browsable, and searchable" by you and your computer.

Conversational structuring, used in Coordinator II, an asynchronous groupware application published by Da Vinci Systems (Raleigh, NC), allows the structure of a workgroup's conversations to be developed and used during what is normally an unstructured meeting. You can see at a glance those messages that are most urgent.

Coordinator II comes with seven conversational paradigms (e.g., an informal note, an action proposal, and a what-if scenario) and prompts you to put your message into one of them. But it's fluid: Your responses need not follow the original message's paradigm. For example, you could reply to a what-if message using a for-your-information response.

This approach works well for Woods Wire Products (Carmel, IN), according to Robert L. Bogue, its LAN/wide-area network manager. Woods Wire Products, a manufacturer of electronic components and telephone accessories, uses Coordinator II to keep in touch with its offices in Canada, Mexico, Europe, and the Far East. "The conversation types that Coordinator II comes with are the basic building blocks of business communications," Bogue says. "I have not encountered any deficiencies in the conversation structures provided."

Workgroup Goals and Tasks

- generate ideas
- develop action plans
- refine data, graphics, and text
- make decisions
- negotiate solutions

Group Decision Making

GDSSes (group decision support systems) are designed to facilitate face-to-face meetings (see the text box "The Public Reacts to GDSS" on page 118). They provide tools for decision structuring, idea generation, voting, and ranking. GDSS meetings are frequently conducted by a facilitator.

GDSSes have three feature levels, but individual systems can have features in more than one level. Level 1 emphasizes the improvement of communication, idea formation and discussion, and messaging. Tools for Level 1 include messaging, screen viewing, rating/ranking scales, agendas, and voting.

For example, VisionQuest, which was developed by Collaborative Technologies (Austin, TX), provides an agenda structure that a workgroup can use to collaborate on documents and to generate, prioritize, and evaluate ideas. VisionQuest allows comments on ideas to be anonymous, and it manages all communications and document proceedings.

Level 2 systems incorporate the strengths of decision-support modeling and group-decision techniques to enhance the system. Examples of these techniques include project planning and control/operations research tools such as CPM (critical path method) and PERT; probability and decision-tree software; and statistical features and decision techniques that are designed to solve complex, unstructured problems and to help to coordinate information exchange in asynchronous problem-solving groups.

When equipped with its optional Advanced Tools, GroupSystems V provides a Level 2 environment on desktop computers linked by an Ethernet or token-ring LAN or in a specialized meeting room (see the photo). An outliner lets a group analyze ideas by constructing an eight-level outline. Its Idea Organization facility lets a workgroup build a list of ideas or categories and attach or import unstructured comments to any item on the list. You can rearrange, edit, and consolidate items and comments. Its group matrix feature helps establish relationships between rows and columns in a matrix format. Ventana's TeamGraphics, which runs on Microsoft's Windows 3.1 or Windows for Workgroups, features collaborative design of graphical

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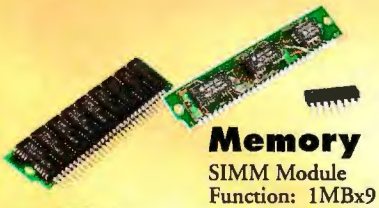

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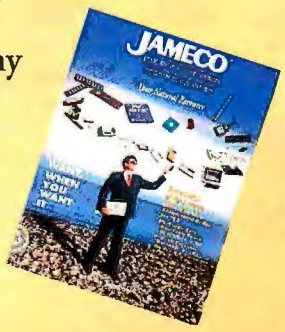

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The Public Reacts to GDSS

JAMES D. GANTT AND CATHERINE M. BEISE

When was the last time you enjoyed a meeting and looked forward to your next one? Surprisingly, these sentiments were expressed by the participants in several tests of GDSS (group decision support system) software.

Early in 1992, we tested reactions to GDSS for the U.S. Army. Test-group sizes ranged from six to 20 members. Participants represented military (20 percent), government (23 percent), and civilian (58 percent) organizations. About one-third of the people were members of minorities, and one-fifth were women. Computer literacy levels ranged from none to expert. Participants were connected by a LAN running GroupSystems V software from Ventana (Tucson, AZ). GroupSystems provides anonymous, real-time, text-based interaction for workgroups.

We collected quantitative data and open-ended comments from participants. Participants used a five-point scale to rate their reactions; 5 was the highest score (see the table).

Our posttest interviews indicated that the less computer literate found GDSS meetings more effective than did their high-powered colleagues, perhaps reflecting lower expectations on the part of the former. More participants commented on GDSS's speed and efficiency than on anything else. And an additional benefit cited was the way GDSS forces a structure on meetings.

Participants believed that learning GDSS was a barrier. But many felt that it would be beneficial after frequent use.

Some participants initially feared using a computer, but they overcame this trepidation, perhaps in their desire to join in the discussion. Others felt interaction was limited by the system's structure. The meeting facilitator's skill affected whether the GDSS system structure was viewed negatively or positively.

One of our more interesting sessions involved members of an academic department with a reputation for raucous meetings. At the end of their test, they were amazed: They had reached a consensus on a touchy curriculum issue with everyone participating but with no one yelling in anger.

In most groups, the participants believed there was a benefit to the level playing field offered by anonymous communication. But this was put to the test by a group of managers. A gentleman in the group began to type his messages in uppercase, perhaps to differentiate himself from others. To his frustration, someone else opted to do the same. We don't know if these actions were deliberate, but one group member said, "I need to know who made a comment to evaluate it."

Overall, our test results indicate that people react positively to GDSS. Its ability to provide anonymity seemed to increase everyone's participation. More important, groups are more likely to achieve consensus and commit to following through on action plans developed at a GDSS meeting.

ACKNOWLEDGMENT

The authors thank Rick Watson and Alan Dennis of the University of Georgia for their contributions.

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PUBLIC REACTIONS TO GDSS

A test group of individuals ranging from computer novices to experts reacted favorably to a GDSS trial run by the U.S. Army. Participants rated each category on a scale of 1 to 5, with 5 being the most favorable rating.

Willingness to use GDSS tools again	4.4
Task accomplishment	4.3
Even participation	4.2
Satisfaction with process	4.1
Satisfaction with outcome	4.1
Good outcome	3.9
Commitment to results	3.8

diagrams, graphical what-if brainstorming, and a group whiteboard to share text and ideas.

Level 3 systems, which are in the developmental stage, automate group communications patterns. They allow you to select and arrange meeting rules and include such tools as an automated counselor and Robert's Rules of Order.

Lotus Notes

Notes from Lotus Development (Cambridge, MA) is a different type of collaborative system, but its effects are far-reaching. "Lotus legitimized groupware with its introduction of Notes," says Groupware '93's Coleman.

Notes can best be described as a group communications environment that lets you access and create shared information. It gives your workgroup E-mail, distributed databases, bulletin boards, text editing, document management, and various applications development tools, all integrated into an environment with a graphical, menu-based user interface. "It's the Swiss Army knife of tools," says Tim Deagan, manager of the services tools development

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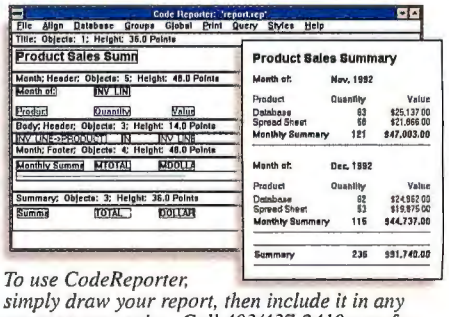

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Workgroups connect with each other from remote sites via a LAN or meet in special conference rooms, as pictured here. (Photo courtesy of Ventana Corp.)

group at Dell Computer (Austin, TX).

Deagan's group at the time, the R&D department, was among the first Notes takers at Dell, where it flourished. However, Deagan says, other department managers, especially those responsible for cost containment, were hesitant to spend the money (i.e., license fees of $395 per user) for a tool that seemed to many not to have a clear mission.

MIT's Malone also sees this as a problem for Notes. "Precisely because Notes is so general, it is often hard to understand at first what it is useful for," says Malone.

Notes has gained acceptance at Dell, says Deagan, finding uses in such diverse areas as database development, training, and quality control. But it was a long journey: "You have to lure people to Notes," he says. "Its versatility has kept Notes above water, but its versatility smothers it."

Windows for Workgroups

Windows for Workgroups integrates groupware into the network environment. It gives you E-mail; group scheduling; real-time conference facilities; network-monitoring utilities; and file, printer, and Clipboard sharing (see "Windows for Workgroups," November 1992 BYTE).

The Windows GUI is an important part of Windows for Workgroups. Its ClipBook Clipboard sharing facility lets you cut, paste, and share pages of data, such as when you transfer pages of information directly into someone's Clipboard. The Schedule+ feature helps you plan meetings on-line by merging prospective attendees' schedules, finding a suitable time, and mailing out invitations.

Brian Howden, a technical specialist working for the British Columbia Ministry of Forests (Victoria, BC, Canada), says that his organization is conducting pilot programs to determine if Windows for Workgroups will solve some of the ministry's connectivity and API problems.

At the ministry, more than 1500 desktop computers run Windows. Dozens of LANs provide shared resources for these and other types of computers, and an IBM mainframe provides ministrywide E-mail. Ensuring connectivity among all workstations and peripherals is a costly and ongoing problem. But Windows for Workgroups supports the Windows Open Services Architecture, so it provides out-of-box standard APIs for applications development. "Anything that provides a standard API is attractive to us," Howden says.

If Howden is apprehensive about anything in Windows for Workgroups, it's that the groupware has its own mail application, which could disturb the ministry's existing E-mail service. Unless the ministry migrates to Microsoft Mail, Windows for Workgroups mail could "entice users to set up noncompatible islands of E-mail within our organization," says Howden (see "Smarter E-Mail Is Coming" on page 90).

Cultural Challenges

Collaborative systems can meet stubborn resistance when they are introduced in a company, because they challenge the organizational culture with a new means of communication. "Groupware moves a company from a very hierarchical structure to one where each individual's input is accepted regardless of sex, race, or office status," says Harold J. Gallagher, CEO of Collaborative Technologies.

Some managers have problems with this because collaborative systems can upset a company's unique environment for getting work done. You must take this into account when planning your collaborative information system. "The collaborative environment adds a new, on-line culture to your organization," says John Donovan, an analyst with Workgroup Technologies. As manager, your "challenge is to define that culture so that you have a more effective organization."

But the higher you climb in a company's organization, the more you can encounter resistance to collaborative computing, says Bernard DeKoven, a management consultant based in Palo Alto, California. DeKoven argues that the monetary incentive systems of upper management are often disincentives to sharing ideas and data, because personal information is an individual's powerbase. "If you don't acknowledge the incentives for competition that exist in your organization, any effort at creating a collaborative system will be sabotaged" by office politics, says DeKoven.

Groupware and collaborative efforts are most successful at the lower levels of an organization, says DeKoven. Lower-echelon employees are used to workgroup projects, have fewer incentives for competitive behavior, and usually are so disempowered that they prefer to wrap their comments, ideas, and suggestions in anonymity, says DeKoven.

DeKoven has worked with several companies that have successfully integrated collaborative systems into their environments. Mostly, they've been companies that have adopted flat organizational structures, where everyone has access to information, and high-tech companies, where workgroups are the norm. In more traditional businesses, collaborative systems succeed best when they spread above and below from middle management, according to DeKoven.

But "the technology is not going to drive the cultural changes," says DeKoven. "As long as there are incentives for competition and control, people will use groupware only to further their individual goals."

For collaborative systems to be truly successful, you must change the way you operate. According to Groupware '93's Coleman, collaborative systems can provide that incentive to change: "Often people perceive their value to a company as their expertise, and if they share that expertise, they've lost their value. But frequently it turns out to be the other way around—their coworkers find out just how valuable they are to the company." ■

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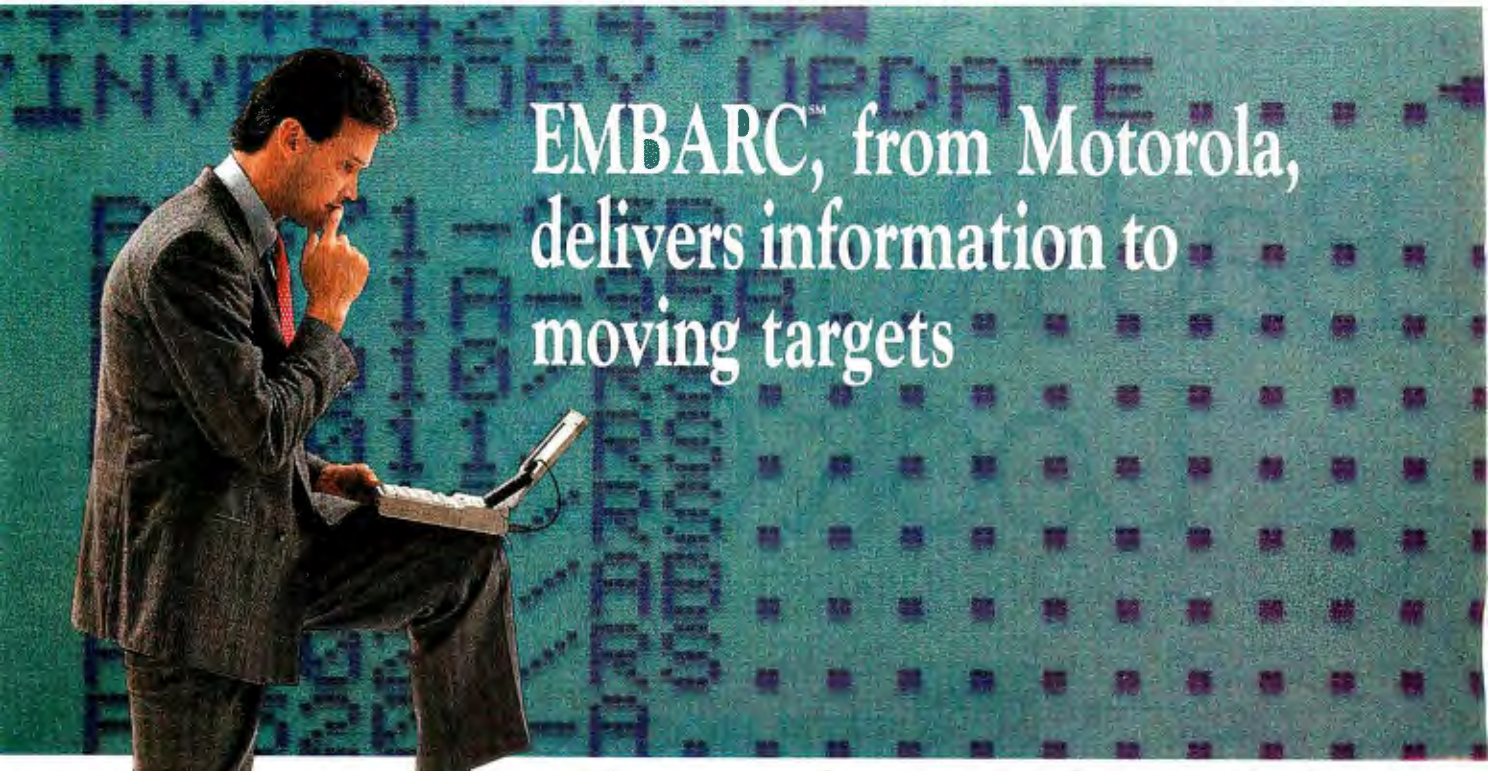

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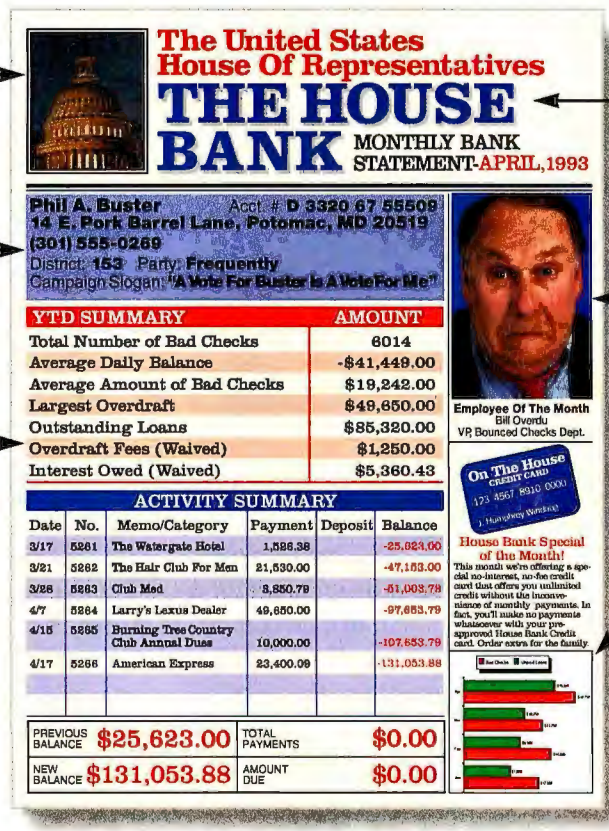

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HITTING WARP SPEED FOR LANS

High-speed networks promise the performance that collaborative computing needs—at a price

MARK A. CLARKSON

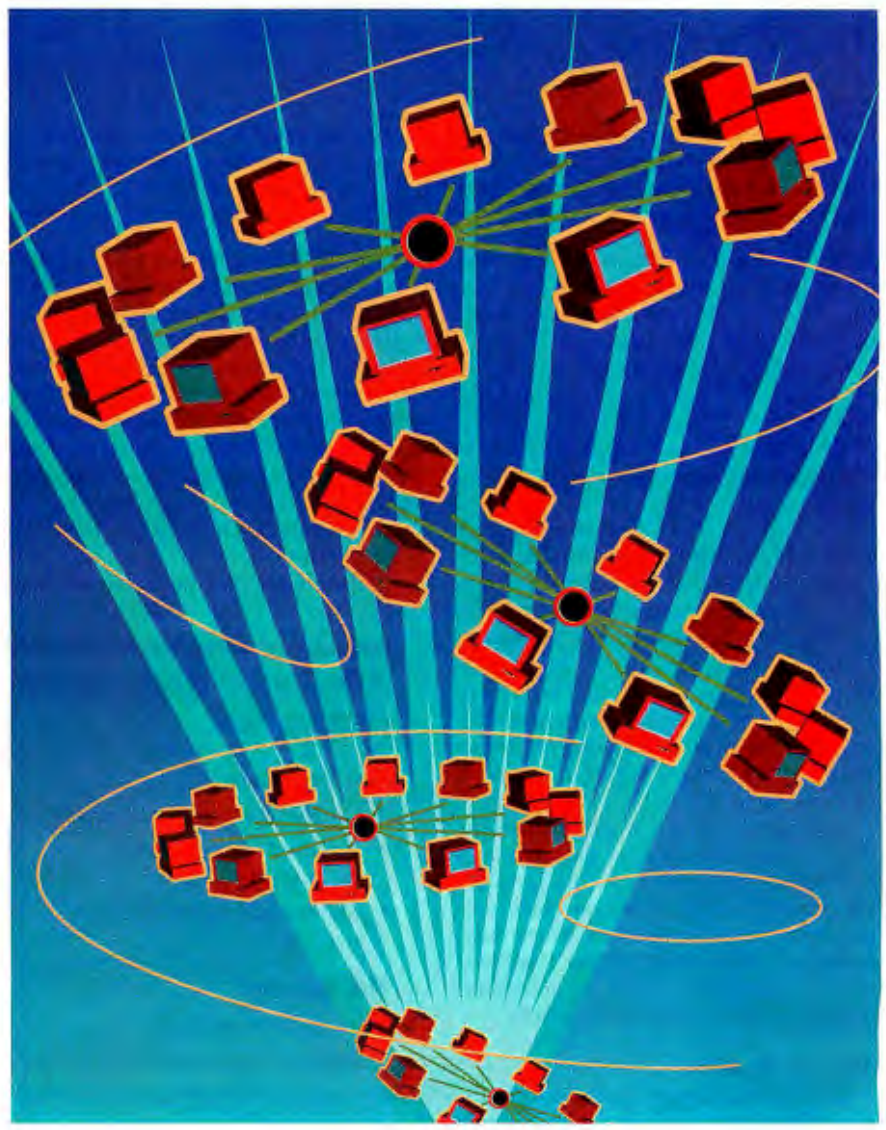
Brian Lyles, a researcher at Xerox PARC (Palo Alto Research Center), designs collaborative applications of the future in areas such as scientific visualization, desktop teleconferencing, and advanced document management. The feasibility of these applications depends on the resolution of formidable problems.

LANs provide limited data-carrying capacity (i.e., bandwidth)—10 Mbps on an Ethernet and 4 to 16 Mbps on a token-ring network. But collaborative applications require moving huge data sets that can overwhelm a network's bandwidth. For example, broadcast-quality video, even at 20-to-1 compression, requires a 6-Mbps data transfer rate. At that rate, a 10-minute broadcast represents half a gigabyte of data, the equivalent of five sets of the *Encyclopaedia Britannica*.

The applications that Lyles envisions involve continuous streams of high-quality audio and video data. "We're not going to settle for one stream of video to the desktop. We have applications that use many streams," says Lyles.

To make matters worse, LANs such as token-ring and Ethernet networks are shared-media networks. They allow only one conversation to take place at a time. And their bandwidth must be shared by all the users on a network.

Shared-media networks work best with short bursts of data (e.g., E-mail messages). In a client-server environment, for example, a number of workstations might share the same server. Because the server can talk to only one workstation at a time, it scarcely matters that the conversation takes place over a shared-media LAN. A network that primarily handles E-mail traffic will do



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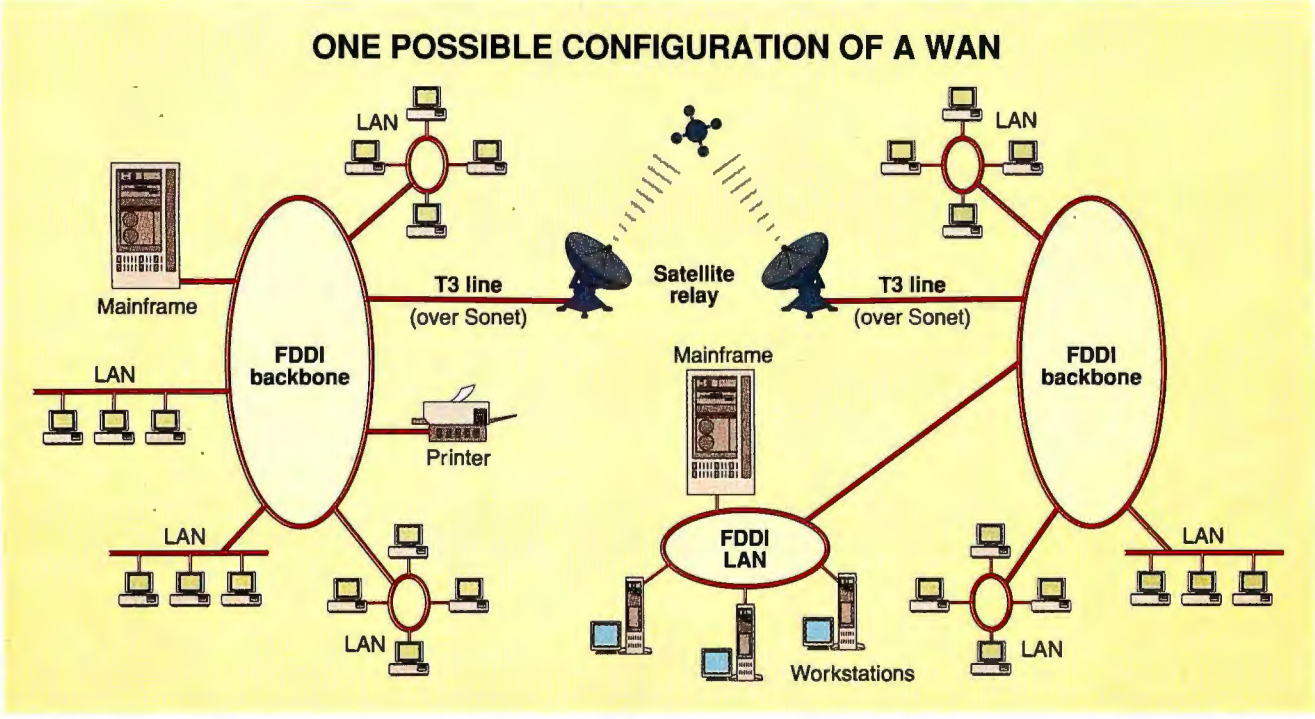

Figure 1: *LANs connect to each other over a backbone network. In this example, FDDI, a 100-Mbps optical-fiber network, provides the connection. Backbone networks can be connected to each other via a variety of private and public services, including leased lines and satellite links.*

just fine at token-ring speeds, but shared-media networks are not good at handling continuous data streams, like those created by a video teleconference.

Collaborative computing presupposes more interactive use of networks than just providing a medium for E-mail traffic. Much of the use is workstation-to-workstation (many-to-many) rather than client-server (many-to-one).

Because you might want to collaborate with someone across town or across the Pacific, your LANs must be connected to each other, and your bandwidth demands grow with every step. To link the slower 10-Mbps LANs, you use the faster 100-Mbps *backbone networks*. And to tie these together into a WAN (wide-area network), you use an even faster network, say something with a 1-Gbps or higher data transfer rate (see figure 1).

Although today's networks are too slow for advanced collaborative applications, a number of network-bandwidth boosters are coming into their own and may provide solutions to the problem. These technologies include FDDI (Fiber Distributed Data Interface), ATM (Asynchronous Transfer Mode), and switching hubs.

Video a Problem

"Video is the data type that will force the commercial networking business to come to grips with the bandwidth issue," says Jim Long, president of Starlight Networks (Mountain View, CA), a maker of video software for Ethernet networks.

Video is a key component of the next generation of collaborative applications, whether for desktop videoconferencing, training, or visualization. Other data (e.g., CAD drawings and true-color scanned images) may gobble up great chunks of network bandwidth, but none so voraciously as video.

"Video is not only huge, but it's continuous," says Long. Unlike a still image, which is finite and will be on the network for a short time, video just keeps coming. Single frames of broadcast-quality video—with compression—are about 12 KB each, and a new frame is shipped 60 times a second. Meanwhile, other devices sit idle because the network hasn't any bandwidth to spare for them. "Even a low-grade teleconference," says Long, "sends more data over your network in an hour than it has ever seen before." Studio-quality video requires 10-Mbps or faster data streams, which overwhelms a typical LAN.

Advanced High-Speed Networks

The Promise:

- variable bandwidth on demand
- new kinds of workgroup applications
- studio-quality desktop audio and video

The Reality:

- incomplete standards
- three to 10 times more expensive
- possible software incompatibility

Token Ring on Steroids

How do you increase your bandwidth? One way is to switch to a faster network, such as FDDI. "FDDI is really a token ring on steroids," says Long. Like token-ring networks, FDDI passes data around a ring, but its bandwidth is 100 Mbps, far faster than a token-ring or Ethernet network. For example, at 100 Mbps, you could ship this article around a network 1000 times a second.

But FDDI has problems. It's a new network with new protocols, and your software may not run on it. FDDI is also 10 times more expensive than an Ethernet network. Pricing for adapter cards starts at around $1000; Ethernet cards begin at about $100.

If FDDI is too expensive, how about

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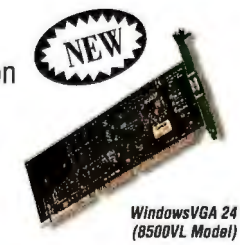

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Rolling the DICE

DICE (Distributed Interactive Collaboration Environment) is a research project under way at the National Center for Supercomputing Applications (Champaign, IL). DICE allows researchers—who may be physically far apart—to collaborate on large visualizations, which they can all view and with which they can all interact simultaneously. Several people can steer and control the parameters of the visualization.

The project was conceived as an environment in which to develop applications that exploit gigabit networks. Although the image processing and number crunching in DICE run primarily on supercomputers, the interactive user interface and the graphical output run on workstations.

Sending a continuous stream of high-definition images can consume more than 500 Mbps of bandwidth for each workstation viewing the simulation. "Nothing has been geared up to support these speeds," says DICE author Jeff Terstriep. "Every step you take, you hit another bottleneck."

As fast as computer speeds have increased, network speeds have grown faster. "All of a sudden, we've got a network that's faster than the VME bus that these workstations are built around," says Terstriep. "Even supercomputers don't necessarily have as much I/O speed as you'd like. It's a challenge."

For a network to support an advanced, interactive, collaborative environment, says Terstriep, it must be fast *and* exhibit low latency—outgoing data must not sit at your workstation, waiting for an opening in network traffic. Without low latency, the value of a fast network diminishes.

One intent of DICE research is to develop methods of efficiently moving large data sets on networks. DICE uses a message-passing system designed to move scientific data sets that range in size from 8 MB to 2 GB (e.g., multidimensional arrays of data) through various pipelines. It uses both high-bandwidth and low-latency networks, splitting the message to achieve the highest performance possible.

For example, the handshaking and control information has low latency. It doesn't require the high data transfer rate that a 2-KB by 2-KB by 24-bit image requires. DICE sends the handshake information through an Ethernet or FDDI (Fiber Distributed Data Interface) network and the image through a high-performance parallel-interface network. DICE ensures that these multiple networks operate in harmony and that the operation is transparent to the application and to the end user.

"Current high-speed networks have relatively high latency. I think you'll see ATM take over, because it offers very low latency at very high bandwidth," says Terstriep.

But better machine architectures are needed to exploit gigabit networks. The speed at which you can read and write to the RAM on your workstation becomes an issue.

"You find you can't afford to copy data from the user space to the operating system, to the networking card, and out on the wire," says Terstriep. All those copies take time and CPU cycles, and at gigabit speeds, time is precious.

speeding up your existing LAN? Grand Junction Networks (Union City, CA) is developing a product called Fast Ethernet, which is an Ethernet standard that matches FDDI's 100 Mbps. Also, IBM has reportedly pushed Token Ring to 64 Mbps.

The idea behind such pumped-up versions of familiar networks is to preserve your investments in network wiring and software while boosting network capacity to meet increased demands. But these so-called fast LANs are up to three times more expensive per installation, although they are far less expensive than FDDI.

In addition, all these fast networks—including FDDI—have flaws that may prove fatal over time. For example, none guarantee real-time data delivery. When audio and video are shipped as separate data streams, it's important that they arrive at the same time. The question becomes: Will 100 Mbps be enough?

"Some people say 100 Mbps is plenty of bandwidth," says Steve Krause, a technology analyst at SRI (Menlo Park, CA), an independent research institute. "But when Ethernet was introduced, people said, 'Ten megabits! No one will need more than this.'" Krause believes that as applications become more LAN-intensive they will need more than 100 Mbps.

Near-Unlimited Bandwidth

If 100 Mbps is not enough, there is a way to achieve almost unlimited bandwidth: *switching*. To understand switching, think about making a telephone call. You dial my number. I answer. We talk. In effect, we have a dedicated line linking us. In fact, our telephones are connected through one or more switches—universal connections—and can be similarly connected to any of millions of other telephones across the U.S. Millions of other telephone conversations are going on concurrently with ours. Even though the telephone lines have a low bandwidth, the capacity of this huge switched network—its *aggregate bandwidth*—is astronomical.

In a shared-media LAN, the aggregate bandwidth is the same as the peak bandwidth of the individual lines. For example, an Ethernet's aggregate and peak bandwidths are both 10 Mbps. Thus, adding nodes to your network increases its load, but not its capacity.

The aggregate bandwidth of a switched network is equal to the peak bandwidth of each line *times* the number of lines going into the switch divided by two. For example, 100 10-Mbps lines equals 0.5 Gbps (i.e., $100 \times 10 \text{ Mbps} \div 2 = 0.5 \text{ Gbps}$).

"That's why I like switched technology like ATM," says Xerox PARC's Lyles. "Switched networks tend to have an aggregate bandwidth that is much higher than their peak bandwidth." When the ATM standard is finalized, says Lyles, ATM should provide sufficient bandwidth for most collaborative applications.

ATM is isochronous (i.e., real-time) and provides high bandwidth on demand. Because it's a *packet-switched* network, it divides data into small clusters, called packets; moves them around the network; and reassembles the packets at their destination. ATM lets you mix and match channels of varying bandwidths and data types (e.g., video, data, and voice). You can have 150-Mbps, 600-Mbps, and 2.4-Gbps links on the same network. "ATM allows you to stop asking, 'What video quality can I get over the network?' and start asking, 'What video quality do I want?'" says Lyles.

Some companies, such as DEC (Maynard, MA), are developing ATM LANs. But the technology is sophisticated and

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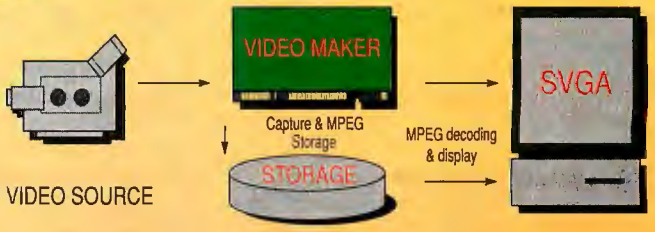

COMPARISON	VIDEO MAKER	THE MARKET
Movies capture	yes	no
MPEG compression	yes (about 30 Kbytes per second)	no
Digital VCR (100 % software)	yes	no
Frame capture	high professional quality	medium quality
Colors	16 millions colors per pixel 4:2:2 (2 times more color samples)	16 millions colors per pixel 4:1:1
Video standard	NTSC, PAL and SECAM	NTSC, PAL.
Spatial definition	768 x 576 (PAL and SECAM) 640x480 (NTSC)	720x512 (PAL) 640x480 (NTSC)
Aspect ratio	square pixel	rectangular pixel
Size of the board	short: compatible with desktop PCs	long
Technology	miniaturized: SMT	classic
Installation	no switches at all	many switches
IRQ, DMA	none: high compatibility	several IRQ and DMA
SVGA modes	all	limited
Video feature connector	not needed	absolutely necessary
RAM limitation in your PC	unlimited	conflict above 8 MB

Cable: 2 meters with RCA, BNC, SCART connectors

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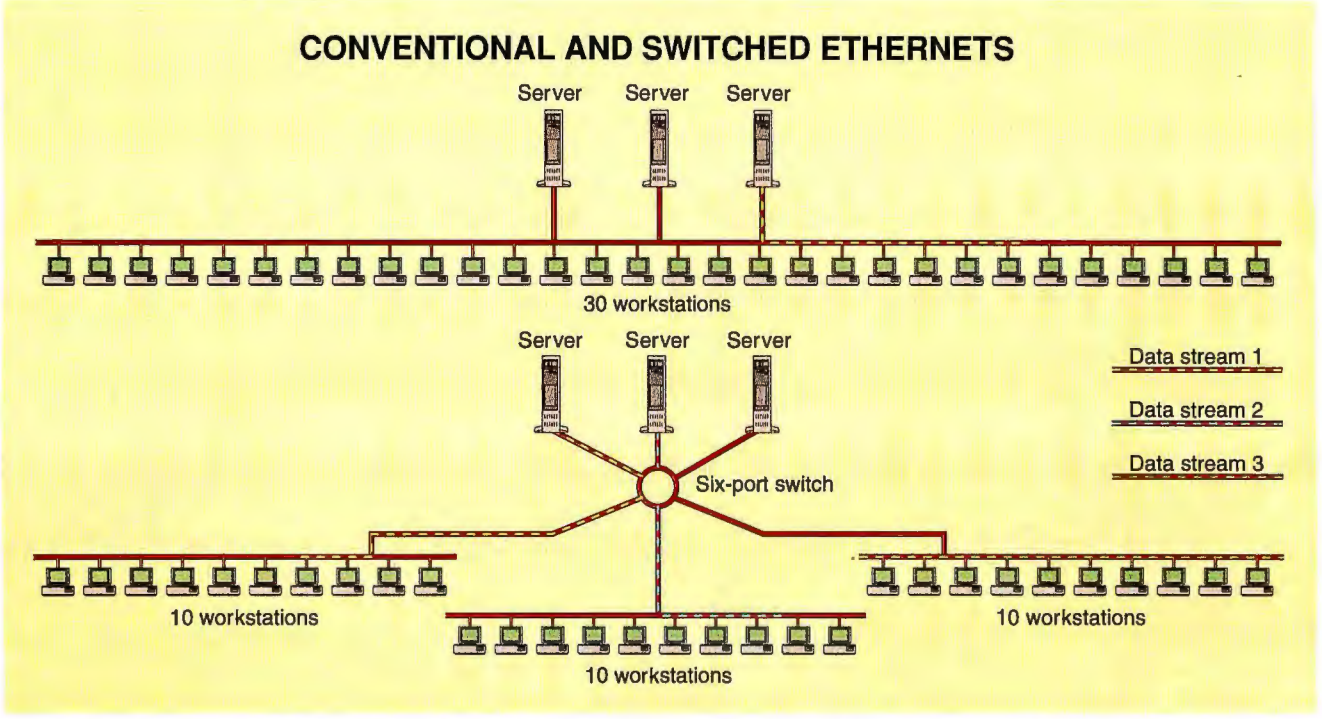

Figure 2: *In a conventional Ethernet network with three file servers shared among 30 workstations, only one conversation can take place at a time. With a three-by-three switch added to the network, you can have three conversations on the network at once.*

expensive—about $6000 per connection, says Howard Salwen, president of Proteon (Westborough, MA), a company that makes networking equipment and plans to deliver its first ATM-based products late this year. Given its cost and that the standard has yet to be finalized, ATM will probably not be a major player in the desktop arena for at least five years—pundits are reluctant to guess exactly how long. "ATM is a wonderful technology," says Salwen, "but it isn't soup yet."

Ethernet for Everyone

Switched-hub technology is already being added to Ethernet. It can turn a single Ethernet into an Ethernet for every network user (see figure 2). The upgrade is simple: You replace the old hub in your wiring closet with a new one. Instead of 100 people sharing 10 Mbps, you have 100 people sharing *1 Gbps*. You haven't restrung any wires. You are still using the same adapter cards and software as before. And it's still Ethernet.

"This could mean a new life for Ethernet," says Avi Fogel of Lannet (Huntington Beach, CA), a manufacturer of LAN hardware products. "It's no longer a shared medium—it provides each user with bandwidth on demand up to the full capacity of the network."

EtherSwitch from Kalpana (Santa Clara, CA) adds ATM-like packet switching to existing Ethernet LANs. It is similar to ATM in that it's a packet-switched technology, says Larry Blair, Kalpana's vice president of marketing. EtherSwitch is intended to boost throughput between desktops and servers.

Seeq Technology (Fremont, CA) adds another dimension to switched-hub Ethernet. Its 80C04 LAN-controller chip set provides Ethernet with two-way, or full-duplex, capabilities. Normally, Ethernet networks are one-way—only one node at a time can transmit, and a node cannot receive data while transmitting. By enabling full-duplex, the 80C04 doubles Ethernet's bandwidth to 20 Mbps (i.e., 10 Mbps to send data, and 10 Mbps to receive data).

A switching hub is about an order of magnitude more expensive than standard Ethernet, say $700 versus $70 per connection, but you preserve a significant part of your network investment. The Ethernet switched-hub approach is so powerful, says Starlight Networks' Long, "that many networking companies are abandoning FDDI for the desktop."

Ethernet may become the ubiquitous connection between computers and peripherals. "Ethernet could become the RS-232 of the nineties," says Long.

FDDI Squeezed

"Ninety-five percent of all computer users will do just fine for the next five years with 10 Mbps," says Long. "Shared servers and backbone networks—that's the arena where the battle for high-speed networks will take place first."

"It's hard to justify investing in a 100-Mbps ATM or FDDI for the desktop," says Lannet's Fogel. "But what if you can find a way at well under $1000 per user for each user to have a full, dedicated 10-Mbps network available? That's a different story."

For those that need 100 Mbps to run the advanced collaborative applications that Lyles is dreaming up in Palo Alto, what will the LAN of choice be? FDDI? Not according to SRI's Krause. "FDDI is in danger of being squeezed out of the desktop marketplace by faster Ethernets and token rings from below and ATM from above."

Most experts agree that the eventual winner in high-speed networks of all sizes will be ATM. According to Proteon's Salwen, ATM delivers bandwidth on demand; synchronous delivery of voice, video, and data; and the possibility of seamless connection between public and private networks (because it's a global standard). "We can do lots of things with ATM that we haven't been able to do before," says Salwen. ■

Mark A. Clarkson is a freelance science writer living in Wichita, Kansas. You can reach him on BIX c/o "editors."

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Operating Systems	39
Programming Languages/ Tools	40
Security	41
Shareware	42
Software Duplication	43
Spreadsheets	44
Unix	45
Utilities	46
Windows	47
Word Processing	48

General

Books/Publications	49
Recruitment	50
Miscellaneous	51

Inquiry Numbers 52-233

52	78	104	130	156	182	208
53	79	105	131	157	183	209
54	80	106	132	158	184	210
55	81	107	133	159	185	211
56	82	108	134	160	186	212
57	83	109	135	161	187	213
58	84	110	136	162	188	214
59	85	111	137	163	189	215
60	86	112	138	164	190	216
61	87	113	139	165	191	217
62	88	114	140	166	192	218
63	89	115	141	167	193	219
64	90	116	142	168	194	220
65	91	117	143	169	195	221
66	92	118	144	170	196	222
67	93	119	145	171	197	223
68	94	120	146	172	198	224
69	95	121	147	173	199	225
70	96	122	148	174	200	226
71	97	123	149	175	201	227
72	98	124	150	176	202	228
73	99	125	151	177	203	229
74	100	126	152	178	204	230
75	101	127	153	179	205	231
76	102	128	154	180	206	232
77	103	129	155	181	207	233

Inquiry Numbers 234-408

234	259	284	309	334	359	384
235	260	285	310	335	360	385
236	261	286	311	336	361	386
237	262	287	312	337	362	387
238	263	288	313	338	363	388
239	264	289	314	339	364	389
240	265	290	315	340	365	390
241	266	291	316	341	366	391
242	267	292	317	342	367	392
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247	272	297	322	347	372	397
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249	274	299	324	349	374	399
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251	276	301	326	351	376	401
252	277	302	327	352	377	402
253	278	303	328	353	378	403
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255	280	305	330	355	380	405
256	281	306	331	356	381	406
257	282	307	332	357	382	407
258	283	308	333	358	383	408

Inquiry Numbers 409-590

409	435	461	487	513	539	565
410	436	462	488	514	540	566
411	437	463	489	515	541	567
412	438	464	490	516	542	568
413	439	465	491	517	543	569
414	440	466	492	518	544	570
415	441	467	493	519	545	571
416	442	468	494	520	546	572
417	443	469	495	521	547	573
418	444	470	496	522	548	574
419	445	471	497	523	549	575
420	446	472	498	524	550	576
421	447	473	499	525	551	577
422	448	474	500	526	552	578
423	449	475	501	527	553	579
424	450	476	502	528	554	580
425	451	477	503	529	555	581
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427	453	479	505	531	557	583
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429	455	481	507	533	559	585
430	456	482	508	534	560	586
431	457	483	509	535	561	587
432	458	484	510	536	562	588
433	459	485	511	537	563	589
434	460	486	512	538	564	590

Inquiry Numbers 591-765

591	616	641	666	691	716	741
592	617	642	667	692	717	742
593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
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780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
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1129	1155	1181	1207	1233	1259	1285
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1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
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1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
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Inquiry Numbers 1305-1479

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1307	1332	1357	1382	1407	1432	1457
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1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
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BETTER THAN BEING THERE

Desktop video teleconferencing could change how you do business

TOM YAGER

Companies labor under primitive notions when it comes to transacting business. Employees commute to and from offices, spend countless wasted hours on airplanes and in hotel rooms, and generally make bad use of time because people insist on doing business face-to-face.

Telephones help, and fax machines and modems help more, but these limited technologies support only one form of communication at a time. Business leaders are reluctant to buy into telecommuting because they understand that *true* communication hinges on the full range of human contact: expressions, sights, and sounds. Yet bringing people together for meetings is costly, both in time and money.

Big outfits like IBM and AT&T are applying technology to solving this problem. They're using expensive satellite-based video-teleconferencing systems to create "virtual meetings" with people in multiple locations. But those without massive resources are in a bind; even scaled-down video-teleconferencing systems cost tens of thousands of dollars. Perhaps more important, they don't offer a complete solution: You still have to go to the video-teleconferencing center.

Why can't video teleconferencing be something you do from your own desk, just like making a telephone call? That's the objective of many companies working on desktop video-teleconferencing solutions. The technology has a long way to go before it's practical, but today's solutions suggest plenty of reason for hope.

Say What You Will

Today's teleconferencing technology falls into one of three categories: voice or data

ILLUSTRATION: STEVEN LYONS © 1993

BETTER THAN BEING THERE

Photo 1: *The PictureTel video-teleconferencing system. (Photo courtesy of PictureTel)*

only; voice and video; and voice, video, and data. Everyone is familiar with the first category; it has been around for years in the form of telephone conference calls—an uncontrolled exchange with notoriously poor quality.

Combining voice and video is advanced technically when compared to an ordinary telephone call. But most commercial video phones support only one video and audio connection (with a maximum of two participants). That's too limited for most business uses.

Once you add the ability to pass binary data with the voice and video, the possibilities are limited only by communications-channel bandwidth, data compression, and applications software (see "Hitting Warp Speed for LANs" on page 123). With the right application, you can start a meeting with a colleague in another office and, without making another call or breaking the conversation, send the colleague a document containing a color chart simply by dragging the document into the appropriate folder icon. In addition to that one-shot use of a data channel, you are able to have a constant binary data stream passing other information, such as the data streaming to and from sensory I/O devices (see the text box "Being Here and There" on page 132).

Video Teleconferencing

- integrates data, voice, and video
- can be used by workgroups
- can reduce business travel expenses
- speeds decision making
- is migrating to the desktop

To enhance your productivity, a teleconferencing solution must at least provide the benefits available in an in-person meeting. You want to be able to distribute a written agenda or a proposal for consideration, scribble on an electronic whiteboard, or even pound on a virtual table to get attention. Without electronic equivalents for the things that happen in a face-to-face meeting, teleconferencing comes up short. But more than that, if a computer's going to be involved in the process, you expect it to let you do things *better* than you can in person.

Both Sides Now

Video teleconferencing is a new spin on an old idea. A dial-up computer service's chat mode is a bottom-rung, multiparticipant teleconference. Participants talk through keyboards instead of with their voices.

More serious versions of text teleconferencing are in widespread use. For example, the U.S. Army Missile Command at the Redstone military base in Alabama uses GroupSystems, a text-based teleconferencing system from Ventana (Tuscon, AZ). This system links participants in graphically managed meetings. Files can be shared among participants, and the system's group-writing feature lets them mark up and comment on shared documents. Meetings can be for brainstorming, voting, and alternative evaluation, according to Danny Washington, one of the system's implementers. External participants can dial in and participate in meetings.

In general, Washington believes that electronic meetings are adequate replacements for in-person encounters and that they may be better than face-to-face meetings for large numbers of people. Washington's group plans to add video capability to its electronic-meeting system, but the text-based side will be maintained.

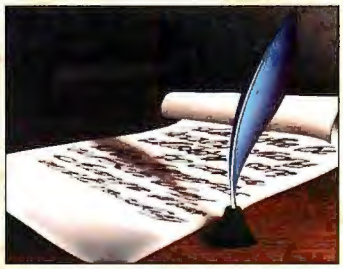
Others at Redstone use MediaMax from

The Evolution of CAD

From the beginning of time, we have tried to express ourselves through graphics.

In the beginning of time people had to use primitive design tools for creating any type of graphics.

In the 15th Century design tools were quill ink pens and crude styles of paper.



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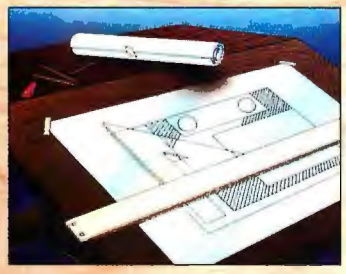
By the 18th Century we had advanced to the drafting table with T-squares, and the dreaded eraser.



In the 20th Century the first CAD programs were very slow and extremely difficult to use, not to mention the expense of buying them.

PC MAGAZINE EDITORS' CHOICE December 17, 1990 DesignCAD 2-D, Ver 5.0

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Being Here and There

DAVID H. MITCHELL

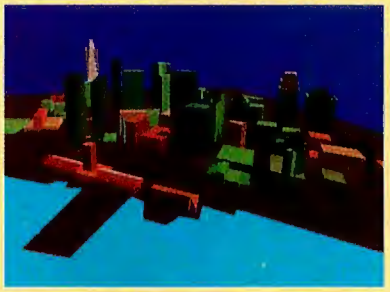
Tele-presence is like the old-time radio broadcasts in which actors re-created the actions of a distant event, except that with this technology you are a part of the action. With tele-presence, you can be in your office in San Francisco and with your colleagues in London at the same time.

Tele-presence uses virtual-reality technology to simulate objects, people, sounds, and worlds (see photo A). You are hooked to your computer through tactile-sensor-equipped gloves and head-mounted displays (see photo B). Your computer (an Amiga 4000 or a Sun Sparcstation 2 is muscular enough) brings to life events in a distant, virtual world using databases or real-time objects and sounds.

Modem-to-modem links or a packet network convey the distant event's essence to you. High-speed (i.e., 19,200 bps) modems are sufficient for two users. ISDN channels are recommended when large amounts of data must be moved quickly for true tele-presence. "With the proliferation of broadband ISDN, virtual worlds will be able to be shared over the phone lines," says Dave Blackburn, founder of The Virtual Reality Institute (Santa Monica, CA).

The output from the digital databases of real objects and sounds are sent to your head-mounted display, depicting scenes such as the one in photo A. Your senses are immersed in an illusionary, yet sensate, world.

These databases are key: They minimize the amount of information that has to be sent to you through your communications pipeline. "With a tele-presence database, you simulate virtual reality without having to pass horrendous amounts of data back and forth," explains Clint Woeltjen, a virtual-reality researcher and developer.



Photos A and B: *Photo A (above) is a virtual model of San Francisco. Photo B (right) shows a man wearing tele-presence equipment. (Photo courtesy of Sense8 Corp.)*

Photo B shows a man wearing a head-mounted display and a tactile-sensor-equipped glove, with which he is reaching out to manipulate a remote object. The roller panels underneath his wheelchair measure direction and velocity, which are used to create a viewpoint in his virtual world. As the man moves, his viewpoint of the world he's seeing changes.

Today, this equipment is as rare as it is expensive. A typical setup like this requires remotely operable hands to manipulate objects, two-way microphones for conversations, and stereoscopic TV cameras so that you can see what's going on. Costs can start at more than $100,000 per user.

In spite of the high costs, tele-presence's proponents are increasingly optimistic. Programs that let you design custom databases of real-world objects are already beginning to show up on the market. For example, the WorldToolKit from Sense8 (Sausalito, CA) gives you a set of C functions that you use to build interactive, 3-D, real-time graphical simulations. WorldToolKit runs on IBM ATs, Sun Sparcstations, and Silicon Graphics Indigo computers. It costs $3500.

Tele-presence is "going to be on-line by the end of 1993 in several large corporations," says Mike J. Donahue, president and CEO of Ono-Sendai (San Francisco, CA), a start-up company specializing in virtual-reality products. Industry insiders anticipate that the first generation of mass-market, affordable tele-presence gear will enter the market in 1994.

David H. Mitchell is president of the Diaspar Virtual Reality Network (Laguna Beach, CA), an on-line system devoted to providing an experimental platform for virtual-reality development.

VideoTelecom (Austin, TX) for video meetings. This conferencing system works with DOS-based PCs and ISDN connections to manage multiple-participant video teleconferencing. Tim Bell, a communications officer, finds that MediaMax is able to handle five or six participants simultaneously before the group's size becomes unmanageable. Participants see color images of each other, accompanied by audio, and they can pass around data through the ISDN link. "The productivity gains are tremendous," says Bell. The video allows them to exchange graphical information and to see facial expressions.

Redstone conference members have to trek to specially equipped video-teleconferencing rooms. There are no plans to equip every desk with video, but offices big enough for small meetings may be set up for video teleconferencing, says Bell.

Alison Raffalovich, marketing communications manager for VideoTelecom, credits her company with pioneering the type of video teleconferencing that is being adopted by emerging desktop products. The MediaMax system that is in use at Redstone operates over any digital link (telephone and satellite links are preferred) with a bandwidth of 56,000 bps or higher. MediaMax is not a desktop solution—at least not yet. Some VideoTelecom customers wire multiple rooms and cart the gear from one location to another, says Raffalovich.

With each site costing from $35,000 to $80,000 to equip, it's likely to be some time before MediaMax or something of its ilk lands on your desktop. But when video-digitizing and compression/decompression chips become less expensive, standards for passing large amounts of data through networks are solidified, and ISDN becomes more available, VideoTelecom's strategy should map well to a desktop or small-group environment.

To Your Desktop

The goal shared by those with a stake in video teleconferencing's success is to make a video call as simple to place as a telephone call while retaining all the benefits that high-speed digital channels offer. As with most things, there's more than one worthwhile approach.

PictureTel (Danvers, MA) is shunning the low end of the market, preferring instead to sell smaller systems that equal the quality of their conference-room gear (see photo 1). "People need systems that deliver good-quality video in a 5-inch window or a 27-inch boardroom monitor," says Ron Taylor, manager of media relations for PictureTel. The company's least expensive system costs about $20,000 and requires an under-the-desk processor unit, but future plans call for personal computer board–based systems and stand-alone videophones.

PictureTel's goal, according to Taylor, is to ensure complete cross-product compatibility. Video-teleconferencing systems "must have a certain level of quality and performance that makes them more than a toy," says Taylor. PictureTel will eventually compete in the low-end market, but for now it seems content to take the high road.

If Taylor's predictions are correct, PictureTel has plenty to look forward to. He estimates that the worldwide video-teleconferencing market will be worth about $7 billion by 1997, with 30 percent to 40 percent of those dollars invested in desktop systems. Because desktop solutions cost less, the share of the market occupied by desktop systems will be closer to 80 percent, says Taylor.

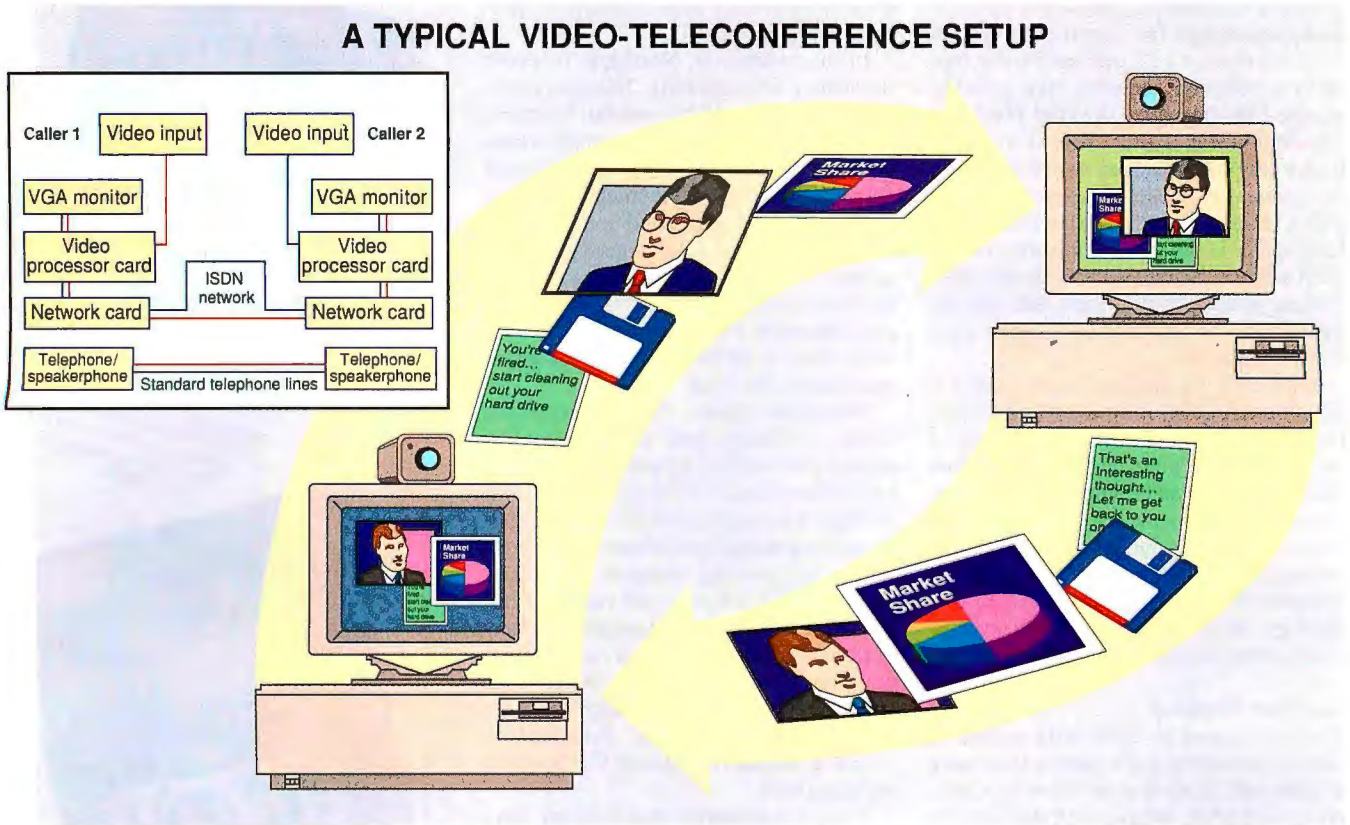
In the meantime, Northern Telecom (Research Triangle Park, NC) is exploring the market with its own full-featured, card-based desktop video-teleconferencing system. Best known as a supplier of corporate telephone equipment, Northern Telecom has long enabled companies to meld their data and voice networks. The advent of ISDN (and its counterparts, such as Switched 56) paved the way for Northern Telecom to extend its connection model to a dial-up video-teleconferencing system that it calls Visit.

With all its options, Visit equips a PC or a Mac to manage both video teleconferencing and ordinary voice telephone calls (with voice mail). After connecting with another Visit-equipped computer, Visit produces a resizable window displaying a gray-scale moving video of the person you're calling. You also see your own image, which lets you keep yourself properly framed. Both participants can bring up drawings and documents in a shared work space, and Visit has annotation tools for simultaneous markup and written comments. In addition, two-way file transfers are supported.

Visit dynamically manages the data channel. When nothing else is going on, the video and audio occupy the channel's full bandwidth, delivering 8 to 14 video frames per second, depending on the size of the viewing window and the transmission medium. Once you initiate a file transfer or do something in the shared work space, Visit multiplexes the channel, trimming the video frame rate and giving the freed bandwidth to the nonvideo activity. If you want faster file transfers, you can put your video window on hold—whatever you're not doing makes everything else go faster.

Visit works with a PBX, which solves one of video teleconferencing's diciest problems: how to get connections to multiple desks (see the figure). Rather than investing in ISDN or Switched 56 for every desk in the company, you have to buy only enough technology to support all simultaneous video users. Visit communicates with a PBX to allocate line resources and route them to the appropriate desk. It doesn't require a Northern Telecom PBX, but its capabilities are said to be enhanced by the pairing.

Jeff Benson, Northern Telecom's market development manager, says that Visit offers robustness, low cost, ease of use, and performance. The per-seat cost of $3899 (this does not include the expense of the computer or the hardware for the telephone connection, which adds from



In video teleconferencing, your images are captured by computer-mounted cameras. Video processors digitize and compress images, which are transmitted over a network bidirectionally. Audio travels via telephone lines or through your network.

$300 to $1500) seems to bear out at least the low-cost portion of that claim.

Benson is not optimistic that Visit or something like it will run on an ordinary voice-grade telephone line. Although he allows that modem and compression technology might advance far enough to make it possible, "the real answer has more to do with market requirements than technology." Users, he says, expect a video-teleconferencing link to deliver good-quality video *and* snappy performance for data-sharing exercises. Thus, even though they cost more, digital-grade transmission lines will be the favored pipeline for systems like this.

No Longer on Hold

The future of video teleconferencing looks bright. The rush of interest in multimedia is driving the development of custom hardware and software to digitize and compress video signals. And video teleconferencing is helping to drive the proliferation of ISDN in the U.S. Assuming the future will offer accessible digital telephone connections and inexpensive video-processing hardware, how far can this technology take us?

Brett Boston, president of Group Solutions (Atlanta, GA), a teleconferencing consulting firm, sees the limited implementation of ISDN as a barrier to widespread acceptance of teleconferencing, "but only in the U.S.—Europe is already there." Small private carriers are already building fiber loops through major U.S. cities. In addition, cellular communications will soon gain enough bandwidth for high-speed data transfer and possibly for low-speed video, he says.

Another impediment to the acceptance of teleconferencing is the lack of conference-capable environments and applications. Of the popular computer operating environments, only the X Window System is inherently able to provide the support for the networked user interface that teleconferencing and groupware require. "More vendors have to put better hooks in their software so stuff works together over a network link," says Boston.

Boston believes that Unix will win out because it already supports most of the cooperative attributes that other environments are struggling to acquire. A Unix application, whether text or graphical, can be run almost effortlessly through any kind of digital data link. It's a short hop from there to the connection of multiple parties in a shared session.

But the biggest problem has nothing to do with technology. "People are just now learning to use voice and electronic mail," says Boston. "Groupware is damn scary for some because it is, by design, quick and completely democratic." That goes against the cultural philosophy of most managers, who are accustomed to central decision making and waiting for paperwork and travel arrangements.

On the other hand, success is often determined by the speed with which a company can make key decisions. Video teleconferencing has the power to reduce or eliminate paperwork delays and commuting and travel time and offers the potential of reducing operating costs by making an employee's work location irrelevant. "Within seven years," says Boston, "there won't be any companies with 3000-person staffs all in one place." ■

Tom Yager is a multimedia consultant and the author of The Multimedia Production Handbook for the PC, Macintosh and Amiga *(Academic Press, forthcoming). You can contact him on BIX as "tyager" or on the Internet at tyager@bytepb.byte.com.*

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MIXED MESSAGING

Multiplatform internetwork mail links diverse network clients

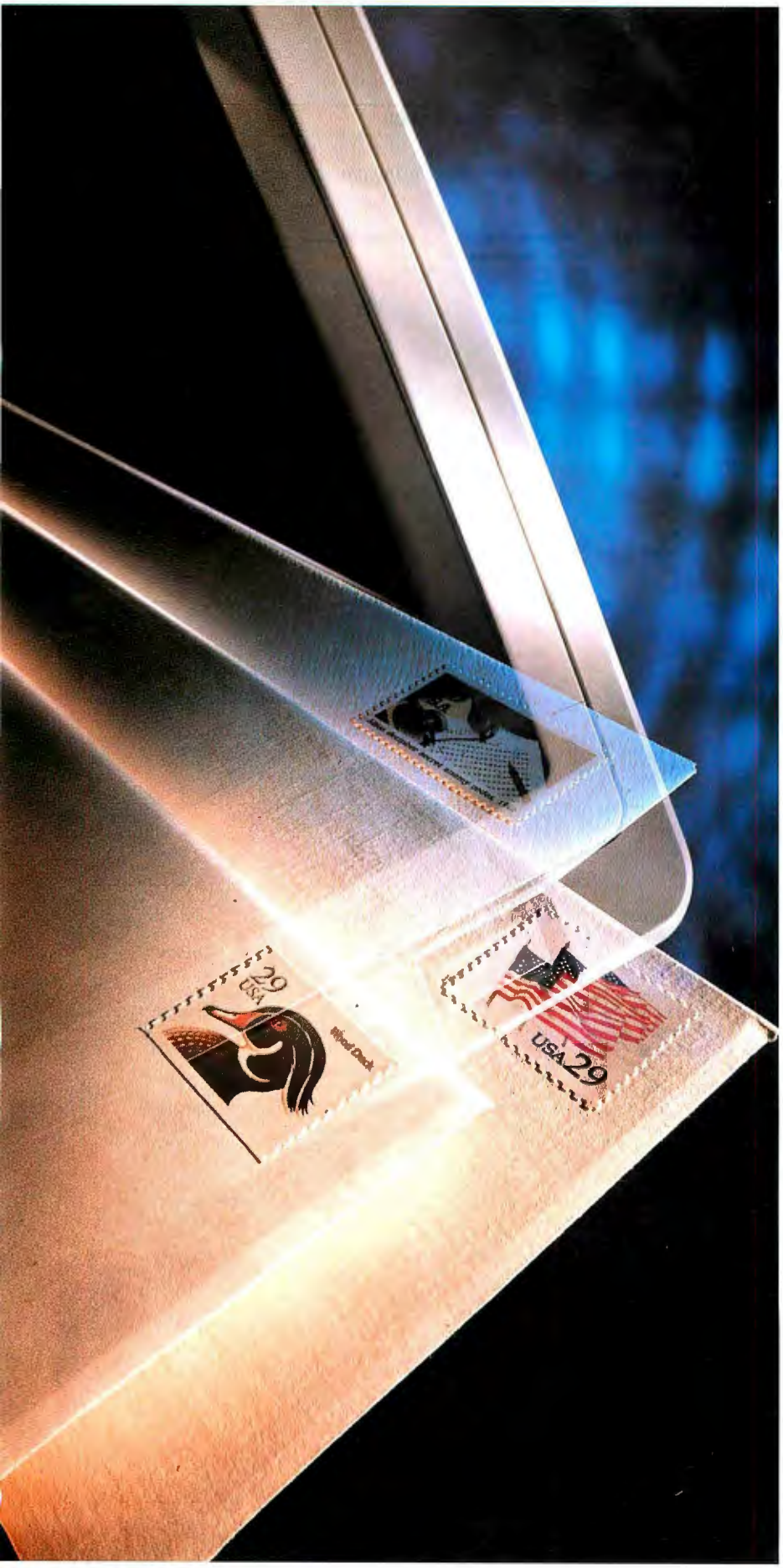
HOWARD EGLOWSTEIN
AND BEN SMITH

If you want to build a multiplatform internetwork mail system today, you have three basic choices. First, you can establish a Unix network and use standard Unix mail protocols. Second, you can mix and match client modules for each platform with vendor-supplied gateways and third-party mail routers. Or, third, you can set up an integrated mail system designed with multiplatform internetworking requirements in mind. Unix mail is a viable solution, but it's one that doesn't readily lend itself to extensive existing PC or Mac networks. For a look at the state of Unix E-mail, see the text box "The Unix Mail Story" on page 148. (Our cover story, "Smarter E-Mail Is Coming" on page 90, explores how E-mail can automate workflow.)

It's the third category, single-vendor mail systems, that we've focused on in this article. We've reviewed E-mail systems that are part of a family of products that promise a full solution to the complex problem of internetwork E-mail. In a shrinking world, where communicating with dissimilar systems at various sites is an everyday requirement, these systems look particularly attractive.

We've selected five E-mail systems that provide both multiplatform client support and a generous allotment of external gateways. Lotus Development's cc:Mail is a network-based system that relies on a shared-file network connection to share mail among Macs, PCs, and Unix systems. Da Vinci Systems' Da Vinci eMail provides client support for PCs and Macs through Novell's MHS (Message Handling Service). Microsoft Mail comes in two flavors, a Macintosh network version (which connects Macs and PCs through AppleTalk) and a PC network version (which connects similar clients through shared files). We tested the PC network version only. CE Software's QuickMail is an AppleShare-based mail system that supports Mac and PC clients. Finally, WordPerfect Office works through various networks and supports many different workstation platforms. The table presents details of client support and lists other features of each product.

Naturally, all these interconnections and all this rampant interoperability create a testing challenge. Our test setup included a battery of Macs and PC compatibles,



BYTE ACTION SUMMARY

- **WHAT MULTIPLATFORM E-MAIL IS**
  Multiplatform E-mail systems offer support for clients on various operating systems and network platforms and provide extensive gateway links to other E-mail systems.
- **LIKES**
  Gateway connections to virtually every mail system; good user interfaces common among platforms.
- **DISLIKES**
  Client support is uneven on different platforms, and some client user interfaces are poor. Configuring and connecting mail systems is very complex.
- **RECOMMENDATIONS**
  For a wide range of client platforms and for connecting to the most diverse systems, cc:Mail excels. For Mac-specific applications, QuickMail is the best choice.

plus a few Unix workstations, all connected over a mixed Ethernet and LocalTalk network. Cayman Systems' GatorBox CS provided the connection between LocalTalk and Ethernet, and a NetWare 3.11 file server running NetWare NFS and NetWare for Macintosh provided a common shared-file system. For wide-area connections, we relied on three Hayes V-Series Ultra (9600-bps) modems.

Each E-mail system that we tested used these resources in a different way; we discuss the configurations in the individual product descriptions. We also describe what it's like to set up, administer, and use each E-mail package in a mixed-client, mixed E-mail configuration.

There's one piece of the internetwork E-mail puzzle that these systems, for all their flexibility, don't totally address—the issue of multiprotocol mail gateways and mail backbones. We get into that subject, with some hands-on experience with Retix Open Server 400, in the text box "Gateways and Backbones" on page 146.

Gateways are likely to become more important as more companies install E-mail systems. At the very least, having gateways in place can save you from having to dial into several commercial systems each day to pick up all your mail. And a fax gateway would allow anyone in your department to send and receive faxes from his or her desk.

continued

FEATURES SUMMARY: MULTIPLATFORM E-MAIL

Gateway support and user-interface features are the concerns we concentrated on during our review, but security and configuration issues are also critical. (● = yes; ○ = no.)

	cc:Mail	Da Vinci eMail 2.0	Microsoft Mail for PC Networks 3.0	QuickMail 2.5	Wordperfect Office 3.0
Configuration					
Workstation environments	Mac, DOS, Windows, Open Look, OS/2	Mac, DOS, Windows, OS/2	Mac, DOS, Windows	Mac, DOS	Mac, DOS, Windows, SunOS, SCO Unix, Interactive Unix, DEC VMS
Requires dedicated mail server	○	○	○	Mac only	●[1]
Conferencing	●	○	○	AppleTalk clients only	○
On-line conferencing	○	○	○	AppleTalk clients only	Mac networks only
Remote-user access	●	●	●	Mac or terminal	PCs only
Mail-center forwarding	●	●	●	●	●
Message creation					
Text editor	●	●	●	●	●
Graphics editor	●	○	○	○	○
Custom forms	Third party	○	○	●	Mac only
Voice mail	Third party	●	○	Mac only	Mac and Windows only
Attachments per message	20	Unlimited	Unlimited	16	100
Message priority levels	3	3	5	5	3[2]
Return receipts	●	●	●	●	●
Message receipt					
Audio alert	Mac, DOS, Unix	All clients	All clients	All clients	All clients
Pop-up	Mac, DOS, Unix	All clients	All clients	All clients (icon)	All clients
TSR/INIT size	32 KB (Mac), 17 KB (DOS)	4 KB (DOS)	42 KB (Mac), 12 KB (DOS)	96 KB (Mac), 9 KB (DOS)	7 KB (DOS), 76 KB (Mac)
View attachments	●	Launches application	Text only	○	Launches application
Administration					
Read any message	○	○	○	○	○
Delete any message	○	○	●	●	●
Purge old messages	●	○	●	●	○[3]
Message tracking	○	○	○	●	●
Security					
Message encryption	●	○	●	●	●
Administrator can access mail	○	●	○	●	○
External mail can be restricted	○	●	●	○	●
Gateways					
MHS	Optional	Native transport	Optional	Third party	Optional
X.400	Third party	Third party	Optional	Third party	Optional
Fax	Optional	Third party	Optional	Third party	Optional
SMTP	Optional	Third party	Optional	Third party	Optional
MCI Mail	Optional	Third party	Optional	Through script	Optional
EasyLink	Third party	Third party	○	○	Optional
AT&T Mail	Optional	Third party	○	Through script	○
CompuServe	○	Third party	○	Through script	○
SprintMail	Optional	Third party	○	Through script	○
DEC All-in-one	Third party	Third party	○	Third party	○
IBM PROFS	Optional	Third party	Optional	Third party	Optional
IBM DISOSS/SNADS	Optional/third party	Third party	Optional	Third party	Optional
Banyan Vines Mail	Third party	Third party	○	Third party	○
VMS Mail	Third party	Third party	○	Third party	○
User-definable	○	○	○	●	○
Others	X.25 networks, GE Quick-Comm, Wang VS, Lotus Notes, Voice/PBX, Telex		Microsoft Mail for AppleTalk	Microsoft Mail	OfficeVision/VM, Verimation Memo
Price	Open Look, $895[4] Mac, Windows, OS/2, $495[4] DOS, $295[4] 10 users, $345 25 users, $845 100 users, $3295 cc:Mail Remote for Mac or DOS, $295 MCI Mail gateway, $1295 cc:Mail Router, $1295 SMTPLink, $2995	DOS Starter (10 users), $499 DOS/Windows Starter (10 users), $799 5 users, $249 30 users, $1299 100 users, $2999 1000 users, $19,999 MacAccess (5 users), $395	Microsoft Mail Server (10 users), $695 5 users, $395 20 users, $1349 100 users, $5500 500 users, $22,500 (All clients included in server price)	1 user, $199 5 users, $399 10 users, $599 50 users, $2499 100 users, $4699 1-user add-on, $99	5 users, $495

Notes:
[1] Dedicated server required if more than one post office.
[2] There are 27 priority levels for Mac clients.
[3] Connection server queues only.
[4] Prices are per post office.

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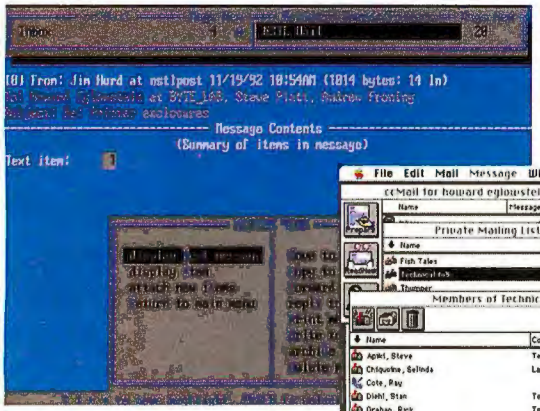
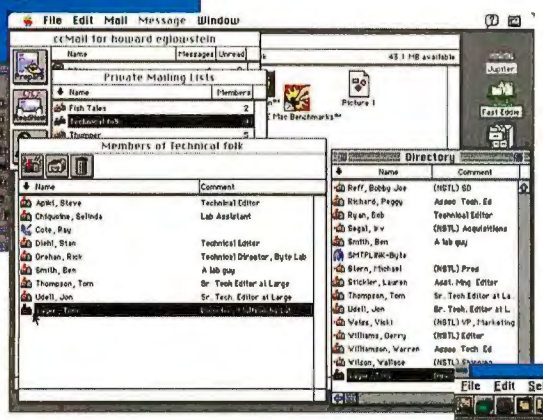
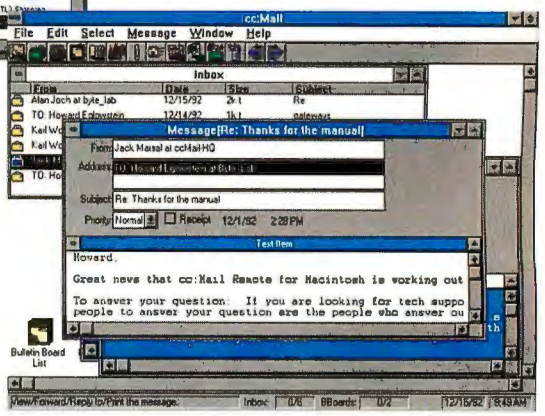


Screen 1: *cc:Mail's DOS interface (left) is straightforward after a little practice. After you select a message from your in box, cc:Mail displays the message and presents you with the Action menu. From here you can reply to, delete, or file the message.*



Screen 2: *With cc:Mail for the Mac (left), clearly labeled icons are the norm. The second window shows the buttons used to prepare new messages. Even the user directory uses icons to show you the location of each user. The large mailboxes are local LAN users; the smaller ones are users at another post office. The blue postal drop box is another post office—in this case, an Internet mail gateway.*



Screen 3: *The Windows user interface (above) has many features in common with the Mac screen, but it suffers from extensive reliance on obscure icons.*

cc:Mail

In the BYTE Lab's last review of E-mail systems ("Please, Mister Postman," March 1991), we found a lot to like in cc:Mail 3.15. We judge the latest cc:Mail, now under the auspices of Lotus Development, to be much improved. In addition to the DOS, Mac, and Unix clients, we also tested an alpha version of a client for the OS/2 Workplace Shell (see the text box "E-Mail from the Workplace Shell" on page 142).

The central cc:Mail engine remains unchanged. On either Mac or PC servers, cc:Mail uses a shared file area on your network for mail exchange, providing BBS and user-to-user communication. All network users access the same mail database, and cc:Mail relies on file locks to control the mail system. We tested cc:Mail in a NetWare environment to make Unix connectivity easier, but the system should work just as well with an AppleShare file server.

You buy cc:Mail in a "platform pack," which consists of an administration package, client software for any one platform, and the ability to create one user, the system administrator. To add more users to your mail system, you buy user packs that add another 10, 25, or 100 users. The administrator copies serialized data from the pack disks to expand the system's capabilities.

The administration utilities are much better than they were in the older version, and they're now available for either Mac or PC platforms. Most of the user interface (see screens 1, 2, and 3) is unchanged. The Mac interface has clear, easy-to-follow icons to lead you through creating and reading your mail. The DOS version mimics the Mac's functionality through a menu system. Once you've spent some time with the DOS interface, it's perfectly usable—it's not a Mac, but not much can compare to a good Mac interface.

The Windows client software is brand new. While it has some attributes of the Mac version, there are a few important differences. Lotus's influence shows in the incorporation of SmartIcons in the Windows interface. "Smart" is something of a misnomer, though, because the icons themselves are small and obscure. The Mac interface has fewer icons and a word or two under each icon to describe its function. The Windows SmartIcons are simply clumped together in a single row, with no label, leaving you to guess what they might mean.

The system administrator manages a system directory, which is the complete list of all users and post offices available to system users. Users can be local (they have mailboxes on the LAN), remote (they have no mailboxes but call in using remote software), or remote via a post office (their mailboxes are not on this LAN but on another). The administrator adds users by name and assigns each a mailbox or a remote address.

Perhaps the most powerful feature of cc:Mail is its wide variety of external gateway support and the ease with which your local users can send external mail. The cc:Mail gateways are typically programs that run on dedicated PCs on your network. When you address mail to a gateway, the gateway machine picks it up, readdresses it, and sends it out via modem, network, or whatever mechanism is appropriate.

For example, cc:Mail's SMTPLink gateway provides transparent two-way access to the worldwide Internet mail system. In the cc:Mail directory, the gateway appears as the post office "SMTPLink." Suppose that your site and ours are both equipped with cc:Mail and an SMTP gateway but don't have a direct cc:Mail connection. If you wanted to send mail to us at BYTE, you'd simply select the SMTP post office and, when prompted, enter the address as letters@bytepb.byte.com. The SMTP gateway sees the message, retrieves it from the network, and forwards it to the local mail relay (you need an existing Internet mail link to use the gateway). The Internet brings the mail to our link, bytepb.

The bytepb link sees the message and forwards it to our SMTP gateway via TCP/IP. Our gateway sees the incoming message, recognizes the addressee as a cc:Mail user, and places the message in our cc:Mail mailbox. A similar mechanism provides for dial-up cc:Mail-to-cc:Mail post office communication, communication between

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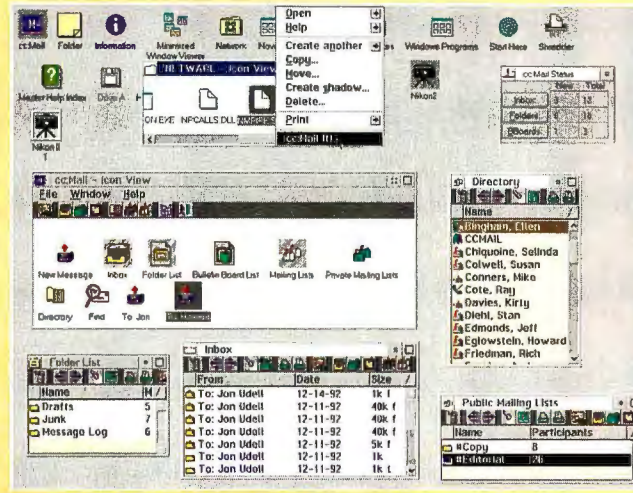
E-Mail from the Workplace Shell

JON UDELL

Testing cc:Mail in the BYTE Lab gave us the opportunity to explore an alpha version of cc:Mail's OS/2 2.0 client (see screen A). We ran the client on an IBM PS/2 Model 90 running OS/2 2.0, which was connected to our NetWare host via the NetWare requester for OS/2 and an SMC (Standard Microsystems Corp.) EtherCard Plus Elite/A Ethernet adapter. We found that cc:Mail for the OS/2 Workplace Shell (the client's official name) lives up to its lengthy title—it is one of the first applications we've seen that truly exploits the WPS (Workplace Shell).



Screen A: *cc:Mail provides excellent WPS integration, including "mail-enabling" of the desktop.*

Because the cc:Mail folder is a standard WPS folder, you can use the normal Control-Shift-drag procedure to "shadow" the objects it contains (i.e., an in box, public and private mailing lists, a folder list, and a message template) to the desktop for quick access. But just dragging these objects to the desktop, without the Control-Shift modifier, achieves the same result, because objects in the cc:Mail folder exhibit shadowing as their default drag behavior. This is just one example of the useful customization available through the WPS API. If you check the cc:Mail folder's "work area" option (another standard feature of WPS folders), the shell will retain the state of your cc:Mail objects and restore them—opening and placing windows as needed—when you reopen the folder.

As with the Windows cc:Mail client, each of the cc:Mail folder's child windows presents a row of SmartIcons that make nearly every function locally available. However, right-clickable context menus localize control even further. In Windows you create a new folder by way of the MDI (Multiple Document Interface) parent's File/Create Folder menu option. Under OS/2, the folder list floats free of a containing MDI parent; you create a new folder by right-clicking and choosing Create Another. You can also reorder any of the list-style displays (messages, folders, addresses) by clicking at the top of the column that you want to be the primary key.

Drag-and-drop behaviors abound in the OS/2 cc:Mail client. To add a user to a private mailing list, you drag an entry from the address book and drop it onto the list. To move a message from the in box to a folder, or between folders, you drag and drop. This internal drag-and-drop capability resembles that of the cc:Mail Windows client. But the OS/2 client goes further: There are various drag-and-drop operations that extend past the boundaries of the cc:Mail folder and the objects it owns. To mail someone a file, you can drag a file icon from a folder and drop it on a message template. (The Windows version can in principle accept drops from File Manager, but currently it does not.) Or you can drag individual messages to the desktop or to other WPS folders, where they can freely intermingle with data objects that represent ordinary files.

You can also drag a cc:Mail message template from the Templates folder. The resulting customizable object acts as a new kind of private mailing list that can contain boilerplate text and attachments and can accept dropped files. Moreover, cc:Mail makes the entire WPS mail-aware: Every file object's context menu offers a "cc:Mail It!" option that invokes a message template containing that file as an attachment. It's a pleasure to see the WPS's rich programming model exploited to such good effect.

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cc:Mail and MCI Mail, or communication between cc:Mail and a long list of supported systems.

When you travel away from the office, you'll want a copy of cc:Mail Remote for either DOS or the Mac. It has essentially the same interface as the local version, but it allows you only to read new messages. You can't access the BBSes or stay on-line while you write your replies. When you make a connection, Remote snags your new messages and sends out any you've written; you read your mail off-line and post your reply to your portable's hard drive.

Sending a reply to a new cc:Mail message requires two connections: one to receive the message and one to send back the reply. Although this might be the most cost-effective way to handle remote mail, it would be handy if cc:Mail allowed you to stay on-line and respond. That way, you could avoid having to establish two connections.

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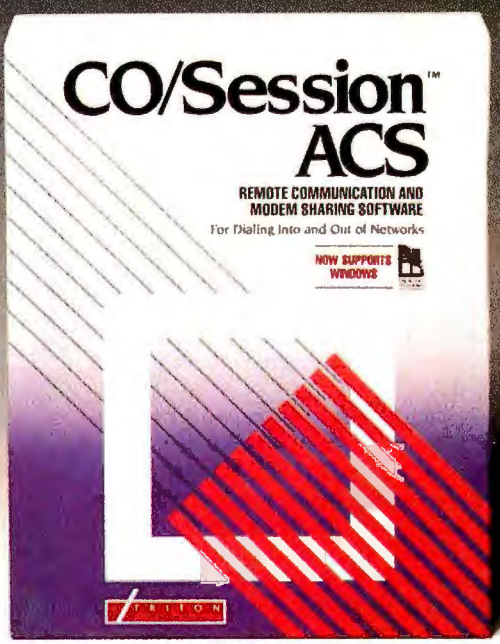

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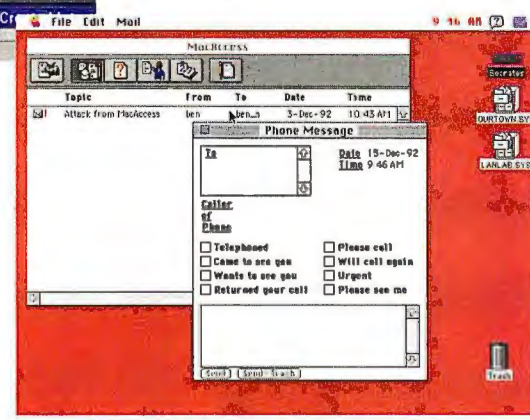


Screens 4 and 5: *Da Vinci eMail provides an excellent Windows user interface (left). It includes tools for composing messages, selecting addresses, and other common functions. Da Vinci MacAccess (below) provides Mac clients with access to MHS-based Da Vinci eMail.*

Da Vinci eMail 2.0

Da Vinci eMail relies on NetWare MHS as its mail carrier, so it's inherently a PC-centric mail package (see screen 4). However, Da Vinci provides support for Macintosh clients through Da Vinci MacAccess (see screen 5), a Mac MHS client.

Relying on a specific network configuration limits the applicability of the system, but it also greatly simplifies its installation and maintenance. Exploiting MHS also gives you the advantage of not requiring a dedicated mail server. Of course, as with all the DOS E-mail systems, you will need separate computers for each gateway.

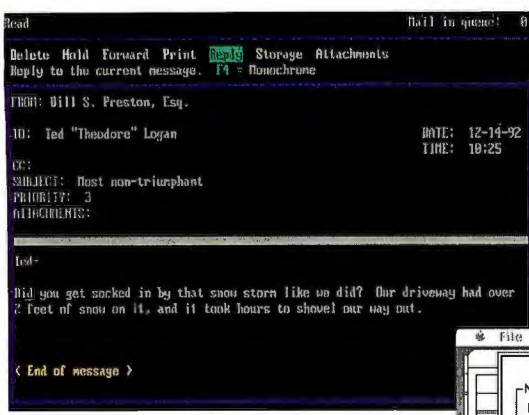
Da Vinci eMail's Windows user interface is very good. It includes all the standard tools for composing messages, selecting addresses, searching the mailbox or folders for messages, and building personal mailing lists. You can include enclosures with your messages; Da Vinci gives you a long list of predefined scripts for launching applications associated with enclosures. If your Windows system can record voice messages, you can easily attach voice components (i.e., .WAV files) to your E-mail messages. Da Vinci for Windows can also send strings and Clipboard contents as E-mail messages through DDE. There are two E-mail DDE request commands: one that finds the current user name, and one that brings up the address list.

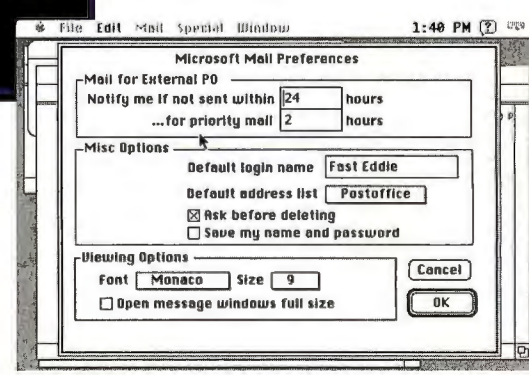
The Windows client also includes predefined forms (e.g., While You Were Out slips). These forms make an excellent addition to standard mail. Unfortunately, there are two critical drawbacks: First, you can share forms only among Windows clients (DOS and Mac clients see only the text), and second, you can't define your own forms.

When you send a message, you can request a return receipt (Da Vinci calls this "Certified Mail"). This forces the recipient's E-mail post office to send you a message when the addressee reads the message or deletes it without reading it.

Under DOS or Windows, Da Vinci eMail notifies you of incoming messages through a separate application that periodically checks your mailbox for new mail. Da Vinci MacAccess clients get notification only when they make connection.

Da Vinci eMail has long excelled in ease of use for both users and administrators. Mail gateway support is outstanding; MHS-based, Da Vinci eMail offers easy access to other mail systems through a long list of third-party MHS gateways.





Screens 6 and 7: *Microsoft Mail provides a good measure of user control over outgoing mail. When you mail from one post office to another, the gateway will notify you if your mail isn't delivered in a timely fashion. Both DOS (above) and Mac (right) mail clients are simple and easy to use. The Windows client provides similar functions.*

Microsoft Mail for PC Networks 3.0

When we last looked at Microsoft Mail (March 1991), there was only a Mac network version. The Mac version uses a dedicated Macintosh on your AppleShare network to store all the mail. To use a PC client, you have to install an AppleTalk board in the PC.

The Mac version (Microsoft Mail for Macintosh Networks) is still out there, but this time we reviewed the PC Network version. The primary difference between the two is that in the PC Network version the shared files reside on a file server, not a dedicated machine. The user interface and gateway issues are essentially the same.

Version 3.0 has an improved interface (see screens 6 and 7). The main window gives you clearly labeled icons for the functions you will use most often. We will not go into elaborate detail, as the interface items are mostly self-explanatory. What we found most useful is the rich variety of administration tools. Of the five E-mail systems in this review, Microsoft Mail gives the

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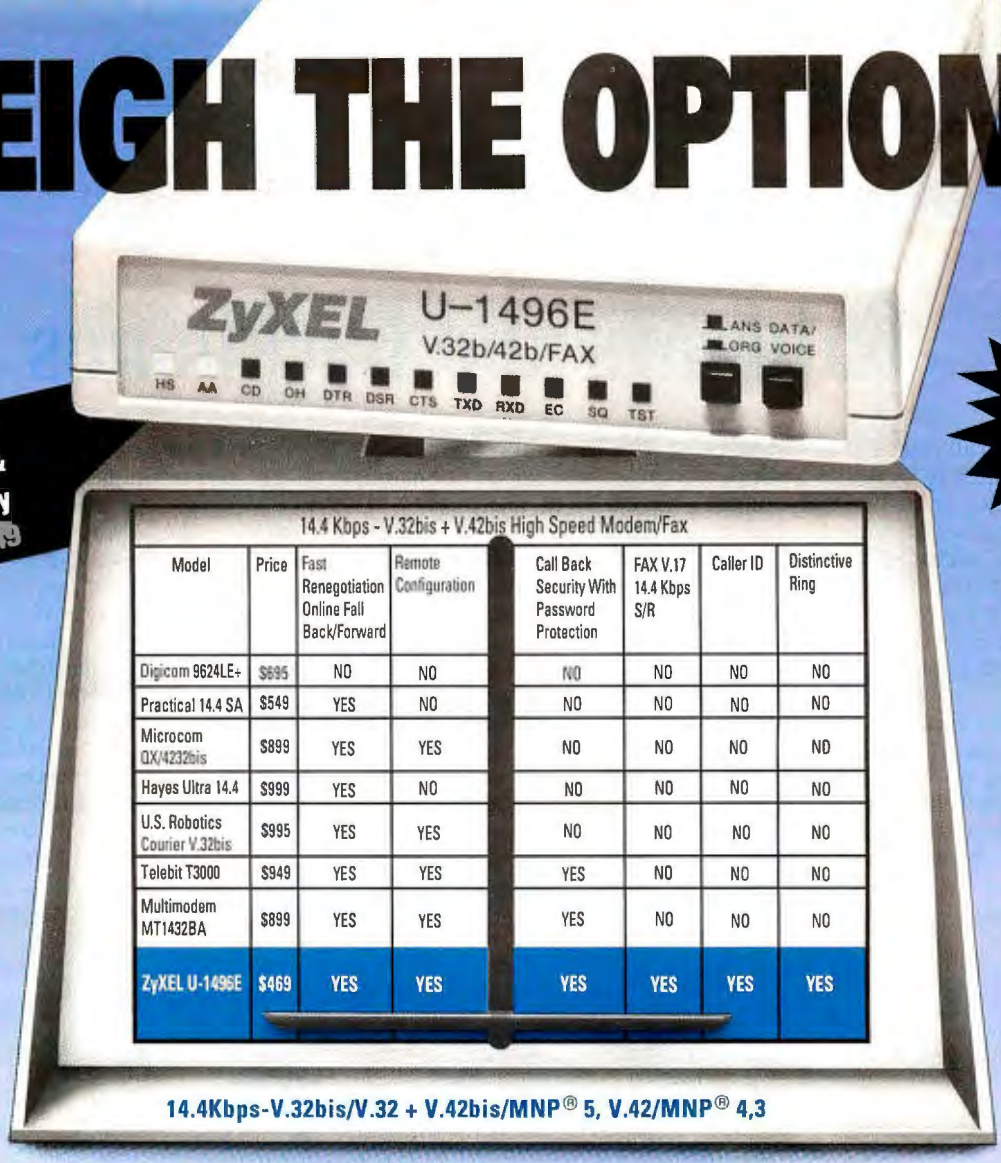

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Gateways and Backbones

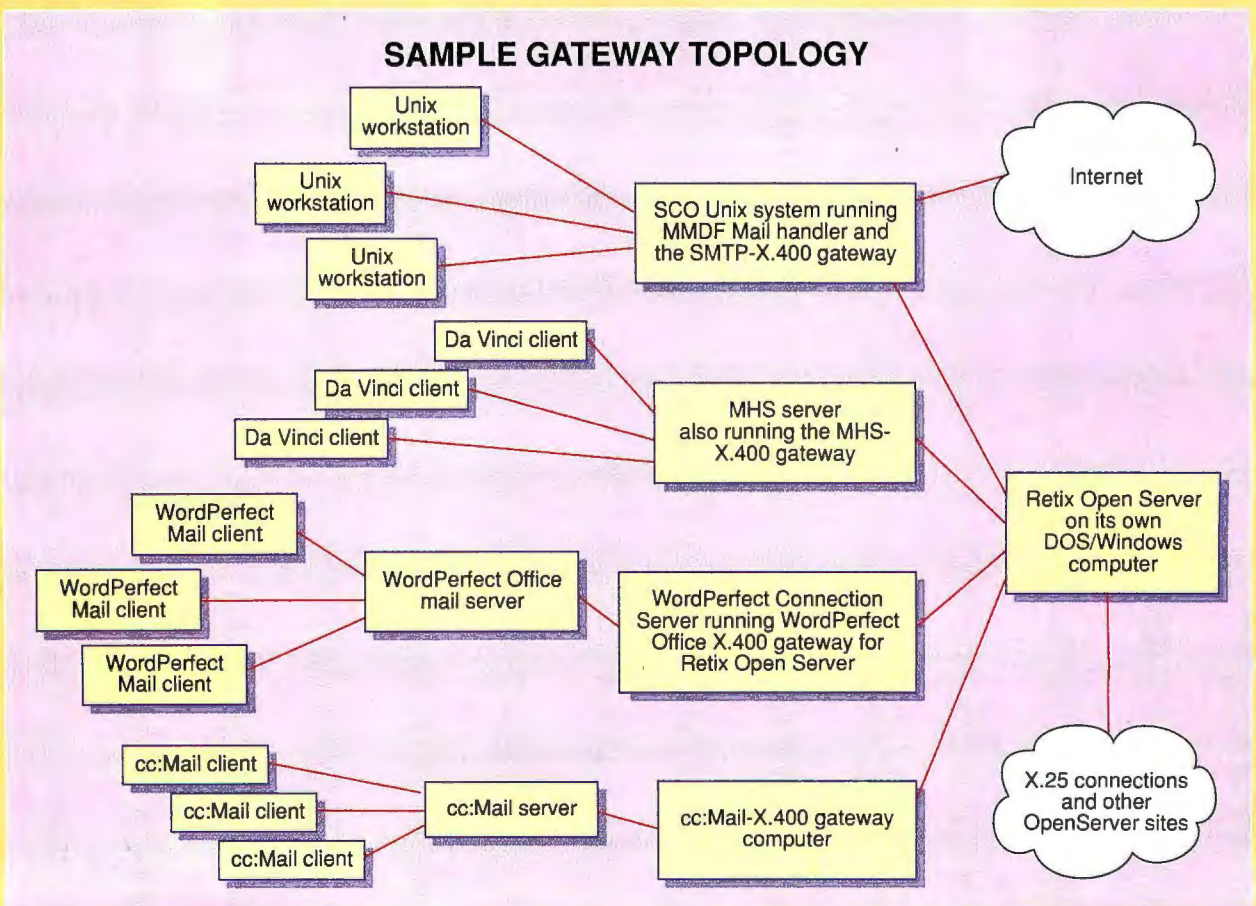
When all your E-mail communication is local, life is simple. You can easily build a robust and secure mail system with any of the packages we've reviewed here. But this simple case is also a trivial one—it's not until your E-mail system can reach out and talk to the rest of the world that you can take full advantage of it.

Reaching out to other sites and other organizations often involves communicating between different E-mail systems, for which you need gateways. All the E-mail systems that we reviewed for this article have gateways to other E-mail systems, at least as options. Besides these, there are also third-party gateways: For example, Computer Mail Services (Southfield, MI) markets M-Bridge (an SMTP–to–MCI Mail gateway) and S-Bridge (an MHS [Message Handling Service]–to–SMTP gateway).

The two most common gateways are to SMTP, the Unix/Internet E-mail protocol, and to X.400, the CCITT-standard E-mail protocol (see "X.400: Standardizing E-Mail" in the December 1990 BYTE). SMTP is important because it is the protocol of the Internet—some 10 million to 15 million mail users. X.400 is important because it is the behemoth of E-mail addressing protocols and a common superset between disparate mail systems. SMTP and X.400 are the protocols that come closest to establishing a common "language" for E-mail systems.

The basic role of an E-mail gateway is to translate address headers between two different mail systems, leaving messages intact. If you have five different E-mail systems and no common denominator among them, you need 10 different gateways, one for each pair. If one of the E-mail systems changes, you must modify four of the 10 gateways. From the perspective of software installation and maintenance alone, this is obviously a nightmare.

An E-mail backbone can help to alleviate this problem. A backbone is a single-protocol connection among dif-



BYTE's network topology, which we used for testing Retix Open Server 400.

ferent systems. Each system has a gateway to the common backbone protocol. An X.400 mail server, such as Retix's Open Server 400 (see below), serves this purpose well. X.400 mail servers also have an advantage in being well suited for X.25 wide-area links.

Of course, there are other mail-routing systems, based on proprietary backbone protocols. The most famous of these is a mail-switch system from Soft-Switch (Wayne, PA) that runs on IBM mainframes and the Data General Aviion.

Even though a backbone system may simplify the overall administration of multiprotocol E-mail networks, it is never a trivial task to set one up. E-mail networks of this complexity are much more complicated than a single homogeneous LAN-based system. If it is at all possible, getting everyone to use the same protocol will probably result in the easiest design, both for installation and maintenance.

Running Retix Open Server 400

To better understand the complexities and requirements of installing a mail backbone, we evaluated Retix's Open Server 400 with gateways to WordPerfect Office, cc:Mail, SMTP, and MHS. We weren't able to get our installation fully operational in the week or so we spent on the project; the major hurdle was understanding X.400 requirements and nomenclature.

Retix requires a "hub-and-spoke" network topology. The Retix server system communicates via X.400 links with each gateway (see the figure). In addition to serving as the local hub, the Retix server is responsible for internetwork mail connections. You need a Retix server system at each non-X.400 site.

We installed Retix Open Server, a software-only product, on an Advanced Logic Research Powerpro running DOS. This was far more machine than was needed for the task.

The MHS gateway ran on the same machine as the MHS server. We installed the cc:Mail gateway on a dedicated low-end PC. The SMTP gateway to X.400 (a Retix product) ran on an SCO Unix system also tied to the Internet. The WordPerfect Office X.400 gateway for Retix Open Server (a product from WordPerfect) required a high-end dedicated PC. However, you can run other WordPerfect gateways on this system.

Installing the Retix server and gateways was easy, at least within the context of configuring the X.400 system. The entire configuration process was very difficult. If you are inexperienced with X.400, count on spending several days studying the concepts and grappling with acronyms before getting under way.

Retix simplifies the task with excellent help screens for every field of every form in its Windows-based configuration utilities. But the help windows are not enough to teach the concepts; Retix's manuals fill this role. In fact, despite the complexity of X.400, a novice network or mail administrator can expect to grasp all the crucial concepts from Retix's manuals alone.

Each Retix gateway performs the same function: mapping the addresses of its mail system to X.400. For users, the entire universe of mail connected to the Retix server appears to fit within the addressing scheme of the host E-mail system, and users can connect to local and remote mail systems using familiar methods.

The user benefit of not having to deal with an address of unknown syntax is nothing to be sniffed at, particularly with X.400 addresses, usually something like G=ben;S=smith;P=byte;A=telemail;C=us. Contrast that with the comparable Internet-domain mail address ben@bytepb.byte.com, which can even be shortened to ben@byte.com.

But the most obvious benefit is for the network mail administrator. With Open Server, you can connect far-flung sites together through any of a multitude of commercial or private transport services. Open Server also simplifies a heterogeneous set of mail systems.

The Unix Mail Story

You may have noticed that the E-mail systems we reviewed for this Solutions Focus are either PC- or Mac-based systems. Where then, you might ask, are the Unix E-mail systems? The answer is: where they have always been—bundled with the operating system.

There are commercial third-party E-mail systems for Unix, but the most common type of Unix E-mail product is merely an enhanced E-mail user agent, the front-end mail component used for sending and reading mail. The underlying routing and transport parts of the system remain untouched. Even the most elaborate Unix user agents (e.g., Next Computer's E-mail, Asterix's E-mail, Z-Code Software's Z-Mail, and Alfalfa Software's Poste) use standard SMTP transports.

E-mail is such an integral part of the Unix world that well-established standards are more easily accepted. This isn't to say that routing and transport components can't be improved on or enhanced. The most commonly distributed routing component for Unix, Sendmail, is an obnoxious kludge. To understand and respect Sendmail, you have to appreciate that significant parts of Unix have grown through accretion of academic endeavors rather than purposeful commercial design.

Sendmail was developed as an experimental project that was distributed and accepted because it fulfilled a need. Understanding and modifying Sendmail's addressing and routing rules is more akin to playing Adventure than to building a structured rule table.

On the other hand, MMDF (the router distributed with SCO Unix) is a very flexible and well-organized system that offers better security and organization than Sendmail. What MMDF lacks is the simplicity of adding connections that Sendmail (and its little brother, Smail) offers. With MMDF, you have to edit and rebuild tables every time you add a new connection. With Sendmail and Smail, you just add the new sites to standard tables.

It's only when you add a new *kind* of connection to Sendmail that you end up getting lost in its twisty little passages, all alike. And it's with this aspect of E-mail—communication in a heterogeneous E-mail world—that Unix mail systems have the most difficulty.

Unix E-Mail Transport

The most common transport mechanism is a temporary asynchronous communication link established through UUCP. This mechanism is the most consistent with the "store-and-forward" model of E-mail. Messages bounce from machine to machine as systems establish connections. The second most common transport mechanism is via an IP network connection using SMTP.

The use of UUCP and SMTP for E-mail is governed by RFC 822, a message-format specification. RFC 822 indicates that the message header and body can consist only of 7-bit ASCII characters. But next to PC-based E-mail systems that allow binary enclosures, Unix mail systems that adhere to RFC 822 seem dated. Users want to send sound and video clips, as well as spreadsheet, word processor, and desktop publishing files. To stay within RFC 822 guidelines, any binary files must first be converted to a 7-bit printable character equivalent. Once a message is received, it must be converted back (traditionally by the programs uuencode and uudecode). Most E-mail user agents that provide for binary enclosures automate this process.

The other Unix approach is not to send the binary file at all, but just a file that notes where the binary file is located and appropriate methods for retrieving it from the sender's computer. This is the approach that is taken by MIME (Multipurpose Internet Mail Extensions), an emerging standard for attaching enclosures.

One great advantage to MIME is that no files are sent until the recipient explicitly requests them. Since these files can be very large, there is a substantial saving of resources when the attachment isn't retrieved. The other advantages are that existing routing and transport mechanisms need not be changed. Only the user agents have to deal with the details. Older user-agent programs can still be used: If you receive a MIME message with a non-MIME-enhanced user agent, you can retrieve the attachment manually by using the human-readable instructions that are part of the MIME message body.

Internet and OSI

If the Internet can make up for its only real E-mail weakness (binary attachments) with MIME, does it need the complexity of X.400 messaging? This is a hotly debated question. After all, the Internet is the great mother of all electronic-message backbones.

But it is the success and growth of the Internet that makes it look to OSI (Open Systems Interconnection) standards. The Internet addressing scheme is too limited; the Internet is running out of addresses. As long as users are protected from the complexity of X.400 addressing, there is no reason not to implement X.400 gateways on all Internet systems. With X.400 addressing and MIME, Unix E-mail will be as flexible as the rest of the E-mail world.

system administrator the most control over user access.

As an administrator, you assign rights to users as you create them. Some users in your organization may not need to create mail, only receive it, or vice versa. Or you may decide to restrict Urgent mail priority to senior management or to keep some staff from sending mail externally. No other package we reviewed gives you this level of control.

Also new in this version is an automatic directory update feature. On a set schedule, Microsoft Mail can automatically exchange user directories with other post offices. This can come in handy if you're working with people who are on the move (e.g., senior engineers who might spend a few weeks at each of your R&D centers). You don't have to burden your mail administrator with making all the address changes. In cc:Mail, the only other package with this feature, it comes as an extra-cost option.

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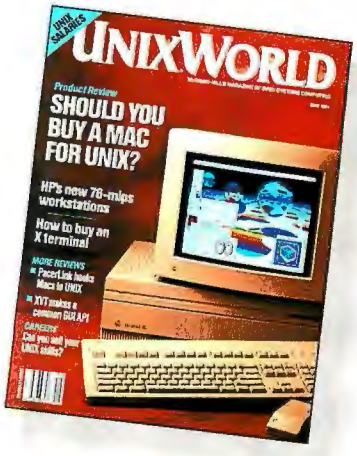

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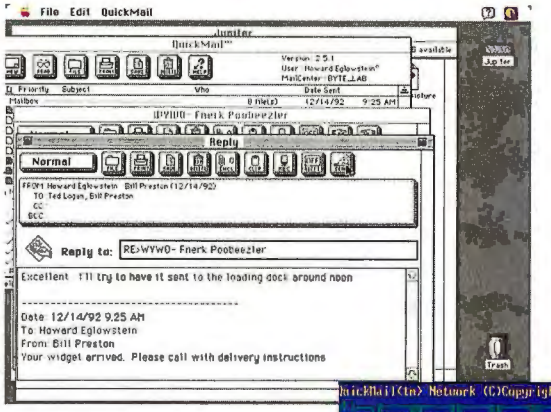
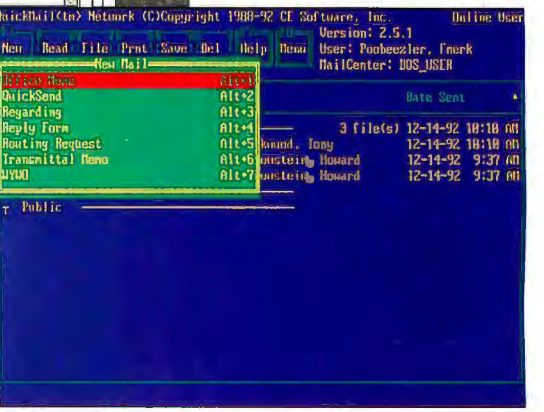




Screens 8 and 9: *QuickMail for the Mac (left) and for DOS (below) use a similar command structure. The Mac version provides labeled icon push buttons, while the DOS version uses a character-based interface. The DOS functions appear in roughly the same place on the screen. Both versions can share forms that you create with the Mac-based forms editor.*

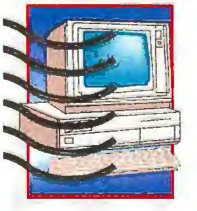
QuickMail 2.5

If E-mail can be called fun, CE Software's QuickMail (see screens 8 and 9), a Mac-based mail system, neatly fits the description. Macintosh clients use AppleTalk protocols to communicate directly with the dedicated Mac mail server. The mail server stores messages; it's also where you install gateway software and physical connections to other networks.

If you need PC clients, you can add them to the AppleTalk network with a LocalTalk card or create a separate post office (a "mail center") to handle the PC side of the network. With mail centers, DOS clients access a shared file area on a server that's accessible to the Mac mail server (in our test environment, a NetWare server running NetWare for Macintosh). The DOS mail center acts as a gateway between the shared file area and the Mac-based mail server. You end up with two separate mail systems, which means that your messages may be delayed crossing platforms.

More important, the two mail centers maintain their own separate user lists. If you set up Bill as a user on the Mac mail center and Ted as a user on the DOS mail center, Bill can't read his mail from a DOS client and Ted can't read his from a Mac.

By running the Mac clients over AppleTalk, QuickMail can take advantage of the direct user-to-user link and provide real-time conferencing. From your Mac, you can get a list of other active Mac QuickMail users on your LAN. Select from the list, and you're in a QuickConference, where everything you type appears immediately on the other users' screens. It's not a replacement for a face-to-face meeting, but it's better than waiting for an E-mail reply, and it sure beats walking across the building to find somebody. Unfortunately, (file-based) PC clients are reduced to second-class citizenship, as QuickConferences work only on Macs.



For remote access, QM Remote gives Mac users the same mailbox access they enjoy from the LAN. You can read any message and reply to it while still on-line. CE Software doesn't offer a DOS version of its remote package but goes one better by providing character terminal access. If you dial into the server via generic communications software, you get a simplified ASCII interface. Any remote user with an ID and a password can send and receive mail without special software.

As with Microsoft Mail, QuickMail's gateways give you good control over external mail. The mail server can display a list of messages in the send queue and give you the choice of canceling any message or returning it to the sender. We also liked QuickMail's catchall gateway, QM-Script, which allows you to define a script to parse your way through any mail system with an ASCII interface.

We have used QM-Script as a gateway to handle BIX mail, and we also spent a few days trying to get it to handle our Opus BBS system. The prompts from an Opus BBS are pretty typical

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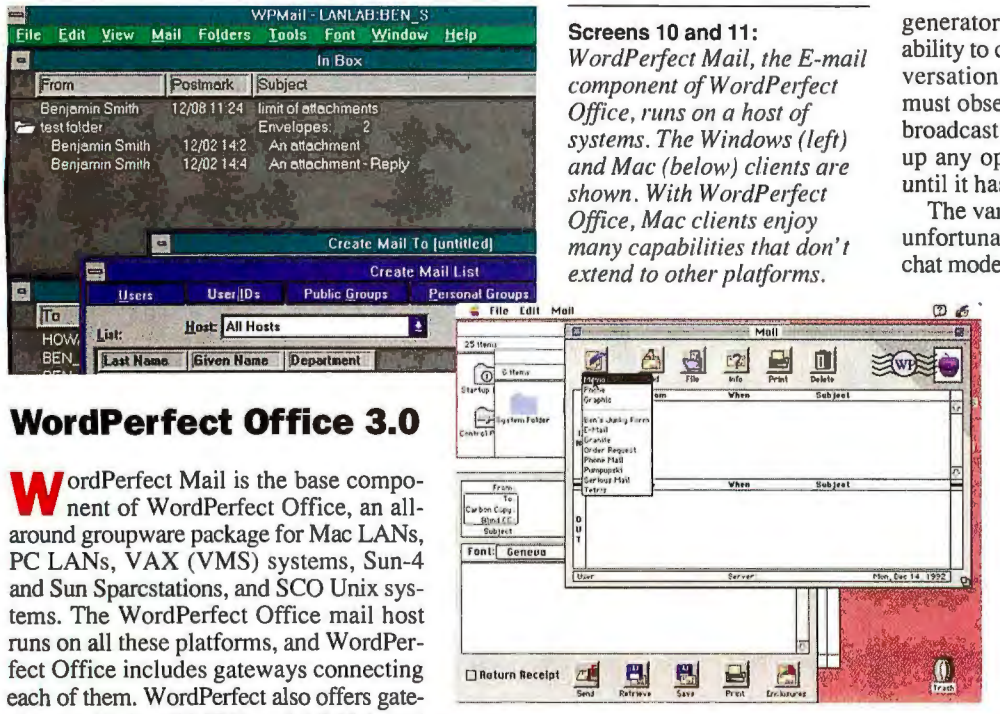
for BBS systems, and it seemed simple enough to set up QM-Script to handle the menu system. Alas, it turned out to be trickier than we thought. A number of the user prompts look similar from menu to menu, and the QM-Script string-matching utilities had some difficulty distinguishing between some of the prompts.

Also, QM-Script doesn't offer any sort of debugger for testing out a new script. You can put comments in the script that get written to a log, but we would have liked an interactive debugging mode. We never were able to get the QM-Script–to–Opus BBS gateway completely ironed out. Still, QM-Script offers a flexible gateway alternative that is not matched in other mail packages. QuickMail and QM-Script represent a good solution to any application that requires linking proprietary messaging systems.



Screens 10 and 11: *WordPerfect Mail, the E-mail component of WordPerfect Office, runs on a host of systems. The Windows (left) and Mac (below) clients are shown. With WordPerfect Office, Mac clients enjoy many capabilities that don't extend to other platforms.*

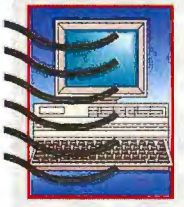
WordPerfect Office 3.0

WordPerfect Mail is the base component of WordPerfect Office, an all-around groupware package for Mac LANs, PC LANs, VAX (VMS) systems, Sun-4 and Sun Sparcstations, and SCO Unix systems. The WordPerfect Office mail host runs on all these platforms, and WordPerfect Office includes gateways connecting each of them. WordPerfect also offers gateways to Unix- (SMTP) and VMS-based E-mail.

On the PC network side, you administer E-mail through a complex collection of menu-controlled forms and DOS scripts; WordPerfect Mail is difficult to install and configure. The only saving grace is WordPerfect's excellent technical-support crew, who can walk you through all the nuances of this system.

In contrast, WordPerfect Office is easy to install and configure on Mac networks. The interface to the administration tools is very similar to that of AppleShare Admin, right down to the icons. But building the Mac–to–PC LAN mail gateway is a complex, difficult process, again mainly because of the problems with the PC LAN configuration.

Surprisingly, WordPerfect Mail for Windows (see screen 10) has the prettiest user interface of any client on any E-mail system we looked at. You can forget about all the unfathomable function-key combinations and convoluted procedures of the WordPerfect word processor. The Windows client has the easiest and most flexible window widgets and gadgets: resizable, movable, tear-off report labels for reports and lists; drag-and-drop selection lists; and hypertext-based, context-sensitive help windows. This interface could well be the flagship for future WordPerfect products on Windows.



You can send and receive attachments as well as messages. The mail reader can launch an application for each attachment based on file extension, and you can add to and modify the list of associations. There is a mail-list manager and message archiving, as well as folders for holding messages.

WordPerfect Mail for Windows supports DDE for Interapplication Communication. However, WordPerfect Mail's documentation of DDE limits the discussion to integration with the WordPerfect word processor.

WordPerfect Office is not balanced between platforms; in addition to a nice client interface of its own, the Macintosh version has significant features that the other versions lack (see screen 11). It includes a forms generator, broadcast capability, and the ability to carry on multiway real-time conversations with other Mac clients. You must observe one caution when using the broadcast feature: The mail notifier locks up any operations on the receiving Mac until it has been cleared.

The varying capability of each client is unfortunate. It's understandable that the chat mode doesn't exist on some networks, but it would be nice if forms generation were supported at least on both the Mac and Windows.

The DOS version of WordPerfect Mail and Office is the same old maddening WordPerfect world of inconsistent and incomprehensible menus. This interface fronts the Unix version, too, with the additional aggravation of a nonstandard terminal-naming scheme and weird screen controls.

One very nice feature of all the clients (even the DOS and Unix versions) is status tracking for outgoing mail. You can see if messages have been received, read, or deleted. What WordPerfect Mail lacks most significantly is a mechanism for automatic mail handling (e.g., an automatic reply when you are on vacation).

First-Class Mail

Choosing one of these systems over the others requires a bit of study. If your organization is already using an E-mail system, that should form the foundation for your choice. Gateways from one system to another aren't always available, and installing universal backbones and multiprotocol mail routers is a very complex task.

If you're not using an E-mail system now, look around and see if you could benefit from store and forward. Even small workgroups can gain productivity through the off-hours and remote communication that E-mail offers.

Despite their multiplatform flair, most of these systems are better on some platforms than others. If you can live with a Mac-centric mail server, choose QuickMail. It doesn't offer a lot for DOS users, and its

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reliance on the mail server as a gateway is limiting. Still, on-line conferencing is a great feature, and QuickMail's remote access and QM-Script are far better than any similar features we've seen.

If mixed-client platforms and internetworking are truly crucial components, choose between Microsoft Mail and cc:Mail. Our choice is cc:Mail. It supports all the major platforms, offers gateways to just about everything, and garners support from dozens of third parties. ■

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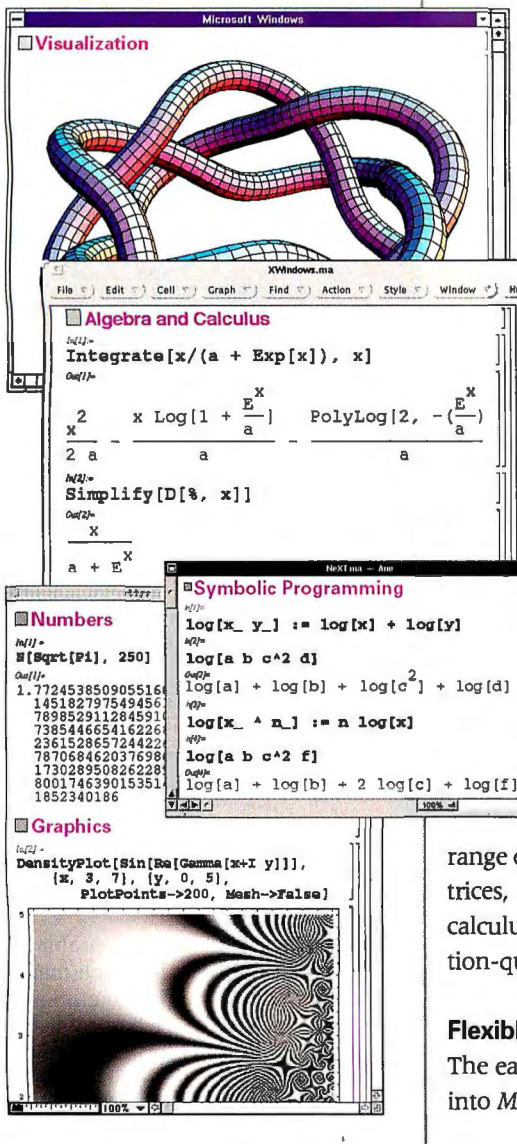

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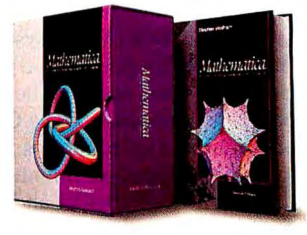

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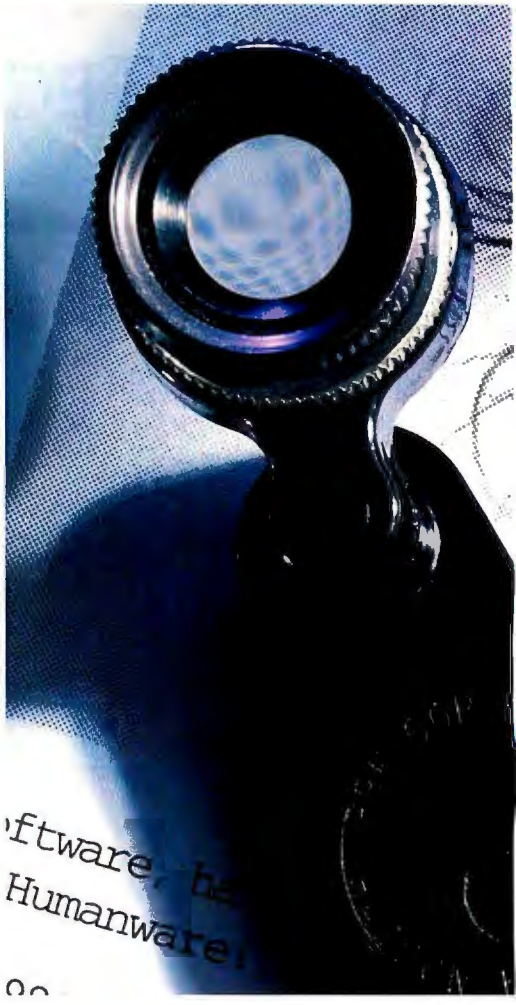

Although the 300-dot-per-inch laser printers of the last several years were a dramatic improvement over the dot-matrix and daisy-wheel printers that preceded them, the increasing sophistication of graphics used in business have made them seem slow and coarse. To solve these problems, new 600-dpi laser printers have come to market with better resolutions than typical laser printers, but with price tags that keep them within the range of general office budgets.

In this roundup, I look at five such printers. All of them offer true 600-dpi resolution, multiple interfaces, multiple PDLs (page-description languages), and high base memory configurations at prices ranging from about $2200 to $4600 (see the table on page 158).

Three of these units—the Dataproducts LZR-965, the Hewlett-Packard LaserJet 4M, and the QMS 860 Print System—are good choices for small workgroups using both Macintosh and DOS/Windows systems, because they offer three active ports ready to respond to users over parallel, serial, or AppleTalk connections. The QMS 860 accepts simultaneous print jobs from its three ports. At 10 pages per minute, the Lexmark LaserPrinter 4029 10A and 10P printers offer the fastest engine-speed ratings in the test group.

A Graphic Difference

None of these printers was designed specifically to serve the needs of graphic artists, although most artists will be delighted with the results. These printers won't threaten imagesetters for reproduction work that includes photographs, but documents comprising text, line art, and screen captures can be published economically with speed and minimal loss of quality.

The geometry of the 600-dpi grid allows for both a finer halftone dot when printing photographs and more gray levels. Most 300-dpi printers offer a choice of 53- or 60-line-per-inch halftones, with more gray levels and better appearance coming from the lower value. These values were replaced by 71 and 85 lines with these higher-resolution units, and the 71-line screen offers a less-visible dot structure and greater tonal range than 300-dpi printers using a 53-line screen. The higher screen value still sacrifices too much tonal range for photographic images, but the less-apparent dots would be useful for illustrations with multiple gray values or graduated tints of small range. Graduated or radial fills that extend over large areas still need the extra gray tones that come with the larger dot size.

A 600-dpi engine creating 71-line halftones should be able to produce 72 gray tones; 53-line screens from a 300-dpi printer have 33 possible tones. Imagesetters operating at 2540 dpi can create all 256 possible PostScript grays with screens of over 200 lines per inch.

The Performance Penalty

The BYTE Lab ran a complete suite of compatibility and performance tests that consisted of a custom version of the Genoa Technologies suite (see the graph on page 160). The results are indexed on the 300-dpi LaserWriter IINTX, so longer bars indicate better performance. Because these printers stock more processing power to deal with higher-resolution output, the performance penalty for better quality is minimal.

In other tests, I strung all the printers on a LocalTalk network attached to my Mac SE/30 and a 386-based PC running Farallon Computing's PhoneNet Talk PC. I sent documents to each printer from a typical range of applications: Word, FreeHand, and PageMaker on the Mac; and Word for Windows, Excel, CorelDraw, and FoxPro on the PC.

There were copious minor problems with device driver files, but each manufacturer said it was working to eliminate them. At press time, Adobe had published a new standard for PPD (printer page description) files to support PostScript Level 2, which Hewlett-Packard had dutifully followed but most software doesn't properly support yet. Adobe had not yet released its Level 2 drivers, and three of these printers support Level 2. The QMS 860 has three selectable options for PostScript support. Printing with Level 2 selected almost doubled the time to print a tabloid page, but color images would not print with Level 1 selected. The promised speed advantages of Level 2 presumably will require the final drivers. In most cases, either the manufacturer or I came up with a reasonable workaround.

All PostScript Level 2 printers will present some of these problems for the next

BYTE ACTION SUMMARY

- **WHAT 600-DPI LASER PRINTERS ARE**
  Laser printers with true 600-dpi resolution supported in the engine, not via software algorithms.
- **LIKES**
  Print quality is clearly superior to that of 300-dpi printers, but prices are in the same range as lower-resolution printers.
- **DISLIKES**
  These printers can't match imagesetters for reproduction work that includes photographs.
- **RECOMMENDATIONS**
  Choose the LaserJet 4M for image quality and ensured support for third-party add-ons, consumables, and drivers.

several months, possibly years, until complete support for Level 2 becomes commonplace. One Level 2 feature, cached forms, will allow blank forms to be downloaded to the printer. The computer will then send the specific data for an invoice or purchase order along with a request for a specific form, drastically cutting down on the network traffic. Until all Level 2 features are widely supported, printer drivers and PPD files will probably need to be updated frequently.

The HP LaserJet 4M and the QMS 860 both use new Canon P270 engines rated at 8 ppm; the Dataproducts LZR-965 uses a Sharp engine rated at 9 ppm; and the Lexmark 10A and 10P are built on Lexmark's own 10-ppm engine. That said, these ratings are generally irrelevant. They come into play only on the very simplest of pages, or when printing multiple copies of a single page. In daily use, the speed of a laser printer depends on the performance of the CPU on the printer's controller.

By the same token, I am mostly ignoring life-expectancy ratings for toner and other consumables. The actual rate depends on your images, and the estimates from the manufacturers are not strictly comparable.

Dataproducts LZR-965

Based on Dataproducts' history in the large-computer market, I expected more of an industrial feel to the LZR-965. In reality, this was the smallest and lightest printer of the group. With the paper tray at the bottom of the unit, the only protrusions during normal operation are the cables, of which there can be several.

The rear panel on the LZR-965 is very clean, with connectors for an external SCSI drive, an RS-232 serial port, Centronics, and LocalTalk, all of which are active until a print job is sent to one of the ports. The printer ships with 8 MB of memory, expandable to 16 MB, and it contains the Weitek 8200 RISC chip. Running at only 7.5 MHz, the chip was specifically designed for printers, so the LZR-965 performs acceptably even when printing complex graphics. Although I did not test this printer with an external disk drive, my experience is that even a small drive attached to a printer—when loaded with the most commonly used fonts—can dramatically speed printing.

The LZR-965 is built around a Sharp engine, the only model in this review to use multiple consumable cartridges. The documentation has clear diagrams for setup, and a 20-minute VHS cassette covers first-time setup, including installing the photoreceptor drum, developer unit, toner tray, toner collector, and fuser roll cleaner. The first four of those parts are combined in the other printers tested, as they have been in all Apple LaserWriters and HP LaserJets. The individual components should reduce the operating cost of the printer, as the drum has a life expectancy of 50,000 pages; the other printers call for replacement or exchange of the toner cartridge when the toner runs out, typically after 3000 to 5000 pages.

continued

600-DPI PERFORMANCE

All the printers reviewed include true 600- by 600-dpi resolution supported in hardware. A SCSI drive, when loaded with the most commonly used fonts, can dramatically speed printing.

	Dataproducts LZR-965	HP LaserJet 4	HP LaserJet 4M	Lexmark 4029 10A	Lexmark 4029 10P	QMS 860 Print System
Price	$2995	$2199	$2999	$2799	$2499	$4595
RAM (min./max.; MB)	8/16	2/34	6/22	5/9	5/9	12/32
CPU	Weitek 8200 at 7.5 MHz	Intel 960 at 20 MHz	Intel 960 at 20 MHz	Motorola 68020 at 16.7 MHz	Motorola 68020 at 16.7 MHz	Intel 960 at 25 MHz
SCSI drive support	Yes	No	No	No	No	Yes
Interfaces	LocalTalk, RS-232, Centronics, SCSI drive	RS-232/422, Centronics	LocalTalk, RS-232/422, Centronics	LocalTalk	RS-232, Centronics	LocalTalk, RS-232, Centronics, SCSI drive
Emulations	PostScript Level 2, HP PCL 4	HP PCL 5+[1]	PostScript Level 2, HP PCL 5+[1]	PostScript	PostScript, PCL 5, IBM PPDS, PCL 4, HPGL standard HPGL/2 optional	PostScript Level 1 and Level 2, HP PCL 4, HPGL
Page sizes (*Standard)	Letter*, legal, executive, statement	Letter*, legal, A4, executive	Letter*, legal, A4, executive	Letter*, legal, A5	Letter*, legal, A5	Letter*, legal, tabloid*, A3, A4, A5, A6, B5, B6, executive
Fonts	35	45[2]	80	39	39	39
Paper	16- to 21-pound bond, 250 sheets[3]	16- to 36-pound bond, 350 sheets	16- to 36-pound bond, 350 sheets	200 sheets	200 sheets	16- to 36-pound bond, 350 sheets

[1] PCL 5 enhanced with TrueType rasterizer.

[2] 35 Intellifont faces, 10 TrueType.

[3] From cassette; 16- to 31-pound stock from manual feed slot.

Hewlett-Packard LaserJet 4M

The newest member of the LaserJet family was the first to arrive, and it set my expectations for the other printers. It also earned a Best Printer honor in the 1992 Best of Comdex/Fall awards sponsored by BYTE and the Interface Group (see "A New LaserJet, a New Standard," December 1992 BYTE). I received the 4M printer, which includes LocalTalk and PostScript built-in, but the table also lists information on the standard LaserJet 4.

The printer opens so that you can easily install the toner cartridge without having to contend with any glaring or obtrusive labels or release buttons. A small lever extends from the paper tray to the front, indicating the level of paper remaining in the tray. The design was so clear, so obvious, that the first page of 600-dpi text rolled out of the printer 7 minutes after I opened the box, and I never referred to the documentation. (When you need detailed information for configuring options, setting up the printer for DOS applications, or maintenance, the manuals are clear.)

The I/O ports—including LocalTalk, Centronics, and RS-232—are clearly labeled and accessible, and all are active. The LocalTalk interface is installed in the MIO (modular I/O) port and can be replaced by interfaces for Ethernet, Token Ring, TCP/IP, and EtherTalk from HP, and third parties are sure to support other specialized network options.

HP's Resolution Enhancement Technology, first introduced on the LaserJet III, is even more dramatic when applied to a true 600-dpi image. The edge quality of text from this printer is the sharpest I've seen. Unfortunately, this only applies to line art and has no impact on the quality of halftones.

Font support is very strong: the standard model comes loaded with 35 Intellifont (HP) and 10 TrueType typefaces; in addition to these 45, the 4M includes the standard 35 PostScript typefaces. An industry-standard cartridge slot adds support for the substantial library of font cartridges developed for past LaserJets.

Lexmark LaserPrinter 4029 10A and 10P

IBM's Lexmark unit was the first of this group to market; Lexmark should have waited until an industrial designer could be brought into the process. Attention to the way printers are used would have warranted substantial redesign. This unit is just not attractive—especially when compared to the others. Three contrasting colors were used in such a way as to emphasize every lump and protuberance. The printer's ivory body is about the same size as the LZR-965's, but the elements that protrude from the shell cause it to take up more space than the LaserJet 4M.

Inattention to the design process didn't stop with the appearance. This is the only printer in the test that required the manual

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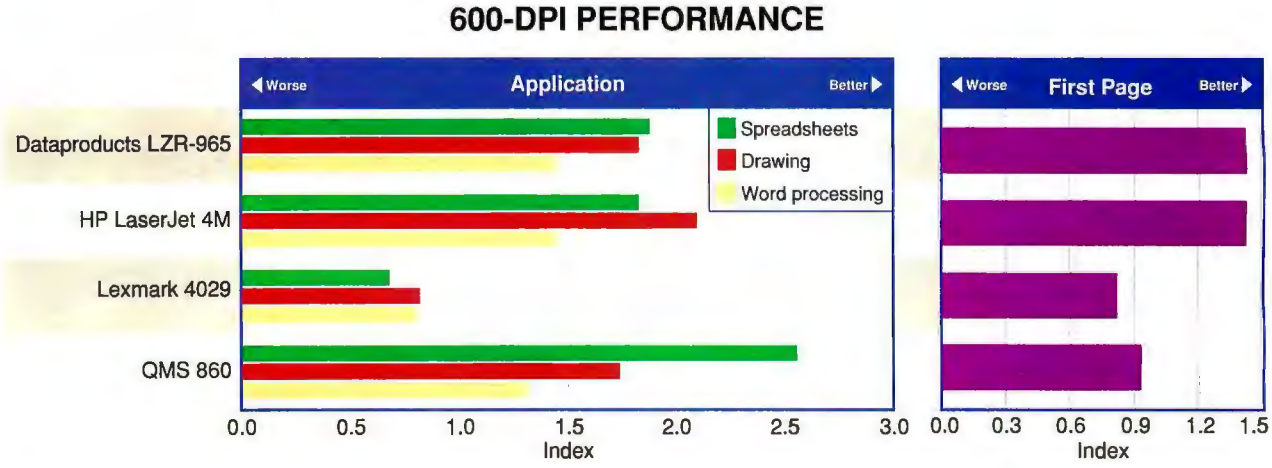
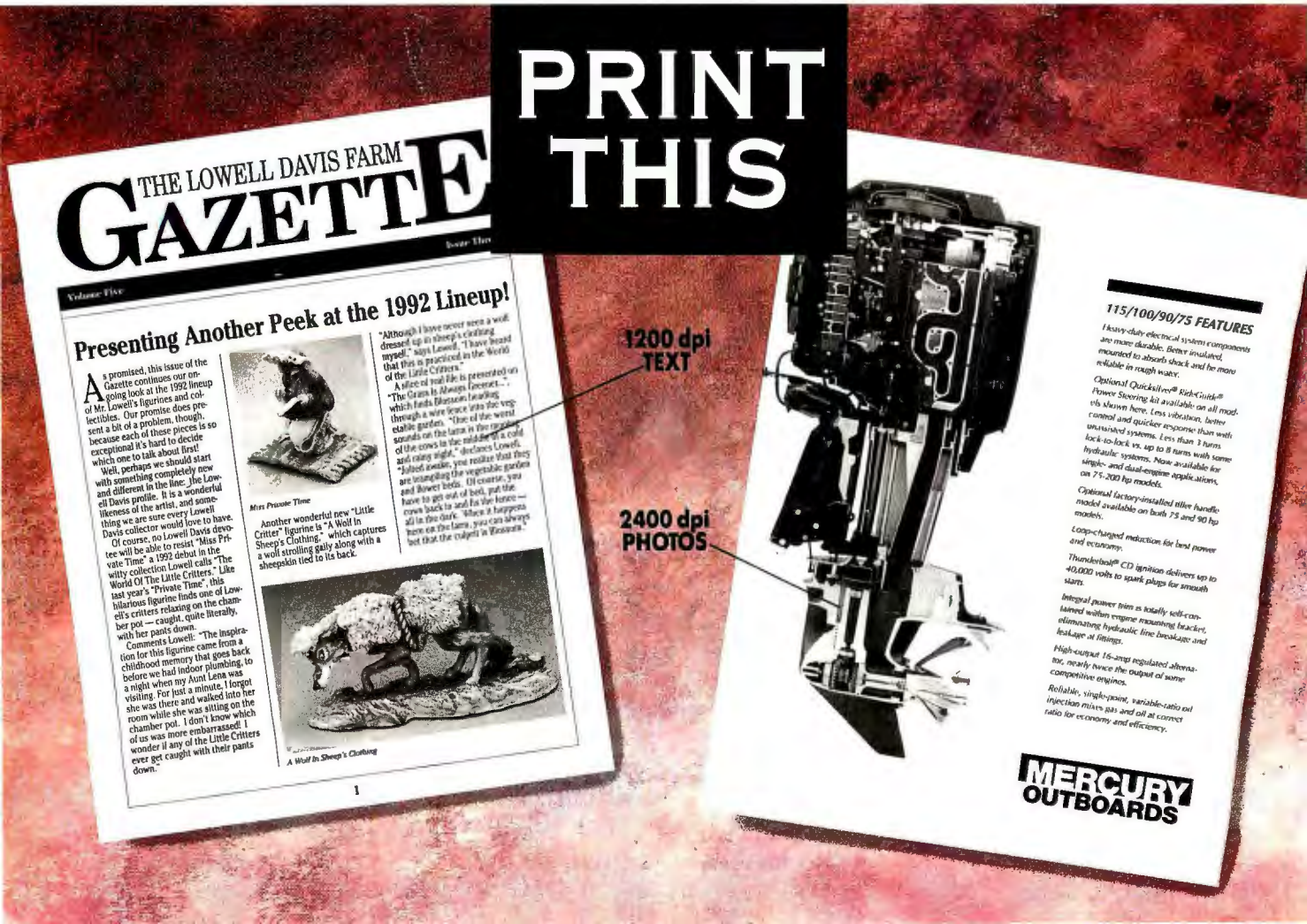


The First-Page Index tests how fast a printer can produce short memos and letters. The Application Index tests common jobs from popular spreadsheets, drawing and design packages, and word processors. Tests are indexed on the LaserWriter IINTX, which has an index of 1 for each test; longer bars indicate better performance.

for basic use. The Lexmark printers share one unusual feature: The toner cartridge is shipped installed. After lifting the printer from the carton, you open the printer and withdraw a laminated foam pad that prevents vibration from damaging the toner cartridge or the contacts with the printer. This almost compensated for the need to attach various feed and delivery guides.

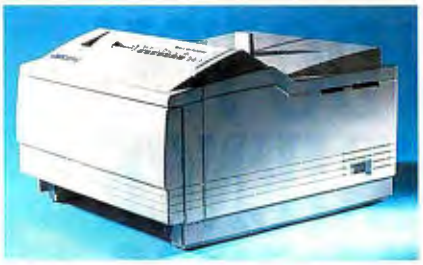
The LocalTalk interface plugs into the Centronics connector, receives power from a separate connector, and is lashed to the



back of the printer housing like freight onboard an oil tanker. The 10A version, intended for Mac users, supports only LocalTalk; the 10P, intended for DOS/Windows users, supports only Centronics and RS-232. While the 10P supports PCL (Printer Control Language) 4 and HPGL (Hewlett-Packard Graphics Language), neither of these is available on the 10A. Mac users aren't likely to miss PCL, but CAD and sign-making applications can make good use of HPGL in a laser printer prior to running full-size plots.

Printing from the Mac required more attention than with the other units, even though this printer is driven by a 16.7-MHz Motorola 68020 that has been in use in laser printers for several years. Rather than use the LaserWriter driver to allow printer options to be chosen when printing, a DA (desk accessory) is used to configure the printer. Using this slow CPU could have been justified if easy backward compatibility had been the goal, but there seems to be none.

During my evaluation cycle, Lexmark dropped the 10A's price by $1200, putting it a little below the LZR-965 and the LaserJet 4M. The slow printing speeds, awkward use, and lack of multiple PDLs in the Mac configuration suggest that this printer should be priced with personal laser printers instead of with these workgroup printers.



QMS 860 Print System

The QMS 860 is priced at $4595, 50 percent above the other printers in this review and over twice the price when in the test configuration. However, it offers immediate value: This printer can satisfy some formidable printing needs.

The new Canon LBP-BX engine supports tabloid (11- by 17-inch) paper at 4 ppm, and letter size output at 8 ppm. The base memory configuration is 12 MB, with expansion to 32 MB possible. My testing was done with 28 MB installed, although the formal benchmarks were run with the base configuration.

All four printers included warnings not to lift the printer out of the carton without help. At 50 pounds for the QMS 860, it would be wise to obey the warning. Although I did need the manual to install the additional RAM and paper tray, I was able to print without it.

As with the other printers, the primary paper tray slides into the bottom of the printer from the front. The test unit came with the 500-page letter-size tray, which installs below the printer in a special feed module. These options attach without tools and are only difficult to install if you insist on doing it alone. After installing the second tray, I ignored the upper and lower feed cassette choice in the printer driver, and the printer correctly determined the proper tray automatically.

Along with the large-format printing, this unit stands apart on the basis of its operating system, QMS Crown. Based on the Intel 960 RISC processor running at 25 MHz, QMS Crown can accept simultaneous printing jobs from the three

standard interfaces. Adding a network interface board does not require removing or disabling any of the three standard ports. Utilities are included that allow the installed memory to be configured as buffers for each port, font caches, or, with application support for PostScript Level 2, logo and form storage. If one or more SCSI hard drives are installed for font storage, the controller can be programmed to use space on the hard drive as additional print spooling.

This system features an intermediate page-description format that is more compact than the bit maps that printers ultimately generate. Information received as PostScript, PCL, or HPGL from the computers is interpreted and converted to this display-list format and queued for printing, increasing the speed at which jobs can be accepted and enhancing the capacity of the printer's installed RAM. Once the print job has been converted to the QMS display-list format, the generation of the bit maps can then take place at the printer's rated engine speed. This will allow multiple-copy printing of collated sets without the time penalty other printers suffer, as the computer normally sends the complete sequence of pages several times when collated output is required.

The QMS 860 includes the basic 35 PostScript fonts, plus the Helvetica Condensed family.

The Remaining Field

One printer that was intended to be part of this comparison is the NewGen Turbo 660 PS, which uses the AMD 29000 processor and the same engine and case as the QMS 860. NewGen was unable to solve my concerns about print quality in time for this review and withdrew the printer from the market until final debugging was accomplished. I expect that it will have printing characteristics very similar to the QMS 860, without the multitasking interface system, and should be available for a price roughly midway between the tabloid 860 and the letter-size printers I reviewed here. I recommend taking a good look at this printer when it is released.

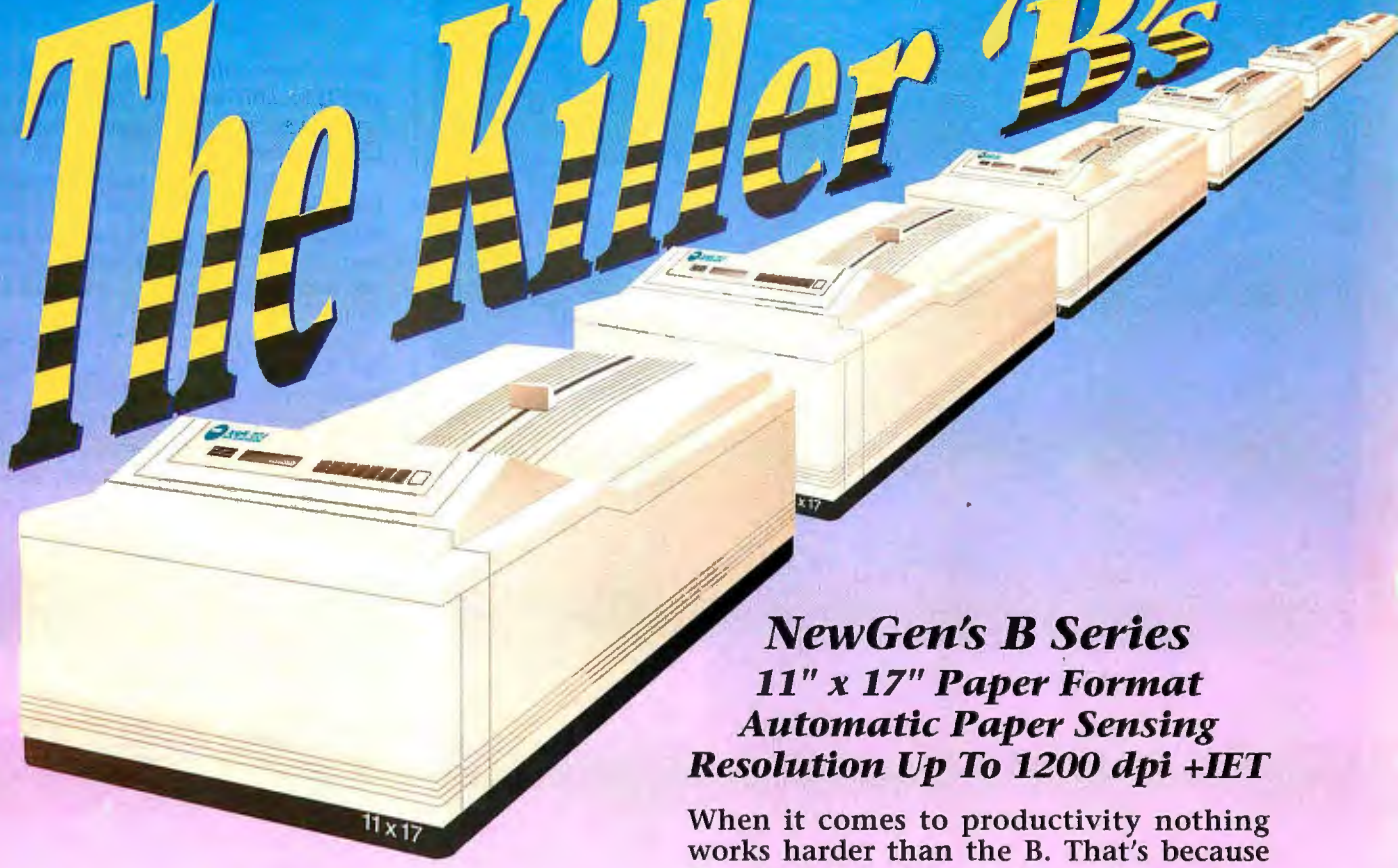
True 600-dpi printers are also expected soon from such vendors as Calcomp, Xante, and LaserMaster.

Final Resolutions

I can't recommend the Lexmark printers. These models simply aren't competitive with other available models at the same or similar price levels.

The LZR-965 is fast, sharp, and compact. It supports hard disk storage to facilitate rapid printing as your type collection

The Killer 'B's



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grows beyond the 35 fonts in ROM, and you'll be able to store forms on a hard drive when that component of PostScript Level 2 is implemented.

If you need to print tabloid pages, the QMS 860 offers print speed barely slower than the LZR-965 and the LaserJet 4M. It also offers the greatest flexibility in memory, interfaces, emulations, and paper handling.

Overall, my vote goes to the LaserJet 4M. It is flexible and offers the best image quality of the group. It also will be supported by a host of third parties offering supplies and enhancements in addition to HP's offerings, and very few software vendors will omit drivers and other support for this model. ■

G. Armour Van Horn is a writer and graphics consultant based in Freeland, Washington. He can be reached on BIX as "vanhorn."

COMPANY INFORMATION

Dataproducts Corp.
(LZR-965)
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fax: (818) 887-4789
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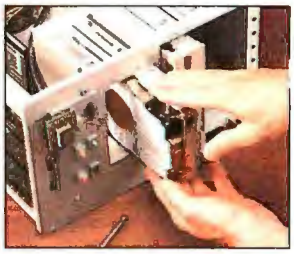

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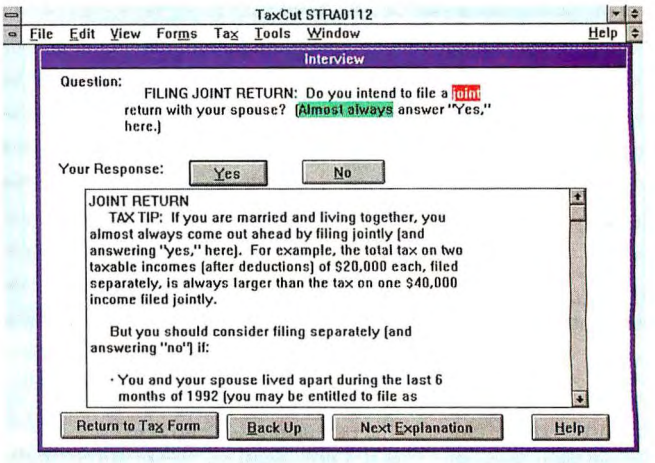
APPLICATION

How to Deal with Taxing Questions

KATHLEEN LARIVIÈRE AND STAN MIASTKOWSKI



Screen 1: *Andrew Tobias' TaxCut, available for DOS, Windows (shown here), and the Mac, features an easy-to-use interview process, although you can't see the forms as you answer questions.*

The approach of April 15 is looked upon with much fear and loathing in the U.S., as yearly income tax returns are due to the IRS. If you're a typical taxpayer—an hourly or salaried worker with perhaps a house and a few investments—tax-preparation software can help in a big way. These programs guide you through the procedure of calculating your taxes and filling out IRS forms, help you make sure you get what refund is due you, and keep you from filing an incomplete form.

We looked at four families of tax-preparation programs for DOS, Windows, and the Macintosh: Meca Software's Andrew Tobias' TaxCut for DOS, TaxCut for Windows, and TaxCut for the Macintosh; Parsons Technology's Personal Tax Edge and Personal Tax Edge for Windows; Intex Solutions' Tax Solver (for Excel, Lotus 1-2-3, and Symphony); and ChipSoft's TurboTax for DOS, TurboTax for Windows, and MacInTax. Prices range from $49 to $80.

At their heart, all these tax-preparation programs are actually spreadsheets using complex links to interrelate numbers and calculations from various IRS forms, schedules, and worksheets. These interrelationships are a big advantage of tax software. You don't need a calculator; most numerical calculations are done for you, and most packages have a pop-up calculator. The programs automatically enter calculated numbers in the correct locations on the related forms, schedules, and worksheets. This capability alone is almost worth the price of admission.

Because there are so many individual items that go into the preparation of a tax return, taxpayers can easily miss common deductions that reduce the tax they owe. To maximize the return, the best of today's tax-preparation programs use a step-by-step interview technique—much like what would happen if you sat down with an experienced tax preparer. This on-line interview approach isn't perfect, but it goes a long way toward making the preparation of your taxes less headache-provoking.

After using one of these packages, you end up with a completed tax return. Instead of filling out printed IRS forms, these programs use printer graphics (laser or dot-matrix) to create a finished package that the IRS will accept in lieu of its own forms. With a complex return, the package can run to many pages.

Because the IRS will not release all the necessary tax forms until around the first of the year (after this article went to press), we used the prerelease version of each package. All the companies offer early versions that taxpayers can use for planning and then ship final versions to customers during January.

We tested the packages as if we were three hypothetical taxpayers: two had relatively simple returns, and one was slightly more complex (with self-employment income). All the scenarios involved several gotchas—common yet often-missed income and deductions that can make a substantial bottom-line difference on tax liability.

Filing Electronically

The best tax-preparation packages also offer you the option of filing your return electronically, sending it via modem (or by mailing a disk), but not directly to the IRS. Because of security considerations and other requirements, the IRS does not encourage individual taxpayers to become "direct transmitters." Instead, you send your return to an IRS-authorized service bureau, which then transmits it to the IRS. (Technically, it is possible to become authorized to file returns directly, but it requires a special 4800-bps modem and a testing process. It's simply not worth the trouble for an individual taxpayer.)

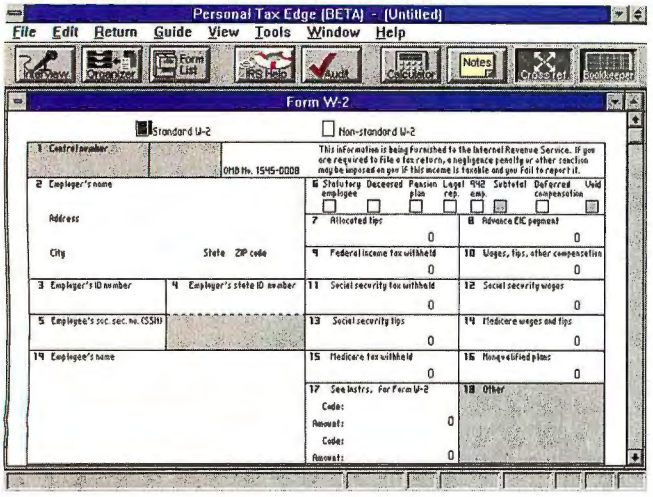
Electronic filing costs extra (costs vary by package, usually $10 to $20), and these packages allow electronic filing only if you have a refund coming to you. The bottom line is, you'll get your refund weeks earlier. If you owe money, you'll have to find a professional who handles balance-due returns electronically, or simply mail your return in the usual manner.

Andrew Tobias' TaxCut

Meca Software's TaxCut carries the moniker of well-known financial planner and

BYTE ACTION SUMMARY

- **WHAT TAX SOFTWARE DOES**
  It guides you through the task of preparing income tax returns.
- **LIKES**
  Interview techniques (usually) help you avoid mistakes that can cost you money; programs perform automatic calculations; links with forms put numbers in the right places.
- **DISLIKES**
  All programs require some tax knowledge, but that's a function of the complex U.S. Tax Code. Some low-cost packages don't give enough help or explanation.
- **RECOMMENDATIONS**
  TurboTax and MacInTax are the best designed and most comprehensive. TaxCut and Personal Tax Edge are also fine, especially in their ability to import a wide range of data.



Screen 2: *Parsons Technology's Personal Tax Edge has a useful toolbar and allows you to see forms as you answer questions. It's available in both DOS and Windows (shown here) versions.*

author Andrew Tobias, who's involved in the design of the program. TaxCut is actually one of the oldest of the personal tax-preparation programs, and it's now available in versions for DOS, Windows, and the Mac.

Internally, all three versions are virtually identical, with, of course, slight differences in the look and feel for each platform. Not surprisingly, the graphics-oriented interfaces for Windows and the Mac result in tax forms that look like the real thing on-screen. But the text and details are identical across the three versions.

Of the packages we looked at, TaxCut has by far the most informative interview process (see screen 1). Its friendly tone and positive approach almost make preparing your taxes a pleasure—almost. As you go through the interview process, TaxCut keeps you informed of what it's doing and why. For example, it tells you what form it's filling in and shows the calculations, points you to further information (e.g., advantages of filing a joint return), and gives you progress reports on how much of the return you've filled out. TaxCut also allows you to jump easily between the form and the interview. Particularly handy is a mini-worksheet that appears between the lines of the form you're working on, giving handy tips and information on what's been calculated and where the numbers came from. In a complex tax return, this can be useful indeed.

TaxCut's interview process isn't perfect. One of our test returns included a scholarship, but the interview never asked about it. If you go directly to the 1040 line 7, where this information would be entered, the program essentially ignores that scholarship income exists; TurboTax, on the other hand, asks specifically about it. TaxCut's failure to flag scholarship income resulted in a miscalculation that (in our test) would have cost the taxpayer an additional $150 of unnecessary tax liability. (It can be fixed, but only if you know how.)

Not surprisingly, TaxCut is tightly integrated with Managing Your Money. If you've used that package to keep track of your finances throughout the year, TaxCut will import the files, do the calculations, and place the right numbers in the right places. Except for very complex situations, it makes tax preparation almost automatic. TaxCut also imports files from Quicken, Microsoft Money, CheckFree, TurboTax, and the TXF (Tax Exchange Format) used by popular accounting programs.

TaxCut's on-line help is very useful, but it fell down on describing inventory and accounting methods used by small businesses, providing a simplistic (and incomplete) explanation. And the definition of handling bad debt was misleading.

TaxCut features almost every possible form, schedule, and worksheet you'll ever need—about 95. But it balked at filling in page 2 of Form 2210, which covers calculating the penalty for underpaying estimated tax. This is not an unusual form for self-employed individuals, but TaxCut refused to calculate it, with a message saying it's "too complex." Other packages handle it with no problems.

You can electronically file your finished TaxCut tax return, with or without a modem. (If you don't have a modem, you can send a disk to the service bureau.) Either way, it costs $19.95.

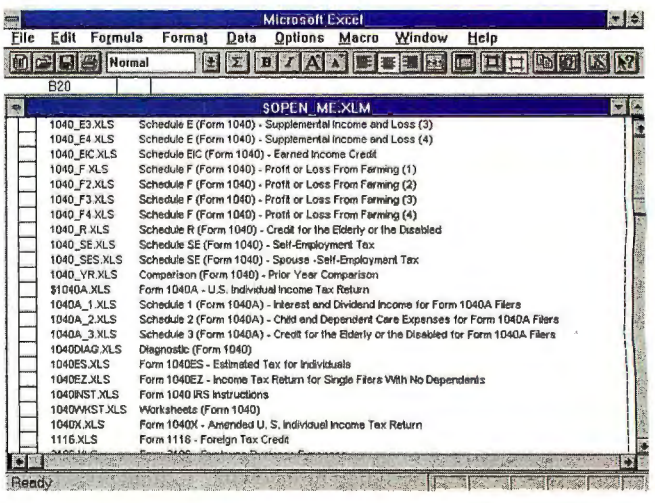
Personal Tax Edge

Personal Tax Edge from Parsons Technology is available for both DOS and Windows. Because of its newness, we focused our testing on the Windows version (see screen 2). The interface is clean, and the forms and instructions are easy to read, even on a standard 640- by 480-pixel VGA screen.

PTE has a unique approach to the interview process compared to the other packages we reviewed. Other packages do not show you the forms until you're done with the interview; PTE shows you the actual forms and source documents as they're being filled out. This is a handy way of keeping track of your progress.

On the negative side, PTE's interview isn't as comprehensive as the others. In some cases, PTE assumes that you have enough tax knowledge to know where to go. For example, while filling out Schedule C (business profit and loss), line 10, the program leads you directly to the related Form 4562 (depreciation), but it gives you no help on how to fill out the form correctly.

PTE ties in most directly with Parson's MoneyCounts financial package, and it will also handle data from Quicken, Managing Your Money, Microsoft Money, and ASCII text. The program has about 70 forms, schedules, and worksheets. You



Screen 3: *Tax Solver from Intex Solutions has a selection of 147 linked forms, schedules, and worksheets available for Lotus 1-2-3 and Symphony, as well as Microsoft Excel (shown here).*

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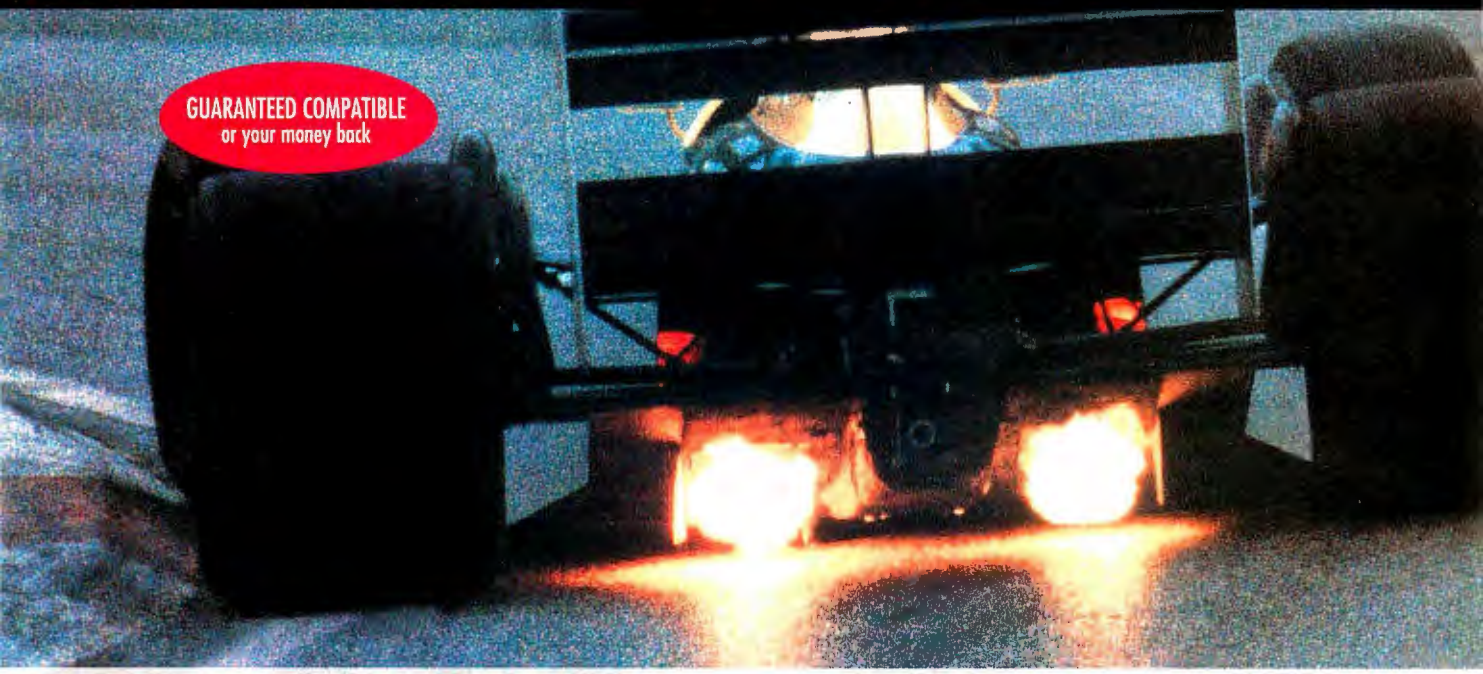

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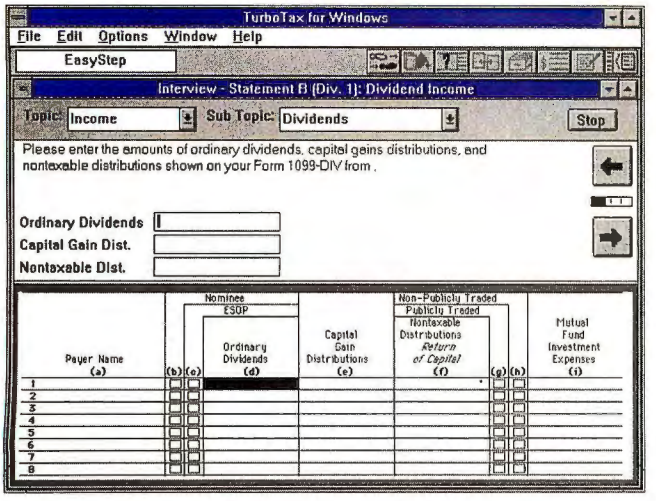

Screen 4: *ChipSoft's TurboTax is the most comprehensive tax-preparation package. It's available in DOS and Windows (shown here) versions. MacInTax is its equivalent for the Mac.*

can also file forms electronically through PTE for only $10.

Tax Solver

This package, also designed for the experienced tax preparer, is an unusual animal. It's the only package we looked at that doesn't stand alone. Different versions of Tax Solver are available for Microsoft Excel, Lotus 1-2-3 (DOS or Windows), and Lotus Symphony.

To use Tax Solver, you need to know how to use the related spreadsheet packages, and the more you know about them, the better. Tax Solver also has the largest selection of forms: 147 (see screen 3). Essentially, Tax Solver is a collection of linked spreadsheets that take up about 4 MB of disk space.

Tax Solver is recommended for the experienced number cruncher who is also comfortable with taxes. It doesn't have an interview form, and it doesn't import from other tax or financial programs (unless they export to spreadsheet formats). And there are no help screens for any of the schedules.

The advantage of Tax Solver is that you can use the advanced what-if capabilities of the underlying spreadsheet. The other packages reviewed here have worksheets for looking at alternative tax scenarios, but they don't have the extensive conjectural capabilities of Excel or 1-2-3.

TurboTax and MacInTax

ChipSoft's TurboTax is available for DOS and Windows (see screen 4); MacInTax is for the Mac. Both programs offer an extensive and helpful interview process, although they tend to assume some knowledge of tax law. For example, they rightly ask if you have any "nominee interest," but they don't explain what that is.

TurboTax and MacInTax also offer the most comprehensive final review of your tax return of any of the packages reviewed here. They are chock-full of hints and suggestions, including steps you can take to reduce your tax liability during the next year. Both offer electronic filing (via modem or disk) for $19.95.

TurboTax and MacInTax neglect to give you a running update on your tax liability until you're done with the entire interview, unless you specifically switch to the forms. And they import data only from Quicken and TXF formats.

Despite minor shortcomings, TurboTax and MacInTax stand out among the packages here in their ability to handle virtually any tax situation. The packages effortlessly and correctly calculate even the most complicated of tax returns. They offer extensive help and hints on advanced tax matters and even point you to IRS publications for further reading.

ChipSoft is the only company here that also sells versions of its programs specifically designed for professional tax preparers. In fact, if you prepare your return with TurboTax and bring it to professional preparers who use the pro packages, they can import your return and check or complete it for you.

Taxing Choices

For taxpayers who want to spend the least amount of time dealing with Uncle Sam (and aren't interested in becoming tax experts), any of the packages offering interviews are logical choices. TaxCut's interview process is thorough, but it has some limitations for complex returns. And while TurboTax's interview has its drawbacks, it's most effective and accurate for all types of returns. Interview-type programs are most effective when used with the financial management packages whose data they can import. That can eliminate the dreaded Shoebox Syndrome as you sift through piles of receipts as the tax deadline nears.

While the DOS versions of these programs are just as functional, we recommend that PC users buy the Windows versions: They put on-screen what looks like an actual IRS form, which is definitely helpful. And surprisingly, we found that the Windows versions were just as fast as their DOS counterparts.

A dose of reality: Because of the complexity of the U.S. Tax Code, the more complex your tax situation, the less cut-and-dried the "answers" are. Like law, taxes require interpretation and opinions, dependent on "facts and circumstances," as the IRS likes to say. Given any complex situation, all these packages could deliver slightly different bottom lines based on the interview. Programs like we've reviewed here are designed for the vast majority of taxpayers and are no substitute for a one-on-one interview with a real tax professional. ■

Kathleen LaRivière has over 14 years' experience as a tax professional; she owns and operates a tax practice in Peterborough, New Hampshire. Stan Miastkowski is a BYTE consulting editor and a freelance writer specializing in computer technology. Both can be reached on BIX c/o "stanm" or via MCI Mail at 530-9979.

ITEMS DISCUSSED

Andrew Tobias' TaxCut for DOS, TaxCut for Windows, TaxCut for the Macintosh.....$50
Meca Software, Inc.
(203) 256-5000
fax: (203) 255-6300
Circle 1225 on Inquiry Card.

Personal Tax Edge, Personal Tax Edge for Windows.....$49
Parsons Technology
(319) 395-9626
fax: (319) 393-1002
Circle 1226 on Inquiry Card.

Tax Solver for Excel, Tax Solver for 1-2-3, Tax Solver for Symphony.....$79.95
Intex Solutions, Inc.
(617) 449-6222
Circle 1227 on Inquiry Card.

TurboTax for DOS, TurboTax for Windows, MacInTax.....$79.95
ChipSoft, Inc.
(619) 453-4446
Circle 1228 on Inquiry Card.

SYSTEM

Compaq Stakes Out Both Ends of the Server Spectrum

BARRY NANCE

When it comes to the network server market, one size most definitely does not fit all. One shop may require nonstop operation, another excellent I/O performance for a large LAN, and a third high-speed processing for a database server. And some companies just need reasonable performance at a reasonable price.

Compaq has addressed both ends of the server spectrum with two recent server introductions. The Systempro/XL (see the photo) is a high-end, dual-processor system with fault-tolerant and management features; Compaq's new ProSignia is a new low-end, single-processor server.

I tested both servers for speed in two environments. In my lab, I alternated between Ethernet and Token Ring to connect up to eight workstations. For a larger-scale test, I used a battery of 50 PCs on 16-Mbps Token Ring to give the XL and ProSignia servers more of a workout. I used the BYTE LAN Benchmarks (for NetWare and Unix) to measure performance on NetWare 3.11 from Compaq and SCO Unix 3.2.4. Figure 1 shows results for varying workstation levels on a Token Ring network.

In the following sections, I'll discuss performance and reliability aspects of the XL. You'll find details on the ProSignia in the text box "You're Not Going to Pay a Lot for This Server," page 172.

Inside the XL

The XL is based on Compaq's new TriFlex system architecture, which Compaq designed to be upwardly compatible with Intel's entire family of fast CPUs. A natural extension to Flex/MP, TriFlex separates system operations among the 64-bit processor bus, the 128-bit memory bus, and the 32-bit EISA bus. The TriFlex DataFlow Manager coordinates the work of EISA adapters and the CPU, providing a 267-MBps path to and from main memory. (For comparison, the IBM Model 295 operates at 200 MBps.)

DataFlow Manager is Compaq's solution to a performance problem that sometimes plagues bus-master adapters. Ironically, as a bus-master adapter uses more memory bandwidth, it reduces the CPU's ability to access main memory during instruction fetch cycles. According to Compaq, the DataFlow Manager lets processors and EISA bus-masters access main memory simultaneously more than 70 percent of the time.

The Systempro/XL features dual processors and advanced system architecture for high performance.

The XL can accept an optional second processor board. The two CPUs in my review unit were 50-MHz 486s, but Compaq says that the XL's 64-bit processor architecture will readily accommodate Intel's future high-speed CPUs—Pentium and beyond. The XL's processor boards also add 256 KB of two-way set-associative, write-back cache.

NetWare can take advantage of the large CPU cache, but it can't make use of the second CPU. Novell says it's still in the design stages of multiprocessor support for NetWare and that SMP (symmetric multiprocessing) support may appear in a subsequent release of NetWare 4.0 late in 1993. Until then, you'll find the dual-processor architecture most useful in an application or database server running SCO Unix with MPX (multiprocessor extension) or Banyan Vines SMP.

The XL comes bundled with a new Compaq network interface card. The NetFlex dual-physical-layer-protocol adapter

BYTE ACTION SUMMARY

- **WHAT THE SYSTEMPRO/XL AND PROSIGNIA ARE**
  The XL is a new high-end server with fault-tolerant features. The ProSignia is a fast, low-cost server.
- **LIKES**
  Fault tolerance and excellent capacity on the XL; low cost but good performance on the ProSignia.
- **DISLIKES**
  No hot-swap capability for the XL; multiprocessing practical only on Unix networks.
- **RECOMMENDATIONS**
  Both servers fit their niches well.
- **PRICE**
  Systempro/XL (with SCSI, four 550-MB hard drives, dual 486/50s, 16 MB of RAM, Token Ring), $22,014
  ProSignia (with SCSI, one 550-MB hard drive, one 486DX2/66, 16 MB of RAM, Token Ring), $6097
- **FOR MORE INFORMATION**
  Compaq Computer Corp.
  P.O. Box 692000
  Houston, TX 77269
  (800) 345-1518
  (713) 370-0670
  fax: (713) 374-1740
  Circle 1223 on Inquiry Card.

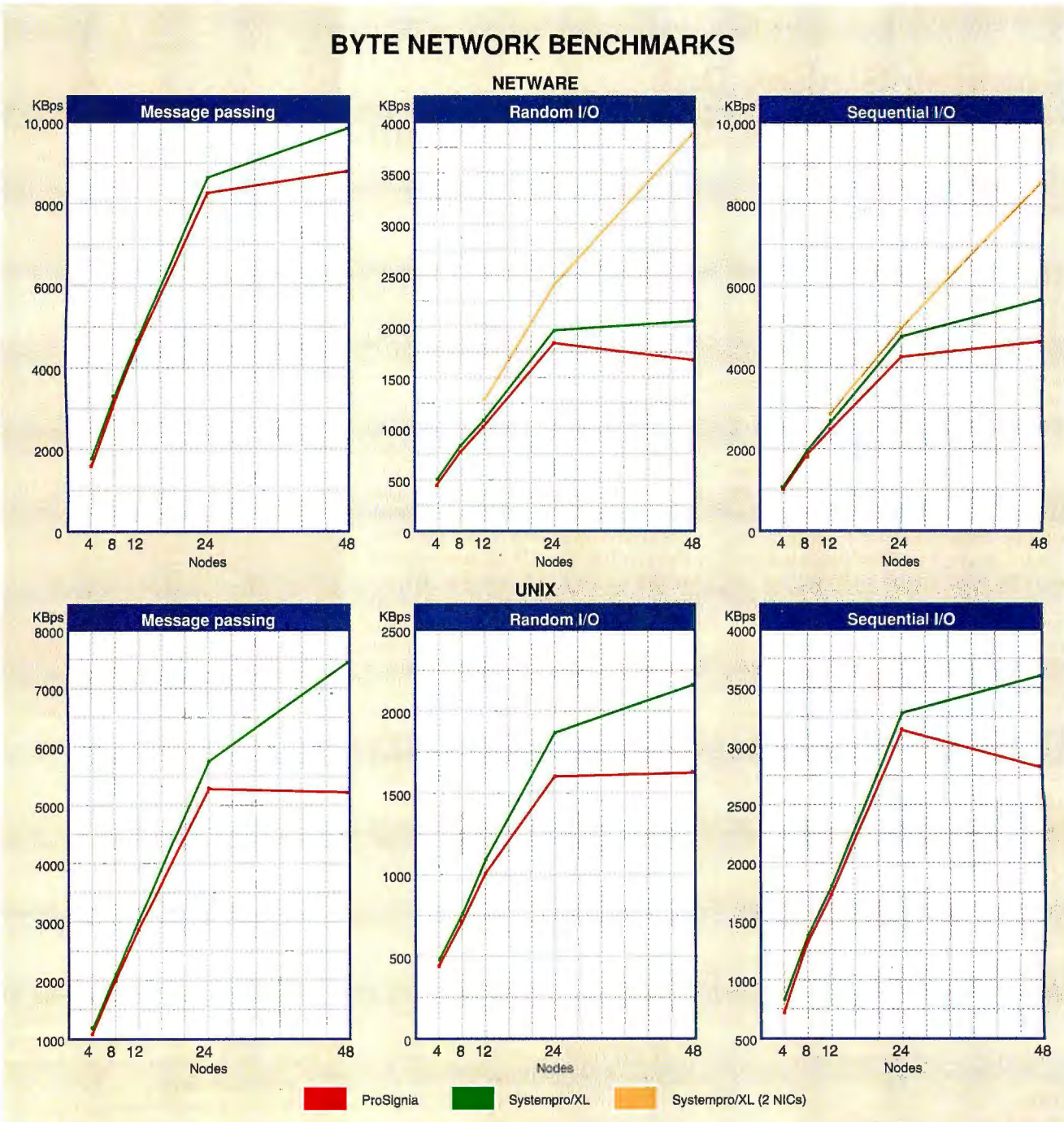

Figure 1: *NetWare benchmark results show that both servers are fast but that the Systempro/XL has considerably higher capacity than the ProSignia. The XL shows no degradation at all with two NICs installed. It ran in a dual-processor configuration on the Unix tests, but because I/O is such a significant component of the BYTE Unix Network Benchmarks, the XL doesn't show much benefit.*

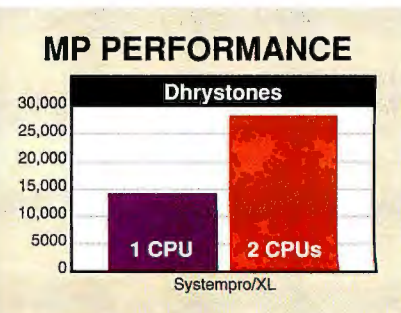

Figure 2: *The Systempro/XL shows a linear increase in processing power when adding an additional CPU running Dhrystones under MPX.*

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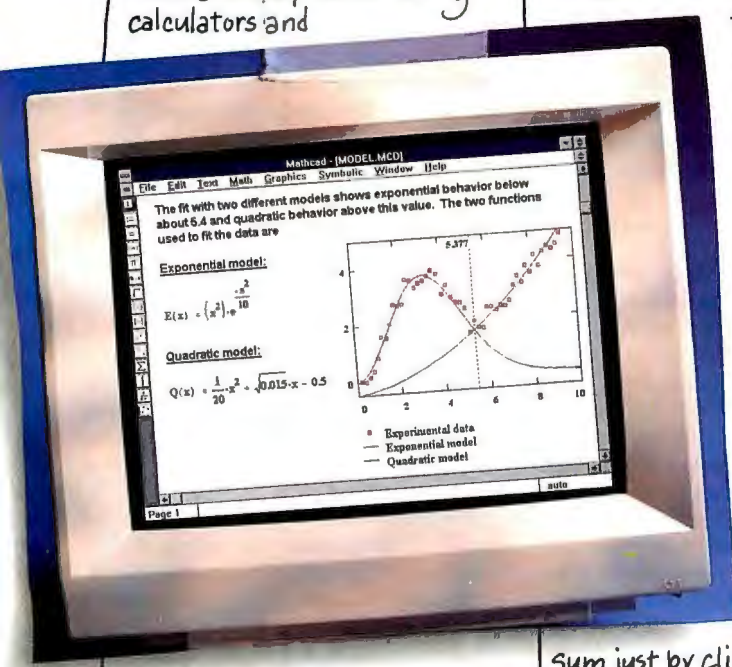

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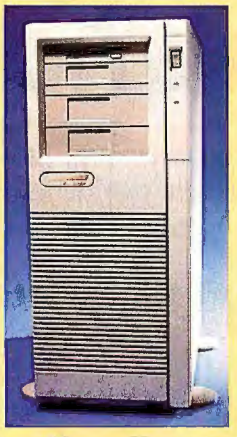
You're Not Going to Pay a Lot for This Server

Compaq's ProSignia is a midrange EISA server, a little smaller than your average Systempro. With a 66-MHz 486DX2 CPU, 16 MB of RAM, a 550-MB hard drive, a network card, and the usual peripherals, the ProSignia costs $6097.



You can choose either a 33-MHz 486 or the clock-doubled 66-MHz 486DX2, boosted by a 256-KB cache. The large CPU socket will support a CPU chip upgrade to a 32-bit Pentium (P24T) chip. You can install up to 128 MB of RAM in the ProSignia. It doesn't have the Systempro XL's TriFlex architecture, but it still held its own on the benchmarks at low usage levels.

The ProSignia server also doesn't have ECC (error-correction code) or other fault-tolerant features of the Systempro/XL, although you can optionally add an IDA-2 (Intelligent Drive Array). However, the standard ProSignia does include Rapid Recovery Services and Compaq's Insight. Standard features of the ProSignia include a 32-bit SCSI-2 controller designed especially for NetWare, built-in server monitoring and recovery, and the 32-bit NetFlex EISA network adapter capable of either Ethernet or Token Ring.

The ProSignia is a fast file server, almost as fast as the XL when equipped with the 66-MHz 486DX2 processor. For networks where fault tolerance and killer capacity aren't critical, the ProSignia is a good investment. It would be an unusual setup, but you could even use DOS 5.x and either LANtastic or Windows for Workgroups 3.1 to turn an XL into a server on a peer LAN.

is based on Texas Instruments' Super Eagle controller. The bus-mastering 32-bit EISA NetFlex provides an RJ-45 port for UTP (unshielded twisted-pair) connection to either Token Ring or Ethernet, an AUI (attachment unit interface) port for thick Ethernet, and a nine-pin port for STP (shielded twisted-pair) Type 1 Token Ring.

I tested the XL with its fast SCSI-2 array controller. This controller gave excellent performance and of course will work with the fault-tolerant features of NetWare, such as mirroring and controller duplexing. To get full fault tolerance, however, you need an optional $2499 IDA-2 (Intelligent Drive Array) controller. The IDA-2 controller supports RAID levels 0 (mirroring), 4 (data-guarding with parity drive), and 5 (data-guarding with distributed parity).

For faster, easier maintenance, disk drives snap into the XL chassis. However, you can't hot-swap; you have to power down the XL to replace internal drives (or any other failed system module).

In addition to fault tolerance at the drive controller level, the XL also includes fault-tolerant memory features. The XL supports up to 512 MB of ECC (error-correction code) RAM. The XL also incorporates memory tracking, which catches ECC RAM faults.

Software for Servers

Compaq offers NetWare 3.11 as an option for both the XL and ProSignia. Compaq supplies the disks; you choose your own configuration options and preferences as you install NetWare. Compaq provides all the necessary drivers, as well as a set of NLMs (NetWare loadable modules) for diagnostic purposes.

The diagnostic NLMs turn the XL into an SNMP agent. You can use Insight Manager, a Windows-based utility for over-the-network management of Compaq PC servers, to collect information from the SNMP agent NLMs.

Rapid Recovery Services, a built-in management feature, monitors for hardware failures and network-operating-system crashes, including specific NetWare ABEND conditions. The diagnostics reside on a separate disk partition.

Measuring the XL's Speed

A faster CPU in a server generally means capacity for more users rather than faster response times for fewer users. A single workstation's response times depend mostly on the speed of the server's I/O subsystems: the hard drives, controller, disk cache, and network adapters.

Figure 1 graphs server throughput for four, eight, 12, 24, and 48 workstations under NetWare 3.11. With one NIC, the XL's server performance degraded somewhat between 24 and 48 workstations. When I added a second NetFlex, the XL performed spectacularly. At up to 48 very heavy, simultaneous users, the XL shows no saturation with two NICs.

The lower row of graphs shows results for Unix at the same usage levels. I didn't run the Unix tests with multiple NICs, but I would expect to see no saturation at these levels (as with NetWare). Although the XL used both processors on this test, the I/O-heavy benchmarks didn't show much advantage. However, if you designate the XL as an application or database server, you should see the benefit of the extra processor as MPX distributes client/server tasks across the CPUs.

I ran Dhrystone tests to more fully test the XL's MP features (see figure 2). The graph shows that performance simply doubles with two processors; you wouldn't see that kind of linear performance gain on an MP system that wasn't symmetric.

More Capacity, Brighter Future

The XL isn't much faster than fast low-end servers like the ProSignia, but it offers much higher capacity for large networks. It's also worth considering as a high-performance application server.

A two-CPU XL is overkill right now for NetWare servers. Further down the road, however, MP NetWare and the XL's support for 64-bit Intel processors should make the Systempro/XL an excellent long-term solution. ■

Barry Nance, a programmer for the past 20 years and a BYTE contributing editor, is the author of Using OS/2 2.0 *(Que, 1992),* Network Programming in C *(Que, 1990), and* Introduction to Networking *(Que, 1992). He is the editor for the IBM Exchange on BIX, where you can reach him as "barryn."*

SYSTEM

Two PowerBooks Great and Small

TOM THOMPSON

Apple's latest round of PowerBook introductions splits the product line into two distinct branches—the high-end, self-contained machines (the PowerBook 160 and 180) and the lightweight, dockable Duo family.

Most of the specifications for these notebooks can be found in my First Impression "New Macs for the Desktop and Road," December 1992 BYTE. Since then, I've had a chance to really live with a PowerBook 180 and a PowerBook Duo 230 for a few weeks, and I've had time to test their performance mettle with the latest revision of BYTE's Macintosh benchmarks.

What They've Got

The PowerBook 180 shares its 6.8-pound, clamshell design with previous PowerBooks. Like the older 145, it has a built-in 1.44-MB SuperDrive floppy drive and includes the usual entourage of I/O ports for ADB (Apple Desktop Bus), serial, sound I/O, and SCSI. Where the 180 breaks from the pack is in performance; its 33-MHz 68030, combined with a 33-MHz 68882 FPU, makes it the fastest portable Mac on the market. The 180 also has a new 10-inch, backlit, 640- by 400-pixel, active-matrix LCD panel that supports 16 gray levels. Finally, the 180 directly supports external video (8-bit color monitors of up to 16 inches) through a display port and a bundled adapter cable (see photo 1).

The PowerBook 180 is a trim machine, but it's a behemoth next to the PowerBook Duo 230. The latter is a svelte slab that weighs only 4.2 pounds, measures somewhat smaller than a notebook page (10.8 by 8.5 inches), and clears only 1.4 inches. The clamshell Duo 230 opens to reveal a 9-inch, backlit screen—a 640- by 400-pixel, supertwist LCD panel that supports 16 gray levels. But to pack that much computer into such a small frame means making compromises.

The system has neither an FPU nor a SuperDrive. The only I/O ports are a mini-DIN-8 LocalTalk/serial connector and an RJ-11 connector for an internal modem. To access floppy disks while on the road, you'll need an optional Mac Duo Floppy Adapter ($135) and Floppy Drive ($199).

However, the Duo 230 is really designed to park inside a Duo Dock docking station, which provides the balance of the features you'd expect in a desktop Mac (see photo 2). A 152-pin docking connector at the back of the Duo 230 acts as a Processor Direct Slot and conveys processor and I/O signals into the Duo Dock. The Duo Dock routes these signals to two NuBus slots, an army of I/O ports (ADB, sound I/O, two serial, SCSI), a SuperDrive floppy drive, an FPU socket, and an optional internal hard drive. The Duo Dock provides 8-bit color output for 12- to 16-inch monitors (16-bit color with additional video RAM).

A motorized mechanism in the Duo Dock pulls the Duo 230 into the dock when you insert it and ejects it when you press an eject button (almost exactly like a videocassette). This arrangement makes for a reliable electrical connection, and it also provides safeguards that prevent you from accidentally clobbering files. For example, you can't insert the Duo 230 into the dock while it's in sleep mode: The Duo Dock ejects the computer, and a dialog box appears on the notebook's screen advising you to shut down the Duo 230. When

Photo 1: *The PowerBook 180, shown here with an external color monitor, bundles more performance than a Mac IIci into a 9.3- by 11.25- by 2.25-inch package.*

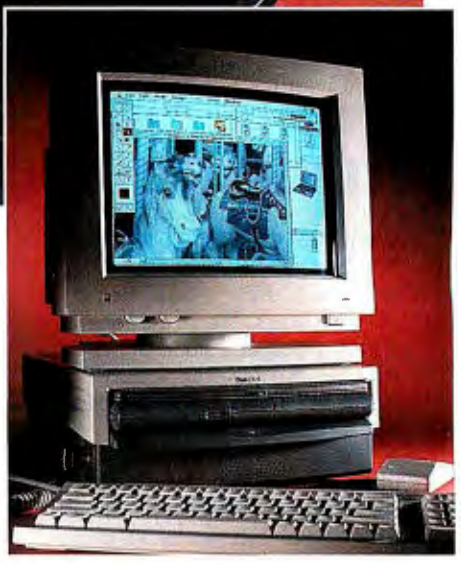


Photo 2: *The Duo Dock turns the svelte PowerBook Duo 230 into an uncompromising desktop Mac.*

you press the eject button, the Duo Dock issues a Shut Down command to the Duo 230, which closes all running applications and prompts you to save any open files before ejecting the computer.

The Duo/Duo Dock combination gives you a powerful computer that you can leave parked on a desk, equipped with a keyboard, a mouse, and an external color monitor, and with access to the office network. But at a moment's notice, you can punch the eject button, grab the Duo 230 out of the Duo Dock, and carry it away on a company mission, secure that all your work is in your hands.

Checking Out the Books

I looked at a PowerBook 180 equipped with 4 MB of RAM, a 120-MB hard drive, and an Apple 2400-bps fax modem. The PowerBook Duo 230 was equipped with 12 MB of RAM and a 120-MB hard drive. It packs more processing power, storage, and memory than the Mac IIci I use at the office.

My first job was to install System 7.1, included with each machine. Along with the usual pack of six high-density System software disks, you also get an Install Me First disk that contains a System file, the Installer application, and a System Enabler file. This System Enabler file contains hardware-specific code and resources required to run System 7.1 on each machine.

You boot the PowerBook with Install Me First; the Installer copies the System Enabler file to the computer's hard drive, and then the installation process runs as usual. The important thing to note here is not to toss the System Enabler file into the Trash: Your PowerBook 180 or Duo 230 won't start without it, and you'll be forced to copy the file off the bootable Disk Tools floppy disk.

The PowerBook 180 supports a SCSI disk mode, in which it acts as a SCSI disk when connected to a desktop Mac with a System Adapter cable. This cable has an extra pin and a female 50-pin SCSI connector; it fits between a standard SCSI cable and the PowerBook. The extra pin signals the PowerBook to operate as a slave SCSI device. I used the System Adapter to copy all my applications and utilities from my IIci to the PowerBook 180. The Duo 230 also supports this SCSI function through an optional MiniDock that provides a SCSI connection. Since the Duo 230 lacks built-in SCSI, I parked it in the Duo Dock and copied the files from the IIci via the network.

The Duo Dock works superbly. It recharges the Duo 230's battery while the notebook is docked—a nice touch. However, there are some mechanical difficulties in working with the Duo Dock. First, the SuperDrive is mounted on the right side of the chassis, and I didn't like having to reach around to insert floppy disks. Second, adding NuBus boards is a chore: You have to remove the cover, loosen some screws, and then flip over a panel covered with electronics to add the boards.

One additional note of caution regarding the Duo Floppy Adapter: Once you get used to the idiot-proof protection mechanisms of the Duo Dock, it's hard to go back to less-tolerant hardware. Plugging in the Duo Floppy Adapter while the Duo 230 is awake causes it to lose power—and any active files.

Software Compatibility Problems

Normally you expect minor software-compatibility problems with any new Mac, but with these PowerBooks the problems are compounded by changes brought on by System 7.1. Specifically, fonts are now located in a Fonts folder rather than in the System file. This makes managing your fonts easier, but it freaks out any software that makes assumptions about font location. Therefore, you'll need to update some applications.

Fifth Generation Systems electronically distributes an update that patches Suitcase 2.1.1 to work with System 7.1. Adobe Type Manager 2.0.3 crashes, because it expects to find its outline fonts in the Extensions folder. Adam Stein's ATM Fixer is an on-line patch that fixes this problem. ATM 3.0 and a beta version of SuperATM (3.5b13) worked just fine.

There were some other software snags. Adobe Photoshop 2.0.1 works, displaying images adequately in 16 grays, but the Mac Desktop palette shifts into a black-and-white mode when you exit the application. Connectix's PowerBook Utilities (CPU) requires version 1.0j to work with the new PowerBooks' gray-scale screens and new hardware. However, there's an interaction between CPU and Suitcase that hangs the PowerBook when you open the CPU Control Panel. Connectix has traced the problem to a bug in the Resource Manager and suggests rebooting with Extensions disabled when you change settings.

Despite these glitches, most software worked fine on both machines, including Adobe Illustrator 3.2 and Adobe Dimensions 1.0, ZTerm 0.9, NOW Utilities Super Boomerang 4.0.1 and WYSIWYG Menus 4.0.1, plus Claris Resolve and MacWrite II. Shiva's NetModem and NetSerial software also worked when hooked to a LAN.

Portable Performers

The BYTE CPU benchmarks show that both the PowerBook 180 and the Duo 230 are about 20 percent faster than a 25-MHz Mac IIci for some operations (see the figure). The Duo 230 didn't do as well on the floating-point tests because it lacks an FPU, but you can install one in the Duo Dock. These notebooks provide full mid-range processing power that will satisfy

BYTE ACTION SUMMARY

- **WHAT THE POWERBOOK 180 AND POWERBOOK DUO 230 ARE**
  Both are 33-MHz, 68030-based portable Macs. The PowerBook 180 is a high-end stand-alone portable; the PowerBook Duo 230 is small and light and mates with a docking station.
- **LIKES**
  Both are fast and powerful. They have display support for 16 gray levels.
- **DISLIKES**
  The PowerBook 180's high price; the PowerBook Duo 230's lack of an FPU and a floppy drive.
- **RECOMMENDATIONS**
  For those who need a self-contained Mac with a sharp display, the PowerBook 180 is ideal. For those who won't compromise on weight and size, yet need desktop power, the PowerBook Duo 230 is excellent.
- **PRICE (AS TESTED)**
  PowerBook 180, $4788
  PowerBook Duo 230, $3439
  Mac Duo Dock, $1079
- **FOR MORE INFORMATION**
  Apple Computer, Inc.
  20525 Mariani Ave.
  Cupertino, CA 95014
  (800) 776-2333
  (408) 996-1010
  fax: (408) 974-6412
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STATISTICA/w

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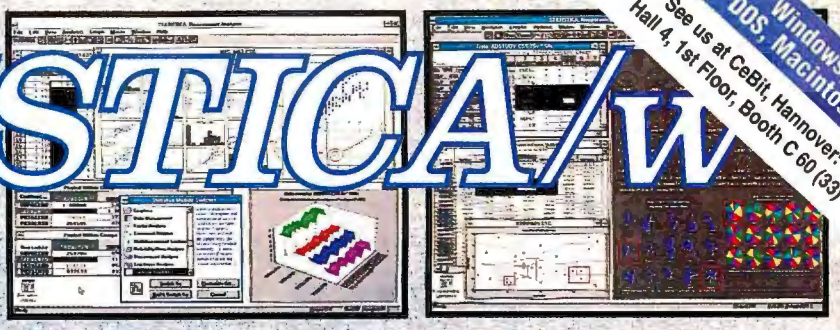

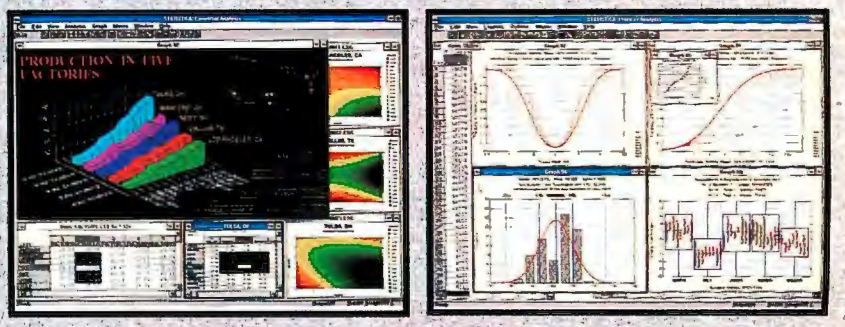

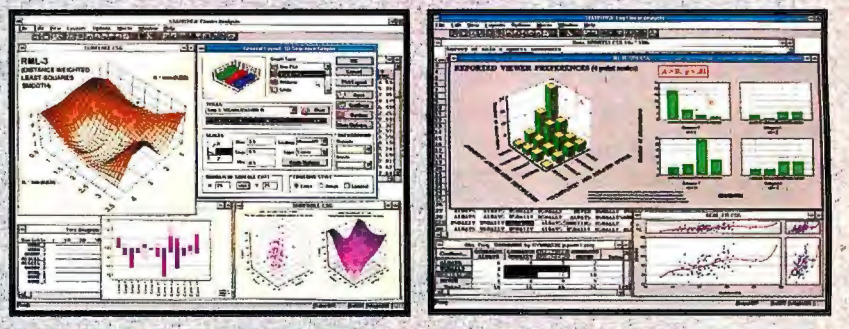

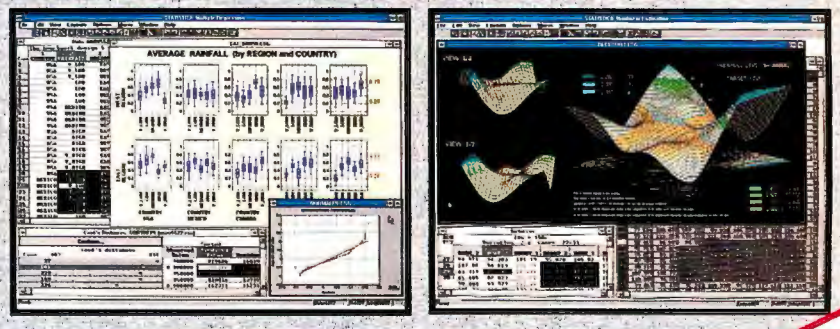

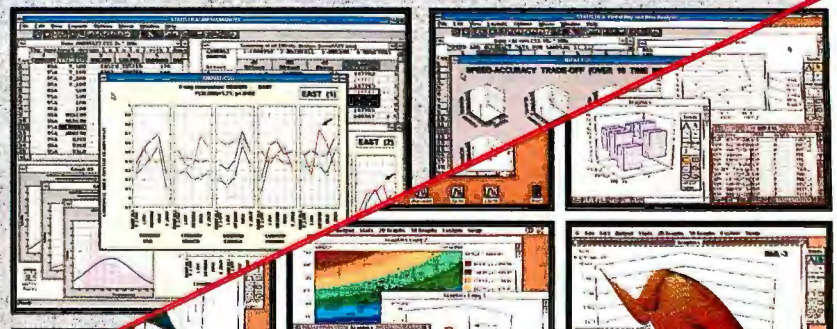

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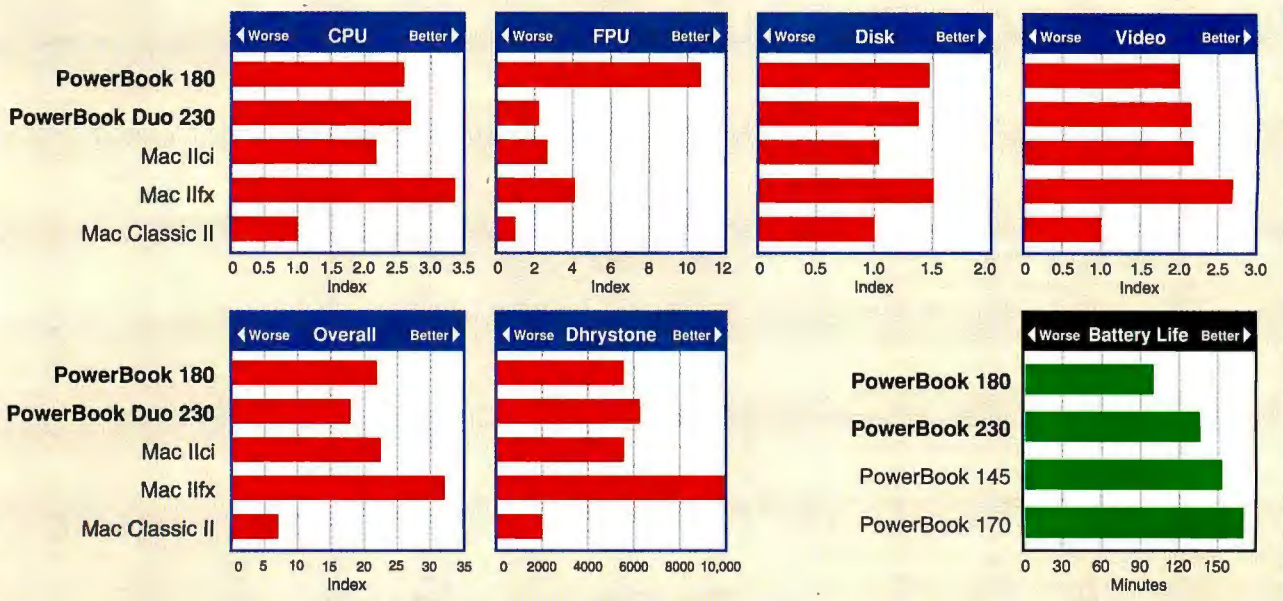
BYTE MACINTOSH BENCHMARKS



BENCHMARK SUMMARY

	PowerBook 180	PowerBook Duo 230	Mac IIci	Mac IIfx	Mac Classic II
Low-level performance					
CPU index	2.60	2.70	2.18	3.36	1.00
FPU index	10.68	2.22	2.66	4.10	1.00
Disk index	1.47	1.38	1.04	1.51	1.00
Video index	2.00	2.14	2.17	2.68	1.00
Application performance					
Word processing index	2.76	2.90	2.99	4.39	1.00
DTP index	1.81	1.86	1.80	2.44	1.00
Database index	2.50	2.59	2.67	3.46	1.00
Development index	2.19	2.27	2.06	2.83	1.00
Graphics applications index	2.63	2.63	2.63	3.63	1.00
Scientific index	4.46	2.67	4.33	6.81	1.00
Spreadsheet index	5.54	3.02	5.98	8.52	1.00
Overall application index	21.91	17.93	22.47	32.08	7.00
Dhrystone	5555	6250	5555	10,000	2000

All machines were tested using System 7.1. Except for the Dhrystone and battery-life tests, all results are indexed, and higher numbers indicate better performance. For each indexed test, a Mac Classic II = 1. Comprehensive test results and detailed configurations are available for all machines on request.

The 33-MHz PowerBook 180 and PowerBook Duo 230 are about 20 percent faster than a 25-MHz Mac IIci in some operations.

the needs of all but the most demanding users.

Both computers' screens were bright and clear, but I especially enjoyed the crystal sharpness of the 180's active-matrix display. As for the Duo, there are a lot of little features to like: the LED in the Caps Lock key, the easy-to-reach Power On button (it's by the keyboard rather than in the rear), and its going into sleep mode when you close the lid. However, its smaller, recessed trackball takes some getting used to. The trackball got mixed reviews among other BYTE editors.

Which computer should you choose? That depends on what you need on the road, and your working style. I have to admit my bias toward the complete, self-contained system represented by the PowerBook 180, and I can't praise the display enough.

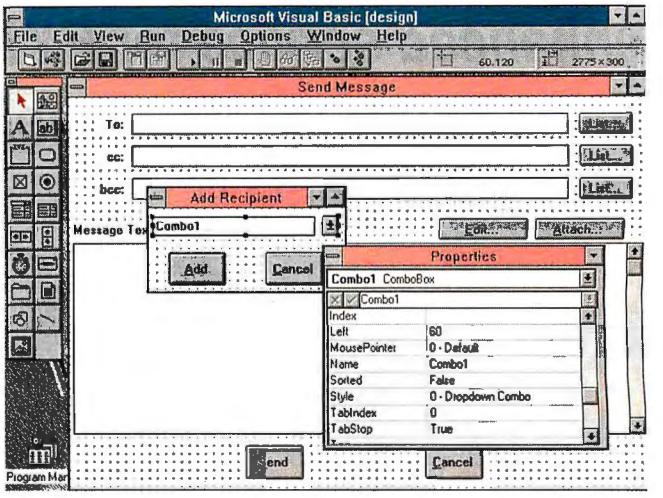
There's a lot to like about the Duo 230's smaller size and lighter weight. Nevertheless, its lack of a floppy drive scares me. While the Duo Floppy Adapter and external SuperDrive are a good solution, it requires keeping track of too many little parts on the road. If the Duo 230 had a built-in floppy drive, I'd like it a lot better. As it is, I'll stick with the PowerBook 180. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. You can contact him on BIX as "tom_thompson" or on the Internet at tomt@bytepb.byte.com.

APPLICATION

Visual Basic for Windows Gets a Face-Lift

TOM YAGER



Visual Basic 2.0 sports a new tool bar and floating window, where you can see multiple properties at once and change properties for multiple selected controls.

Until the arrival of Microsoft's Visual Basic for Windows, programmers had to spend hours learning complex development tools just to work in Windows. Visual Basic simplified working in Windows and gave the rewards of custom programming to even occasional programmers. However, its limited feature set was deficient for some, particularly when a large application needed to be created. At those times, many programmers were forced to write portions of their programs in C or another language.

The latest release, version 2.0, removes many but not all of the original version's limitations. Improved performance and new capabilities make custom Windows programming easier than ever. However, Visual Basic still lacks some pieces that I consider important, including a native-code compiler.

Greater Magnitude

I tested Visual Basic for Windows 2.0 on three machines: a Toshiba T2000SX laptop (a 16-MHz 386SX), an ALR Flyer 32LCT with a 66-MHz 486DX2, and a Uniq file server with a 50-MHz 486. I spread the testing around to get a feel for the new Visual Basic's performance. However, I did most of my test work on the laptop because I wanted to see how Visual Basic's changes played on a system with minimal display resolution and color depth, limited CPU speed, and relatively limited memory (5 MB). If Visual Basic 2.0 could make it there, it could make it anywhere.

The first thing that struck me about Visual Basic 2.0 was its magnitude. I installed the Professional Edition, which occupied about 22 MB of disk space and took close to an hour to load on the T2000SX. The installation lets you selectively leave out parts of the package and does a fine job of comparing and displaying required and available disk space.

The appearance of Visual Basic 2.0 has changed noticeably (see the screen). Most obvious is Microsoft's ubiquitous toolbar. The toolbar is where the old properties combo box pair used to be; Visual Basic 1.0 users might find the change a little confusing at first. Properties are now managed through a floating window.

I wasn't sure I'd like the new setup until I loaded a project I created in the old Visual Basic. The new properties window has a spreadsheet-like feel to it, with one column each for names and values. The type and name of the selected control are always visible at the top, and a single interface gives you access to all the properties of all the controls in your application. Double-clicking on a cell in the properties window cycles that property's value—true becomes false, numerics get incremented, and so on. When you select multiple controls, the values column in the properties window goes blank and the properties list is trimmed to only those shared by all the selected controls.

Reduced Tedium

Veterans of Visual Basic 1.0 will recognize the properties window as a blessing because it puts an end to the familiar and tedious "select control—change property—select control..." cycle. Also, Visual Basic 1.0 allowed changes to only one property at a time through the toolbar. Multiple controls can now be selected by dragging a marquee around them, and properties shared by those controls can be changed with a single action.

I recommend that you get used to the new properties window's approach (a two-column grid topped by a combo box) because it appears elsewhere in the new Visual Basic, including the environment and project options dialog boxes. The only drawback of the properties window is that it takes up more screen space than the old method. On my laptop's display, I had to keep popping the properties window up and down because there wasn't room for it to be on-screen constantly. All my non-portable systems have at least 1024- by 768-pixel screens, and I leave the window permanently popped up. Even when you're not actively changing properties, the window holds a lot of useful information.

Once I loaded code into Visual Basic 2.0, I found it easier to find my way around this version than previous releases. A dialog box pops up with a key press and lets you zip to any procedure in your application by name. The syntactic color coding in the edit windows is an aid, particularly for large projects or big edit windows. Although there's multilevel undo and redo, the undo stack is strictly last-in, first-out. There's undo/redo in the forms builder as well, but that's only one level deep.

Overall, the new Visual Basic environment is at least as comfortable as the old one. The properties window is a big improvement if you can afford to leave it on-screen most of the time.

Some Performance Improvement

Microsoft says it improved performance through faster application starts, smaller .EXE files, and faster access to those attributes of objects called *properties*. In addition, version 2.0 lifts the barriers on array sizes, so you can use all available memory in your system. (Arrays also can now be resized without discarding their contents.) Other arbitrary limits have been raised, including the number of procedures in a program and the number of controls (i.e., interface elements) per form.

My testing turned up mostly positive results, but there were a few questionable areas. The size of my test projects didn't benefit from the claimed reduction in .EXE

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file size. The faster loading and displaying of a program's initial form *did* show itself: All the applications I ported from the old Visual Basic to the new one had their load delay time cut almost in half.

The lifting of data size limitations seems more dramatic than it actually is; many kinds of data still suffer from limits imposed by segmentation. Individual strings are still limited to 64 KB each, and the manual paints a confusing picture of how segment limits affect other data types.

Among the other enhancements for version 2.0 is the program's support for the MDI (Multiple Document Interface) to provide access to the MDI services and events that the previous version wouldn't let you near. Standard now is 256-color support, as are access to DOS file I/O functions and the `hWnd` property of every windowed control (primarily for use with Windows API routines). Also, you can independently set the Z-order (i.e., stacking order) of each control and form.

The language itself has some significant changes as well. There is a new data type, called `variant`, that you can use practically anywhere a typed variable will serve. Controls can now have default values—data returned when the control name is referenced alone in a program. A single form can exist in multiple instances as well (particularly useful with MDI applications), and variable type declarations and global definitions can exist anywhere in the program. Programs, forms, and projects can all be stored in ASCII representation, making room for the use of code management tools and code generators.

Finally, buyers of the Professional Edition will find an assortment of custom controls similar to those included in Visual Basic 1.0's Professional Toolkit. New to this release are Windows 3.1 support (the help compiler and on-line API reference), MAPI (Messaging API) support for E-mail links, ODBC (Open Database Connectivity) support for database access, a communications control for serial communications including file transfer, and a host of other features. Two parts of Visual Basic 1.0's Professional Toolkit have been moved to 2.0's Standard Edition: the spreadsheet-like grid control and the OLE client control.

Missing Pieces

For all the changes Microsoft made, it still didn't address some of the areas I consider important and missing in Visual Basic. To name a few, there still isn't a native-code compiler, and there's no option to produce single .EXE files (Visual Basic .EXEs require separate DLLs at run time, sometimes several). The program also lacks integration of an ISAM (indexed sequential-access method) or other database engine into the Professional Edition (Visual Basic for DOS has this, and the Windows version will communicate with optional, external databases through ODBC).

Even with those areas in mind, Microsoft has taken giant strides toward making Visual Basic palatable to programmers. The need to run off to C or some other language to get the work done has been diminished somewhat. While I'm not packing up my compilers just yet, I am a fan of the new Visual Basic for the same reason that I like the old: It's still the quickest, most painless way to create professional-looking Windows applications. ■

Tom Yager is a former BYTE technical editor and consultant for multimedia and Unix applications. He can be reached on BIX as "tyager" and on the Internet at tyager@bytepb.byte.com.

BYTE ACTION SUMMARY

- **WHAT VISUAL BASIC 2.0 IS**
  A new release of Microsoft's programming system for Windows applications.
- **LIKES**
  Floating properties window; huge arrays; faster application loading and display.
- **DISLIKES**
  Still lacks some features that professional developers expect; runs best at screen resolutions of 800 by 600 pixels or better.
- **RECOMMENDATIONS**
  The best choice for the development of non-performance-critical Windows applications.
- **PRICE**
  Standard Edition: $199 (upgrade from version 1.0, $79); Professional Edition: $495 (upgrade from version 1.0, $99)
- **FOR MORE INFORMATION**
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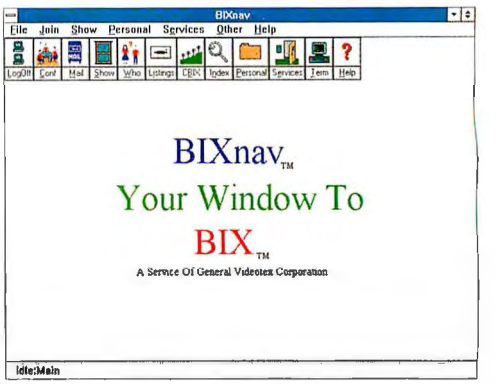

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APPLICATION

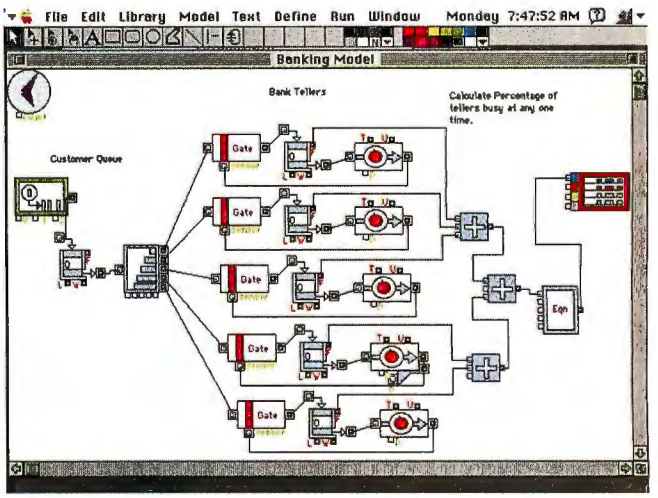
Imagining the World

RAYMOND GA CÔTÉ

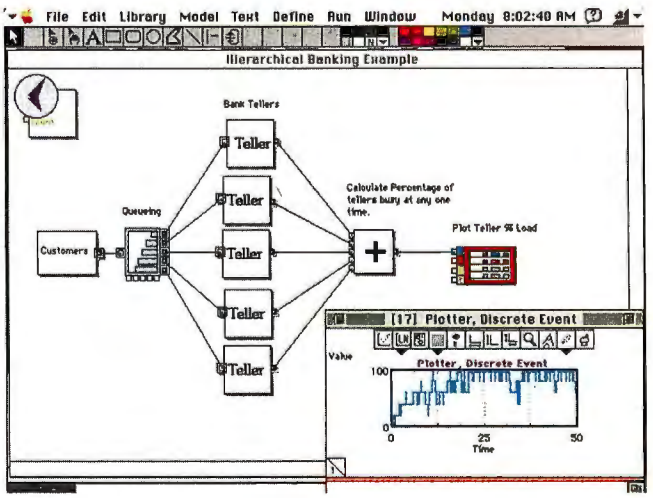
Computers are the ultimate what-if machines. Beyond the what-if solutions offered by spreadsheets extends a realm of real-world problems. Extend+ Manufacturing 2.0 from Imagine That is a professional-quality computer simulation tool for the Macintosh that allows you to explore real-world problems.

Simulations cross many disciplines, such as business, finance, process, science, engineering, and manufacturing. Extend provides a set of well-stocked component libraries to address problems in these widely diverging areas. Basic library elements include discrete and continuous events, animation, and plotting.

The plotting library provides various on-screen output devices for graphing the simulation results. The electronics library provides various digital and electronic components, but Extend is not suitable for simulating complicated circuit designs. Instead, items such as an A/D converter and voltage sources could be integrated into a process-control simulation. The $300 Manufacturing Library extension provides just about everything you need to lay out a complete manufacturing facility—including assembly stations, stock rooms, conveyor belts, palletizing stations, and automatic guided vehicles that follow a prescribed path from station to station.



Screen 1: *A banking simulation model without hierarchical blocks. Although technically correct, the details of the model get in the way of the process. Even if you are familiar with all the Extend icons, the number of interconnections is confusing.*



Screen 2: *This model works the same as the model shown in screen 1. All the details have been hidden in hierarchical blocks. Although operation of the two models is identical, this version is much simpler to explain and modify.*

Flexible Design

With almost any type of graphical development tool, your display rapidly devolves into a mass of unreadable lines and boxes: the ultimate spaghetti code. Hierarchical blocks are the solution to this problem. Screen 1 shows my first effort to design a simulation where a single queue of bank customers waits to be serviced by multiple tellers. Although this simulation works well, it does not efficiently communicate the process. Too many details get in the way. Screen 2 shows a hierarchical solution to the same problem. All the gritty details have been hidden within the custom-built blocks. Once I had built the original model and understood how to compose a teller queue, the second diagram was simpler to complete.

If the standard building blocks are not sufficient, you can extend the simulation environment with new blocks. The simplest way is by using ModL, a C-like programming language built into Extend. The language library includes support for file I/O, statistics, financial calculations, and matrix manipulation. ModL also provides you with a link to the outside world by way of a generic driver interface, XCMD support, and Apple events. These three features provide the gateways to communicate with any other application or drivers installed on your Macintosh. Sample applications include using Apple events to access an external spreadsheet for calculations and another block for communicating with an IEEE-488 test interface.

The Learning Curve

Extend is fairly easy to learn. I was able to build and run several original simulations within an hour of installing the software. My original flat-model simulation took slightly over an hour to construct. Once the application was up and running, it took only about half an hour to break it into the more understandable hierarchical blocks and rebuild the system.

At this point, I could put my model through its paces and determine if it actually did what I expected it to do. I wandered down to the local bank with a stopwatch and notepad to capture some real live banking action. Armed with my small real-world sample, I returned to put the model through its paces. Although several parameters required final tweaking, it performed as expected.

Now I could really begin to work. What happens if I reduce the number of available tellers by half? Can they handle an extra-large lunchtime crowd? What happens if the average transaction time increases?

continued

BYTE ACTION SUMMARY

- **WHAT EXTEND+MANUFACTURING 2.0 IS**
  A computer simulation design tool for the Macintosh.
- **LIKES**
  Graphics presentation; extensibility; hierarchical designs.
- **DISLIKES**
  Small-scale tutorials.
- **RECOMMENDATIONS**
  An effective simulation tool.
- **PRICE**
  Extend 2.0, $695; with Manufacturing module, $990
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While using my model and comparing it to the real world, I found several deficiencies. Most important was the inability to add a new teller temporarily during peak traffic times. It took me about 45 minutes to redesign the model to trigger the opening of one or two more teller stations based on the number of people waiting in line and limited by the total number of tellers available. Finally, I had a simulation that met my needs and correctly approximated the real world.

Although it sounds tedious, each of the redesigns went quickly because I could cut and paste large sections of previous designs into a new model. Also, the reusable hierarchical components could be modified and used in each new design. This allowed me to leverage my previous experience in constructing new models.

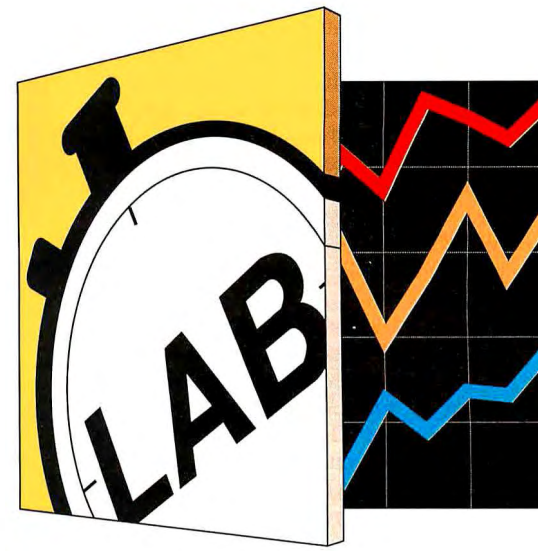
My final simulation is fairly complicated, but it models a simple process. These models still only scratch the surface of Extend's capabilities. Experienced Extend users are simulating complex and innovative environments. For example, Je Oh of Pitney Bowes Strategic Information uses Extend's discrete simulation abilities to demonstrate the flow of mail through a large mail-processing line. An example of a large continuous-process simulation was provided by Michael Locasio of Gentek, who uses Extend to simulate alternative energy systems that include ice ponds for cooling and cogeneration plants for generating electricity. Both Je and Locasio cite the ease with which simulations can be built and the ability to use hierarchical design to hide the complexity of a simulation during presentations.

Extend 2.0 is a suitable tool for simulation professionals as well as novices. Although it is a complex product for solving complex problems, its consistent user interface requires a relatively short learning period. If you have a process over which you need to gain control, and particularly if you want to present the process to others, then Extend 2.0 is the tool of choice. ■

Raymond GA Côté is a software development engineer for Appropriate Solutions, Inc., specializing in cross-platform applications development. He also edits the Robot Explorer *newsletter. You can contact him on BIX as "rgacote" or on the Internet at rgacote@bytepb.byte.com.*

It Worked Fine a Minute Ago

RICK GREHAN



Who is to blame when incompatibilities grind your Mac to a stop? Blame those who deserve it: applications builders who failed to follow Apple's guidelines.

Thoughts about things Macintosh have dominated the BYTE Lab in recent weeks, thanks to a host of new products coming from Apple (see "Two PowerBooks Great and Small" on page 173), the updating of our Mac benchmarks, and last month's accelerator roundup. As we tested these dozens of new products and fashioned tests that could accommodate the range of CPUs, we constantly ran into hardware and software incompatibilities.

Compatibility is a hard job for Motorola's CPU designers, who build the 68000 family of processors used in the Macintosh. Engineers seek backward compatibility so that new chips can run existing software. At the same time, they must add new, performance-enhancing features to the CPU line to keep pace with users' expectations and those of Apple's systems engineers.

To protect existing software, Apple indicates throughout its gargantuan *Inside Macintosh* documentation the importance of accessing the Mac system's internals via the operating system. It boils down to this: If your program wants to tweak the machine's hardware or operating-system software, it must do so by using documented operating-system calls.

The DOS World

Let's draw a parallel with the MS-DOS world. On PC-class machines, BIOS routines allow a program to read and write individual pixels on the screen. Most MS-DOS applications that perform substantial graphics operations simply ignore the BIOS and instead read and write video memory directly. This direct access lets software programmers optimize graphics code for speed.

In the IBM PC world, processors such as the 80x86 series let code and data exist side-by-side in the same memory region. Granted, the processor does distinguish between code and data segments via the CS and DS registers, but it's easy for a program to sidestep this distinction with segment-override instructions. And although the 386 and 486 allow protected-mode programs to set specified segments as being "execute only" (and therefore code segments), an "unprotected" MS-DOS program can more or less freely mix code and data.

This isn't the case on Macs incorporating 68020s, 68030s, and 68040s. When the 68020 appeared, Motorola had taken a step in the direction of separating code and data. The trend continued with the 68030 and 68040. Although code and data come into the processor from a single 32-bit-wide data bus, the internals of the CPU see code and data as flowing from separate sources. This occurs thanks to separate on-chip instruction and data caches that feed the processor's heart.

Separation of code and data increases the parallelism inside the processor. For example, in a 68040, if upcoming instructions can be fetched from the instruction cache, they move directly from the cache to the execution unit and free the data cache for simultaneous transfers of data values to and from memory. This parallelism improves performance.

However, this also causes one of the most frequent Macintosh compatibility problems you'll encounter. Some applications practice "self-modification"; they write instruction codes into memory as though they were writing data to memory (this can happen if a program builds a jump table). The idea is that the program will execute that code in the future.

Unfortunately, this has the danger of placing the contents of memory out of synchronization with the instruction cache. The result is that the program "thinks" it's executing the proper instruction, but it isn't. In the best case, you'll get a bomb box; usually, the Mac just freezes.

We in the Lab recall when the Mac II and its 68020 first appeared. Applications failed so often that we had to write an Fkey to disable the processor's cache. Most accelerators come with similar, though more sophisticated, software.

Who Done It?

So who's to blame when your Mac grinds to a stop? Let's put the blame on those who deserve it. Admittedly, programmers working on the Mac before the appearance of the 68020, 68030, and 68040 probably had performance as their top priority and therefore put future compatibility in the backseat. Many programmers might reasonably argue that while they were writing 68000 code, they had no idea what the 68020 would look like, so how could they prepare for it? But in the great majority of cases, Mac applications that run on early-generation Macs but break on later-generation models do so because the applications builders failed to follow Apple's guidelines.

Dan Monahan of Radius, the company that markets the Radius Rocket accelerator, says the company's software engineers spent an excessive amount of time trying to keep misbehaving applications running on the Rocket. "If more applications builders would follow Apple guidelines," he concludes, "we could be spending our time developing new products rather than working out compatibility problems." ■

Rick Grehan is technical director of the BYTE Lab. You can reach him on BIX as "rick_g."

BOOK AND CD-ROM REVIEWS

THE AI DEBATE REVISITED

What Computers Still Can't Do
Hubert L. Dreyfus
MIT Press, $13.95,
ISBN 0-262-54067-3

The Twenty-Four Hour Society
Martin Moore-Ede
Addison-Wesley, $22.95,
ISBN 0-201-57711-9

HUGH KENNER

If you were born the year *What Computers Can't Do* was first published, well, congratulations. Old enough now to order a martini, you're still young enough to have missed a lot of wrangling with and about Hubert Dreyfus. Prof. HD, whose field is philosophy, was suspicious of roseate AI claims as long ago as the 1960s. Back when 10-year-old chess novices were beating the best available programs, *Science Journal* had machines already playing chess "at the championship level."

It's amazing, that early hype for AI. And when Dreyfus launched his skeptical book (1972), how vehemently he got smeared is arresting, too. *Creative Computing* was warned by one AI guru that to publish a piece by HD would be to incur "disapproval from the AI community and reprisals from MIT Press." Well, MIT Press not only hasn't flayed HD, it has now taken over his book and published an update (the second) as *What Computers Still Can't Do*. Even if you read the first version all those years ago, you'll find it a different book in the light of what we take for granted today and what we've quietly jettisoned.

The argument, when we get to it, is essentially that the general knowledge required to understand—let alone answer—a random but sensible query is not the kind that can be reduced to a database. Pooh, says AI, we just need "a machine with the child's ability to learn." Ah, says HD, but that would entail a suite of transmechanical capabilities, for instance, a child's understanding of involvement with a body. (Nausea, fatigue, ecstasy: Define for a machine what such words say to a human.)

Chess programs are an instructive special case. If today's best, like Belle and Deep Thought, are very good, it's thanks to the CPU speed that permits the evaluation of several million potential positions. A chess master assesses only about 100, but he or she has learned how to first zero in on an area of interest. How he does that we don't really know; likely, spotting similarities to golden oldies. But explain *similarity* to a CPU? Table lookups won't do; two positions identical in mapping save for one pawn can be utterly different in thrust. We're talking strategy, and programs understand no strategy. Quite small children do, notably near nap time.

And So to Bed

Cats take catnaps, and so do all other creatures great and small save humans, who try to jam a solar cycle's ration of sleep into one 8-hour parenthesis. Oddly, by just napping the instant we feel tired, we can manage nicely on perhaps 4 hours' sleep per 24. Buckminster Fuller knew about that; so did Edison and da Vinci (whose daily sleep total was a mere 2 hours). So do long-distance solo ocean racers, with "a clear correlation between who was winning the races and how much they broke their sleep into short naps." *Correlation* says *research*, hence "a compelling problem."

In *The Twenty-Four Hour Society*, Dr. Martin Moore-Ede explains why it compels. We work graveyard shifts, cross six time zones at a leap. We doze off—Chernobyl, Exxon's *Valdez*. Hence, researchers, and more about sleep than you knew there was to know.

Thus, research shows that to suppress the night-shift worker's "waves of sleep," we need the same light that adjusts our bedtime seasonally, and at something like the same intensity. But Edison put us in a dim world indeed. A "brightly lit office," nighttime, boasts about 500 lux; in nature, that's before sunrise. Boost it to, oh, 10,000 lux and watch alertness soar.

We all sleep, even you. And you'll not soon find a book closer to your most restorative experience. ■

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. His recent books include Mazes *and* Historical Fictions. *You can contact him on BIX as "hkenner."*

OBJECT LOGIC

Logic and Objects, *Francis G. McCabe*, Prentice-Hall, $18, ISBN 0-13-536079-X

Logic and Objects is the name of both this book and the new programming language that it describes. L&O is the brainchild of Francis McCabe, a computing lecturer at London's Imperial College, who also had the distinction of producing the first microcomputer implementation of Prolog (MicroProlog for CP/M in 1980).

McCabe's book explains why it's a good idea to meld object orientation with logic programming. He critically reviews several previous experiments in this direction before presenting his own elegant solution, L&O. His argument in brief is that object orientation adds the modularity necessary for structuring large applications, which is lacking in Prolog's clause-based syntax.

L&O offers full OOP (object-oriented programming) features, including multiple and differential inheritance as well as a functional programming notation. The syntax of L&O remains very much like that of Prolog, but groups of clauses get bracketed together as named objects called "theories." The book is clearly written and illustrated, but it will be comprehensible only if you have a working knowledge of Prolog. McCabe develops several nontrivial program examples, including a Macintosh-graphics solution to the Traveling Salesman problem, in L&O. If you believe that C++ does not mark the end of history, and that progress in language design must continue, there's much here of interest.

—Dick Pountain

THE INTERNET WORLD TOUR

Exploring the Internet: A Technical Travelogue, *Carl Malamud*, Prentice-Hall, $26.95, ISBN 0-13-296898-3
Zen and the Art of the Internet, *Brendan Kehoe*, Prentice-Hall, $22, ISBN 0-13-010778-6
The Whole Internet User's Guide and Catalog, *Ed Krol*, O'Reilly & Associates, $24.95, ISBN 1-56592-025-2
The Internet Message, *Marshall T. Rose*, Prentice-Hall, $44, ISBN 0-13-092941-7

The Internet, that wild, sprawling conglomeration of uncontrolled and uncontrollable computer connections, is garnering much recent media attention. Accompanying this newfound attention is an increase in Internet-related books ranging from popular travelogues to detailed user's manuals.

Most Internet community denizens restrict their travels to the worldwide electronic highways. Carl Malamud, on the other hand, decided to see the world node by node. The result is *Exploring the Internet: A Technical Travelogue*. Like many travelogues, this book provides insight into the sights and wonders of far-off places. Unlike traditional guides, these sights consist of high-speed backbones, racks of Cisco routers, and standards meetings. Beyond the technology exist the personalities that continue to make the Internet happen. *Exploring the Internet* paints a picture of this thing called cyberspace.

Zen and the Art of the Internet by Brendan Kehoe should be given to each and every first-time Internet user. It answers many of the novice questions that plague network administrators and consume network bandwidth. This is not a user's manual, but rather a beginner's guide to the services and wonders available on-line. Issues such as etiquette, proper usage, and societal rules are presented to ensure that your passage into this new community is a smooth one. The list of `telnet`-available databases (from scholarships to extragalactic technical data) provides a starting point for your own explorations.

Kehoe's book tempts you with tantalizing glimpses of far-flung data. Ed Krol's *The Whole Internet User's Guide and Catalog* is more of a Baedeker-style guide. Krol takes a practical approach to the Internet, from turning off that first, massive news feed to accessing servers using `telnet`, `ftp`, and E-mail techniques. Access to services ranging from Archie to WAIS are described in detail sufficient to guarantee first-time success. Members of the Internet community will want to keep this practical handbook.

Mail on the Internet comes in many shapes, from the simple transmission of text to multimedia films. *The Internet Message* by Marshall T. Rose is an in-depth look at E-mail—its transport and its format. Even if you never have to write or maintain a secure multimedia mail application, Rose's book is handy for deciphering problems when things go wrong. Although it's packed with technical data, this book maintains a light, readable tone, making it suitable for those who simply want to know how the world works.

—Raymond GA Côté

IMPRESSIVE SEARCHING

The New Grolier Multimedia Encyclopedia for Macintosh, DOS, or Windows/MPC,
Grolier Electronic Publishing, Sherman Tpk., Danbury, CT 06816, (203) 797-3530

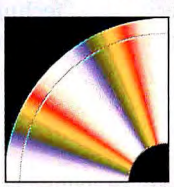
Here's the *Academic American Encyclopedia*, all 21 volumes, on a single CD-ROM. The "1992 edition" (internal evidence hints at a 1990 cutoff) claims some 7000 new or revised articles; many new images, monochrome or color; motion-video sequences (i.e., film clips) of such events as the first space-shuttle launch; animated sequences to explicate global matters like weather, the human body, and the solar system; and a Timeline and a Knowledge Tree, both of which we'll come to. Only DOS and Macintosh versions support the motion-video feature, only Macintosh and Windows/MPC the animation.

As encyclopedias go, Grolier's, print or CD-ROM, is about average. One entry begins, "A bed is a piece of furniture on which persons sleep or rest," and must thereafter struggle to justify its presence. (Whoever will look up *bed*?) There's an overall looseness—T. S. Eliot did not "decide" to stay in England permanently in 1914; he was stranded there by the war—offset by occasional crisp authority, as in the "fractal geometry" entry.

Which brings us to one advantage of CD-ROM searching. Scan through the book version the only way you can, by article title, and you'll not find "Mandelbrot, Benoit." But go to the CD-ROM version's first menu, which has five options; choose the first, Word Search; type "Mandelbrot"; and you'll quickly find that he's present again and again, notably in "fractal geometry," but in other entries as well. If you'd just this morning happened on the word *fractal*, Grolier Multimedia would be a quick and effective way to acquire a sense of its scope. Word Search produces every instance of any word you type, save for 134 deemed too common to matter.

Other options on that first menu include Browse Article Titles, Knowledge Tree, Timeline, and Multimedia. Knowledge Tree is "a hierarchical list of topics," something that's fascinated savants since the late seventeenth century. The first stab here is, The Arts, Geography, History, Science, Society, Technology. Select Science to get a submenu, a lot of sciences starting with astronomy.... You see the idea.

As for Timeline, it comes up telling you that in 40,000 B.C., Cro-Magnon man (i.e., Homo sapiens) was active in Europe and the Middle East. You can just go paging down that list, or you can zero in on a date like 1914. Any of the items there will send you to an encyclopedia entry you might not have found. Thus, 1914 includes Chaplin, the article on whom branches to items like "slapstick" and "film, history of." You can even view those two on adjacent windows, even if you're in DOS instead of Windows. Not a bad knowledge engine, no, not at all.



—Hugh Kenner

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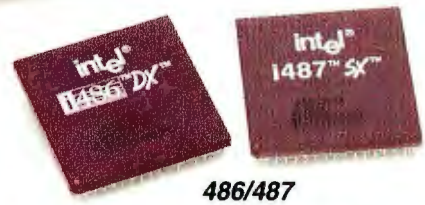

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THOMAS JEFFRIES

DIVIDE AND CONQUER

Many programmers—even very good ones—would rather have their teeth pulled than face writing interrupt service routines. ISRs are demanding; writing them usually calls for knowledge of assembly language, multitasking, hardware, and sometimes special coding techniques. However, most programmers can handle those items reasonably successfully, or are willing to learn as part of taking on an ISR. The real roadblock is in the debugging phase.

Debugging is often a challenge in any kind of programming, but with non-interrupt-based code, you can usually get enough of the code running to get some clues that will help you narrow your focus. If the program crashes every time you read data from the disk, you'll figure out pretty quickly that you forgot to initialize the pointer to the data buffer. If your floating-point calculations are producing incorrect results, you don't need to bother looking at the screen-drawing code while searching for the problem.

ISRs are not quite so nice. Often the only clue provided is a complete system crash, with a cryptic message like "Stack Overflow." Once you've paid your dues and written a few ISRs, you'll have a better idea of how to interpret such gems. The learning curve, however, can be steep and painful.

Diagnostic Limitations

With mainline code, you can usually write diagnostics to the screen or a disk file (e.g., `printf()` or `fprintf()`). In general, this is not possible in an ISR, either because of operating-system limitations (e.g., DOS is not reentrant, so an ISR cannot safely call video and disk I/O functions) or because of the time-critical nature of interrupts.

It's best to follow a methodical approach when you are debugging interrupt service routines

I remember a client calling me while trying to incorporate into his program an ISR I had written. The program was crashing in my code, and we were trying to figure out what was wrong. I asked him to try to narrow down the exact place where the program was crashing.

"That's easy," he said. "It crashes during the `printf()`."

"Ummm... what `printf()` is that?" I asked.

"Why, the `printf()` I put in your code to see if it was working, of course!"

Needless to say, once the offending `printf()` was eliminated, the program ran just fine.

These days, programmers are used to tools that perform much more sophisticated tasks than writing to the screen or to a file. Source-level debuggers let you step through your code, watching variables and catching side effects before they have a chance to be noticed as bugs. Source-level debuggers are great, but some of the worst bugs in ISRs revolve around concurrency issues, and stepping through code on the interrupt usually doesn't give you an

Listing 1: *A complete ISR skeleton.*

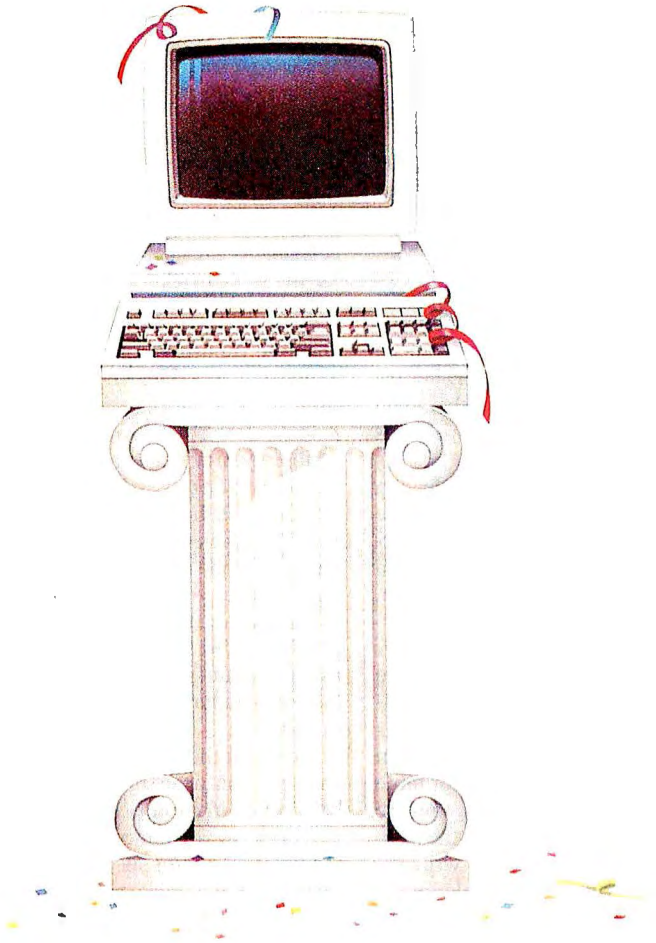
```
.DATA

int_seg   dw  0 ;for DOS timer interrupt vector
int_off   dw  0 ;segment and offset
int_used  db  0 ;the interrupt number we are using
_counter  dw  0 ;this can be used to test if ISR is
                ;accessing data properly
@curseg    ends

.CODE
      ;Here's the trick—we save the application's
      ;data segment in the code segment of the
      ;interrupt handler, so the interrupt handler
      ;will know where to find it.

datsegst  dw   0 ;storage for data segment

Inthandler proc FAR ;This is the interrupt handler,
                    ;capable of accessing data.
  push  ds
  push  ax
  mov   ax,cs:datsegst    ;note segment override!
  mov   ds,ax       ;now we have access to data
  inc   _counter    ;just to prove we can do it
  mov   al,EOI
  out   20H,al ;send EOI to 8259 interrupt controller
  pop   ax      ;restore registers
  pop   ds
  iret          ;note special return instruction
Inthandler endp

    GLOBAL _Setint:proc
_Setint proc  ;This function saves the vector for
              ;the interrupt to be changed and
              ;then points the vector at Inthandler.
              ;The interrupt number is in AL on
              ;entry to the function. This version
              ;saves the data segment for later use
              ;by the interrupt handler.
  ARG   int_requested:WORD
  push  bp
  mov   bp,sp
  mov   al,int_requested
  mov   int_used,al
  push  ax          ;save interrupt number
  mov   ax,ds       ;get the data segment,
                    ;store in code segment
  mov   ax,cs:datsegst    ;note segment override!
  pop   ax          ;restore interrupt number
  push  es
  push  bx
  cli               ;disable interrupts
  mov   ah,35H      ;get the old vector from DOS
  add   al,8
  int   21H
  mov   int_off,bx ;and store it
  mov   int_seg,es
  mov   dx,OFFSET Inthandler ;get offset of new
                             ;vector
  push  ds          ;save the data segment
  push  cs          ;get code segment in data segment
  pop   ds
  mov   al,25h  ;AL has vector no., AH has int no.
  mov   al,int_used
  add   al,8
  int   21h      ;have operating system change vector
  pop   ds       ;now restore DS to proper state
  sti            ;enable interrupts
  pop   bx
  pop   es
  pop   bp
  ret
@curseg     ends
    END
```

Listing 2: *This C program sets the interrupt vector to point to your ISR and then looks to see if the ISR is correctly incrementing the variable.*

```
#include <stdio.h>

#define TIMER_INT 0 //use timer interrupt for test,
                    //since we know it's active

extern unsigned int counter;

main()
  {
    Setint(TIMER_INT);  // set interrupt vector

    printf("\nPress any key to exit.\n\n");

    while(!kbhit())
          printf("\ncounter = %u",counter));

    Restoreint();
  }
```

Listing 3: *This small subroutine takes the values in AL and BL and puts them in a trace buffer each time it is called until the trace buffer is full. AL and BL were chosen arbitrarily for the sake of illustration; any desired variables or tokens can be written. You can use a circular buffer if needed.*

```
,DATA

TRACE_BUFF_SIZE    EQU    4000
BYTES_PER_WRITE    EQU    2

trace_buff      db TEST_BUFF_SIZE DUP(0FFH)
trace_buff_ptr  dw OFFSET trace_buff
trace_buff_end  dw (OFFSET trace_buff +
     TRACE_BUFF_SIZE - BYTES_PER_WRITE)

@curseg    ends

.CODE
   ;Enter with first byte of data to be stored in AL
   ;and second byte in BL; keep writing data until
   ;buffer is full.
trace_data:
  push di         ;DI used as index into trace buffer
  mov  di,[trace_buff_ptr] ;Get place in trace
                           ;buffer
  cmp  di,[trace_buff_end] ;Make sure don't overrun
  jae  no_more
  mov  [di],al
  inc  di
  cmp  di,[trace_buff_end] ;Make sure don't overrun
  jae  no_more
  mov  [di],bl
  inc  di
  mov  [trace_buff_ptr],di
no_more:
  pop     di
  ret

@curseg     ends
```



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accurate idea of the order of events. Older chips (e.g., the 8086) don't let you trace on the interrupt, so sometimes source debuggers are not an option even for simple problems. Also, source debuggers don't usually help find problems related to the use of the interrupt hardware.

So what's a programmer to do? It would be nice if you could buy ICEs (in-circuit emulators), which provide all sorts of neat things, such as trace buffers, that can tell you exactly what instructions were executed in which order. However, ICEs can cost well into five figures. Most individual programmers and even small companies can't afford such equipment.

Tricks of the Trade

I started writing ISRs on machines with very primitive debugging capabilities, and, painful as those early experiences were, I learned some tricks that I still use, even when I have sophisticated hardware and software available to assist in debugging. The examples in this article are for Intel microprocessors, but the principles apply to almost any environment.

The first and most important technique I use is no stranger to believers in modular programming. The strategy boils down to this: Divide and conquer. There are three basic areas of difficulty common to most ISRs: dealing with the interrupt mechanism itself (both the hardware and the operating system), getting access to your data, and debugging the actual functional code that runs on the interrupt. If you can get each of these three areas working independently, when you combine them you will have to worry only about problems introduced by their interaction.

Typically, there are four parts to dealing with the interrupt mechanism: telling the system to call your code when an interrupt happens, catching the interrupt when it occurs, returning control to the system, and making sure the normal interrupt vector is restored when your program exits.

Wherever possible in dealing with the interrupt mechanism, use operating-system services to avoid the need for debugging. For example, in MS-DOS, you can write directly to the interrupt vector table to set up your interrupt, or you can use INT 21h services to get and set the vector. Programmers who decide to write directly to the interrupt vector table create programs that will not work as expected under environments like Windows, which runs in protected mode and virtualizes memory. Save yourself trouble down the line, and do it the right way from the start. The best debugging is the debugging you never have to do.

Next, write an ISR that consists of the absolute minimum of instructions—just a return, if possible. Remember to use the right kind of return; on Intel systems, the mnemonic is `IRET`. On IBM PCs and compatibles, you will also need to send an `End Of Interrupt` signal to the interrupt controller. (See listing 1 for a complete, if tiny, ISR skeleton for the IBM PC.) Then write the code needed to set the appropriate interrupt vector to point to your ISR. Even if you can't use your source debugger on the ISR itself, you should be able to use it to double-check that you're passing the correct address and selecting the correct interrupt.

Now run the code. If nothing seems to happen, you probably got it right. Next, try loading in another program. If the system crashes, you almost certainly changed the interrupt vector successfully. Now you must change it back to the original vector before exiting your program.

continued

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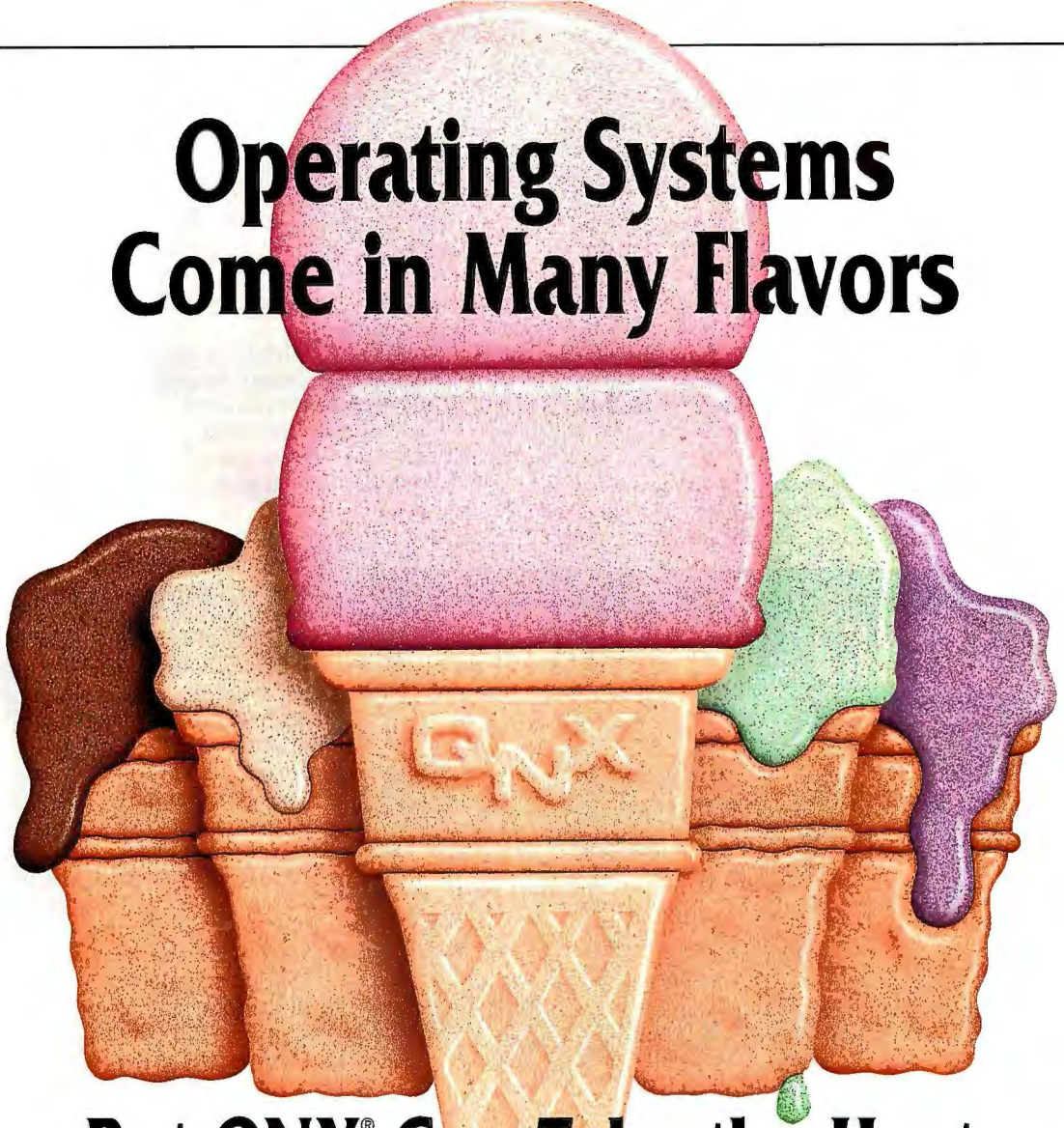

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If your tiny program crashes, you have to find out whether the problem lies with the way you are altering the interrupt vector or with the ISR itself. Usually there is some way you can find out whether your ISR is being executed—for example, by writing a character directly to screen memory. If your ISR is being called, then the problem is almost certainly in the code being executed in the ISR. Double-check to make sure you have saved every register you use, including the flags if the microprocessor doesn't save them; triple-check to make sure you have restored all registers in the proper order. If you are calling a function in a high-level language, make sure all registers get saved before the call and restored after the call. Better yet, eliminate all calls to external functions until you are sure they are not the source of the problem.

It is realistic to expect to have to reboot frequently while getting your first ISR running, especially while working on setting up the interrupt mechanism. If you don't have to reboot quite a few times on your first ISR, you're doing a lot better than I did on my first one.

The Next Step

Once your program can set up and restore the interrupt vector and execute an interrupt without crashing, the worst is over. Now you can start working on the second area of basic difficulty: accessing your data.

With the old 8-bit processors, it was easy: Memory was limited to 64 KB of absolute address space. Both 16- and 32-bit processors usually use some form of relative addressing—for example, segment-relative addressing on the Intel chips or address register–relative addressing on Motorola chips. Motorola chips offer the option of absolute addressing, but there are penalties in both code size and execution speed, so most systems use relative addressing.

The trick is getting your data's base address (usually referred to as the *segment* or *selector* with Intel microprocessors). When you enter an interrupt, the only registers you can count on are the ones that point to the current instruction. There are two ways of getting a base data address: You can store it at a known absolute address or at a known offset to the current instruction.

Storing something at an absolute address is fine if you are sure you're the only one that will ever be using the system. That leaves out almost all PCs, since, even if you are not actively multitasking, you have to make sure you don't step on the operating system or a TSR program. In fact, this option is mainly viable for embedded systems.

Fortunately, storing the data at a known offset from the ISR's first instruction is relatively simple. The exact details vary with different chips and compilers, but listing 1 shows one way (of several possible ways) to accomplish this under MS-DOS.

The next step is to make sure that your ISR works and that you really can get at your data. Listing 2 shows a small test program, again for MS-DOS, that simply increments a variable on each interrupt, with some mainline code that prints the variable to the screen. If the variable is being incremented, your code is correct; if not, make sure you're using the correct base data address.

Sometimes it's hard to tell whether there is a problem with the base data address or whether your ISR is simply not being executed. In this situation, here is a useful trick: Set up your ISR to replace an ISR that you know is being called (on a PC,

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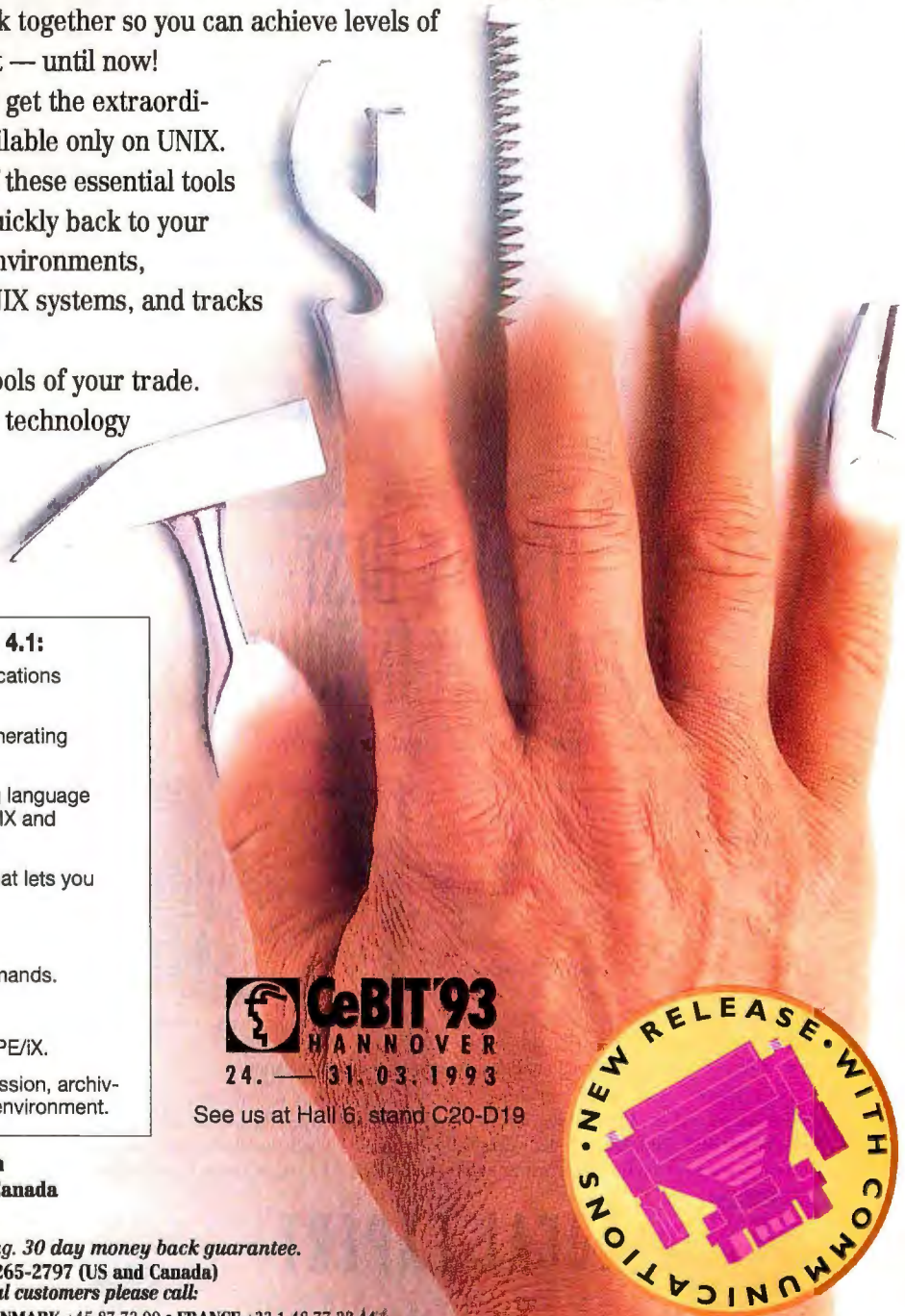

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Circle 112 on Inquiry Card.

the timer interrupt is ideal). If nothing changes, you are probably missing the data. If the data is now being accessed, the interrupt that you were using before is not being generated.

At this point, note what you've accomplished: All the interrupt-related issues have been isolated (well, most of them; more about that later), and you can proceed to the third basic area—debugging the functional code—without worrying about the interrupt.

Defensive Programming

Several other common trouble spots are best dealt with through defensive programming. First, since the interrupt occurs asynchronously, you must be absolutely certain that you save and restore all registers. Normally, you make assumptions about registers: For example, AX (or D0) is not preserved across function calls. Interrupts are a different story. They can happen at any time, between any two instructions, and if they trash a register, the results are unpredictable.

Second, on most systems, especially IBM PCs, interrupt code needs to execute quickly and get out of the way. Several problems can occur when one interrupt interrupts an ongoing interrupt; the most severe is a system crash, but none of them is fun. Avoid complex calculations (e.g., floating point) during interrupts. Pass the values to the mainline code to do the slow stuff. If possible, avoid high-level languages and stick with assembly language for ISRs. You'd be surprised at just how inefficient C can be.

Again, practice defensive programming. Debugging the problems that arise from a slow ISR can be difficult, so avoid the situation. There's still a place for tight, fast code, even in this power-glutted age.

I find it useful to write the functional code for an ISR so that it can be called from mainline code. In this way, I can step through it before it is running on the interrupt, to catch bugs and side effects when it's still easy to do so. Just make sure that your code is not also being executed by the ISR while you're stepping through it from mainline code, or you'll hopelessly confuse your debugger.

Other Snags

Usually, once the basic pieces of your ISR are working correctly, you're finished. Sometimes, however, problems arise involving coordination between the ISR and the mainline code. The ISR may access a variable before it is set to the correct value, or the mainline code may alter the variable before the ISR has a chance to do what it needs to do with the old value. These concurrency problems can be very hard to debug, and source-level debuggers don't always help, because they can alter the order of events. I suggest two techniques for solving these classic real-time bugs.

Say you need to know the value of a variable during the first execution of the ISR. Simply have the ISR copy the variable into another memory location, and have the mainline code display the copy.

Even if you don't have an ICE, you can roll your own software trace buffer. Set up a circular buffer, and write data and tokens to it that you can examine later to see just what happened during interrupt processing. You can often find subtle order-of-execution problems by carefully examining this buffer. You can use the buffer to accumulate information during processing, and then you can print it to the screen or write it to disk and examine the information at your leisure. Listing 3 demonstrates this technique.

I recently used this technique while I

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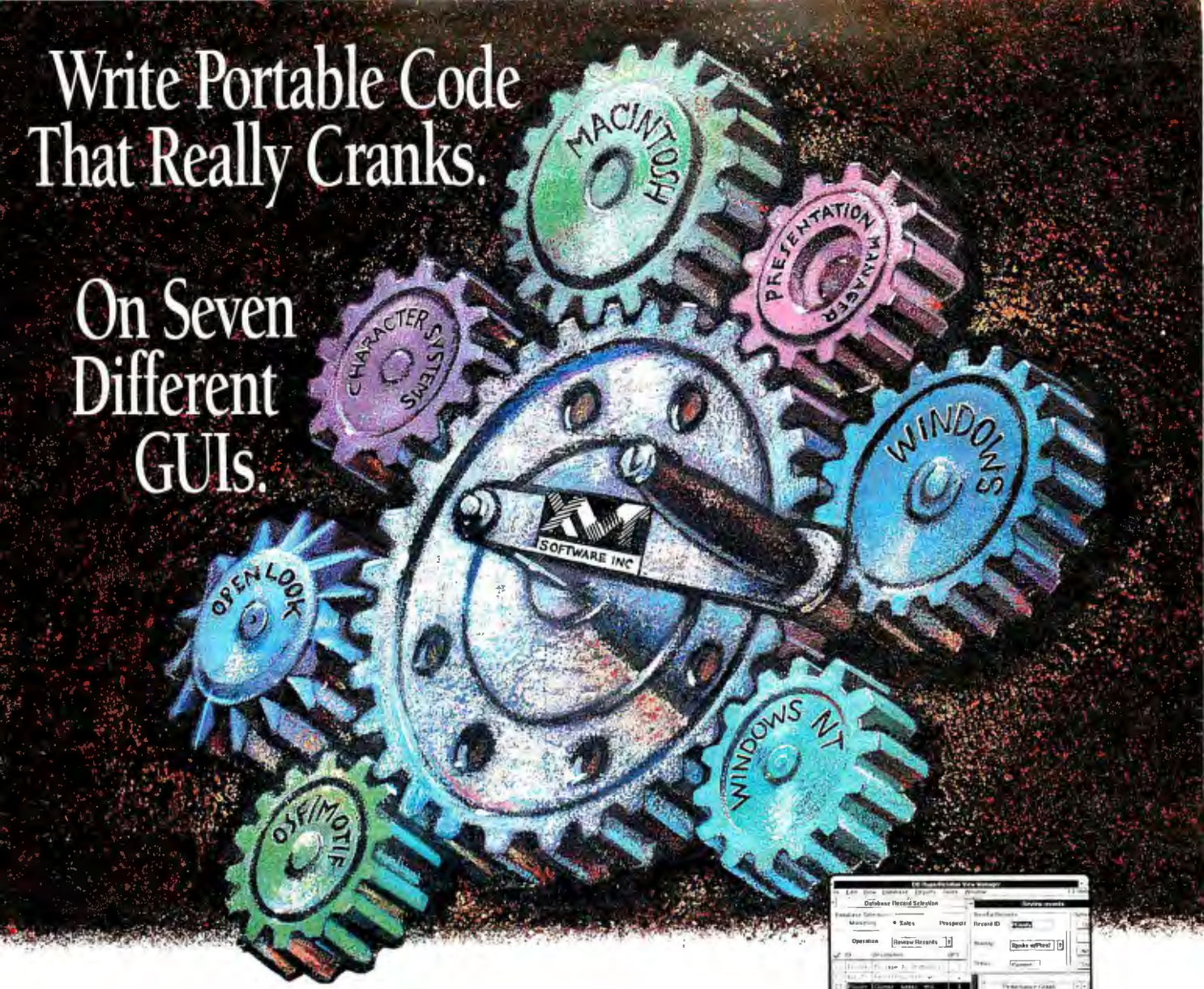

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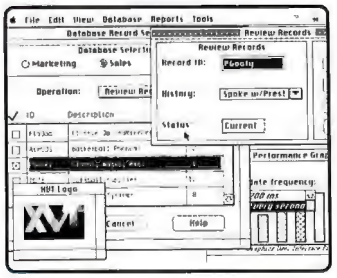

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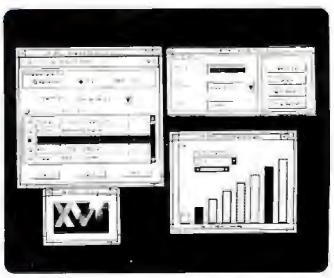

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Shown above are four of the seven GUIs supported by XVT.

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was writing a Windows device driver. I could step through the code and everything would work fine, but when the code ran in real time, something went awry. The code was complex: Data was passed to the driver in a series of buffers of varying sizes, copied in small chunks into other buffers, and then sent via interrupt-driven DMA to a peripheral board. Both the mainline and interrupt code used the key functions, and everything had to happen in the right order. It was impossible to tell the order of execution by any conventional means, so I added a software trace buffer and wrote tokens to it that indicated the order in which functions executed. Once I had the tokens to examine, finding the problem was simple.

Debugging Tools

My emphasis in this article has been on worst-case debugging—routing out the nasty little critters when normal techniques won't help. If your equipment allows you to use a source-level debugger, then by all means do so. You can find some fairly inexpensive hardware and software tools that will help, too. I work almost entirely on IBM PCs, so the list I give here won't help much if you work on Macs or Sun workstations, but it may give you some ideas.

One of my favorite tools is the breakout switch, which causes an NMI (nonmaskable interrupt). You need software that patches the NMI vector to point to debugging code; then, when the machine hangs, you can hit the switch and find out what code was executing. Periscope makes a great hardware/software combination with a breakout switch that lets you pop into any executing code.

Both Periscope and Nu-Mega provide software that—when running on a 386 or higher processor with adequate RAM—performs many of the functions of an ICE, including complex breakpoints and trace buffering of code that has executed. This kind of tool is almost indispensable if you write a lot of ISRs. Nu-Mega also sells a tool that will spot out-of-bounds memory accesses. That's handy for finding uninitialized pointers in mainline code and ISRs alike.

If you have the money, Periscope also makes a board that contains a trace buffer that errant code can't overwrite. With this board, you have almost all the functionality of a true ICE at significantly lower cost.

A true ICE lets you do more than just buffer instructions. It can also keep track of exactly what is happening on the bus and at selected other points in your system. However, most of the time you will not need this information for debugging ISRs; it's mainly needed for hardware development.

The time will come, though—no matter what debugging hardware and software you own—when you won't be able to find a way to trace the problem through ordinary means. That's when you need to apply the fundamental rule of dividing the problem into its component parts and then use your ingenuity to find out what is going wrong. ■

Editor's note: *The complete listings for this article are available in electronic format. See page 5 for details.*

Thomas Jeffries is president of Singing Electrons, a Lopez, Washington, company specializing in developing multimedia audio tools and products. You can reach him on BIX as "tjeffries."

ROGER C. ALFORD

CD-ROM INSIDE AND OUT

Here's how CD-ROM drives work, how CD-ROM discs store data, and what the standards mean

Technology advancements, new standards, and improved software are propelling CD-ROM toward widespread acceptance among personal computer users. But while the impact of CD-ROM technology is clear (see "Start the Presses," February BYTE), the underlying technology and standards can be confusing. Knowing how typical CD-ROM drives work and what standards such as ISO 9660 and CD-ROM XA (Extended Architecture) mean should help anyone who's shopping for a CD-ROM drive.

CD technology was developed in 1976, the result of a joint effort between N.V. Philips of the Netherlands and Sony Corp. of Japan. This led to the 1982 Red Book specification for CD audio, which defined media size and characteristics, physical data layout on the disc, error correction, disc rotation speed, and other parameters.

The potential application of CD-ROM technology as a high-capacity, low-cost medium for read-only data storage resulted in the 1983 Yellow Book CD-ROM specification. While the basic technology remains the same as that for CD audio, CD-ROM data requires greater data integrity: A corrupt bit that's not noticeable during audio playback becomes intolerable with computer data. In addition to the Red Book CIRC (cross-interleaved Reed-Solomon code) standard for audio CDs, the Yellow Book specification dedicates more bits for EDCs (error-detection codes) and ECCs (error-correction codes).

Other CD-ROM specifications have followed, including the Green Book CD-I (Compact Disc Interactive) specification, which allows for interleaved audio and video data, and the upcoming Orange Book specification, which governs the new CD-R (CD recordable) drives.

CD-ROM Basics

A standard CD-ROM disc measures 120 millimeters (4.72 inches) across and has a 15-mm (0.6-inch) spindle hole in the center and a thickness of 1.2 mm. Unlike conventional disks, which have concentric circular tracks divided into sectors, CD-ROM discs have a single spiral track, as a record does, that starts near the center and spirals outward (see figure 1). This 3-mile-long track is divided into equal-length sectors, or *blocks*. The track width is about 600 nanometers wide, and adjacent turns of the spiral track are about 1600 nm apart, for a density of about 16,000 turns per inch.

Data on the spiral track is in the form of small, variable-length, 120-nm-deep depressions called *pits* and intervening flat areas called *lands*. The CD-ROM's read head—an optical assembly with a low-power gallium arsenide laser and a photodetector—reads the pits and the lands. The assembly directs the laser beam through a one-way reflective mirror to the disc's surface (see figure 2). The lands reflect light from the laser; the pits disperse it. The reflective mirror redirects the returning light to a photodiode.

continued

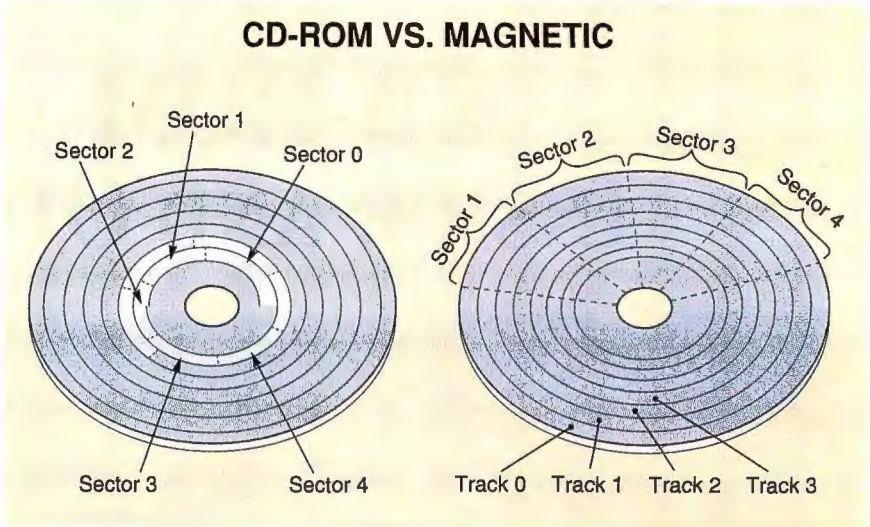


Figure 1: *CD-ROM discs use a continuous spiral track that has sectors of equal length (left). Magnetic hard disks organize data into concentric circular tracks and divide the tracks into sectors of varying sizes (right). This design has a marked effect on performance.*

The disc itself consists of a transparent polycarbonate substrate onto which the manufacturer impresses a pattern of lands and pits. A reflective aluminum or aluminum-alloy film covers the substrate, followed by a coat of protective lacquer and the vendor's label (see figure 3). The drive reads the disc from the bottom, through the polycarbonate substrate. This tough plastic material, which is also used for bulletproof windows, is unharmed by exposure to direct sunlight.

CD-R

Probably the most exciting—and certainly the most technologically advanced—area of recent CD-ROM development is CD-R. Philips and Sony laid the foundation for this technology, which was introduced under the guise of the Orange Book (Part 2) specification. Also called CD-WO (write once), CD-R lets you write data to a specially manufactured writable disc. Any standard CD-ROM drive can read such a disc.

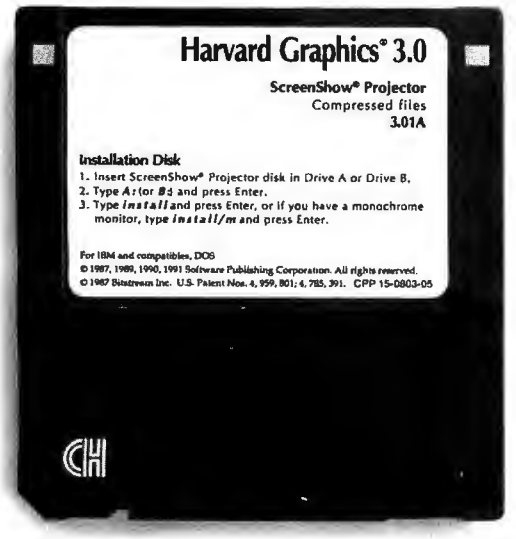
The Orange Book specification also includes a provision for appending information to a CD-R disc that already has information written on it, displacing the standard CD-ROM-mastering requirement that all information must be available from the start and applied to the disc simultaneously. Currently, however, a standard CD-ROM drive can read only the first session on a CD-R disc; subsequent sessions must be read on the CD-R drive that was used to create the disc.

A writable CD-R disc consists of the same polycarbonate substrate and spiral groove that are present on standard CD-ROM discs. But instead of having an aluminum coating, the groove on a CD-R disc is covered with an organic-dye recording layer, followed by a layer of gold and a lacquer coating. Once the lacquer layer is scratched, the dye and gold layers on CD-R discs are more susceptible to damage than the aluminum layer on conventional CD-ROM discs.

Dye selection is critical to the successful operation of CD-R. The dye must exhibit the same nominal 70 percent reflectivity as the lands on standard CD-ROM discs, and it must be laser-alterable to a nonreflective (i.e., light-dispersion) state. Long-term stability is also important, since discs in the hands of consumers are subjected to scratches, temperature extremes, and exposure to direct sunlight.

The components of a CD-R drive read/write head are essentially the same as those of a standard CD-ROM drive head. The CD-R head, however, has a higher-powered laser for burning data pits. The laser power required varies with the disc's rotational speed. To perform faster write operations, the disc must spin faster; thus, it requires a higher-power laser with shorter pulses. CD-R drives use the laser in low-power mode to read discs.

The preformed groove on a writable CD disc—which is 600 nm wide and 100 nm deep—is used for tracking purposes. Since the virgin state of the dye-on-gold is reflective (like CD-ROM lands), the laser is used to alter the dye so that it disperses light instead of reflecting it. This creates areas that look like CD-ROM pits. This



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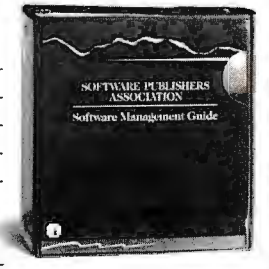

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approach allows the drive to create a disc that, optically speaking, has the same lands and pits as a standard CD-ROM disc and thus can be read by an ordinary CD-ROM drive. While the CD-R head assembly has more components, the path from laser to photodiode is essentially the same as for a standard CD-ROM drive.

Data Organization

The lands and pits on a CD-ROM disc do not represent ones and zeros. The reason is complex to explain. Briefly, each bit requires about 300 nm of length along the spiral track. Thus, if a sector had 2048 data bytes consisting of all zeros or ones, then it would have a pit or land measuring 4,915,200 nm or longer. The CD-ROM drive would have to maintain a precise clock that ticked at an interval representing 300 nm in distance so the next bit could be read at the right time. That's virtually impossible with today's technology.

Instead, designers limited the length of the pits and lands to a specified range. This ensures that a transition from one to the other occurs frequently enough for the CD-ROM drive to derive a clock. The drive uses this clock to count the number of bits a pit or land represents, as determined by its length. The bits are stored on the disc in RLL (run length limited) format—the same self-clocking approach used for storing data on most hard disks.

CD-R is the most exciting and technologically advanced area of recent CD-ROM development.

Each transition on a disc between a land and a pit represents a one, and each non-transition represents a zero. The minimum practical length of a pit or land is 3 bits (900 nm); the maximum is 11 bits (3300 nm). It's important to note that the 3-bit minimum precludes having two consecutive one bits (i.e., two back-to-back transitions). In other words, you must have at least two, but not more than 10, zero bits

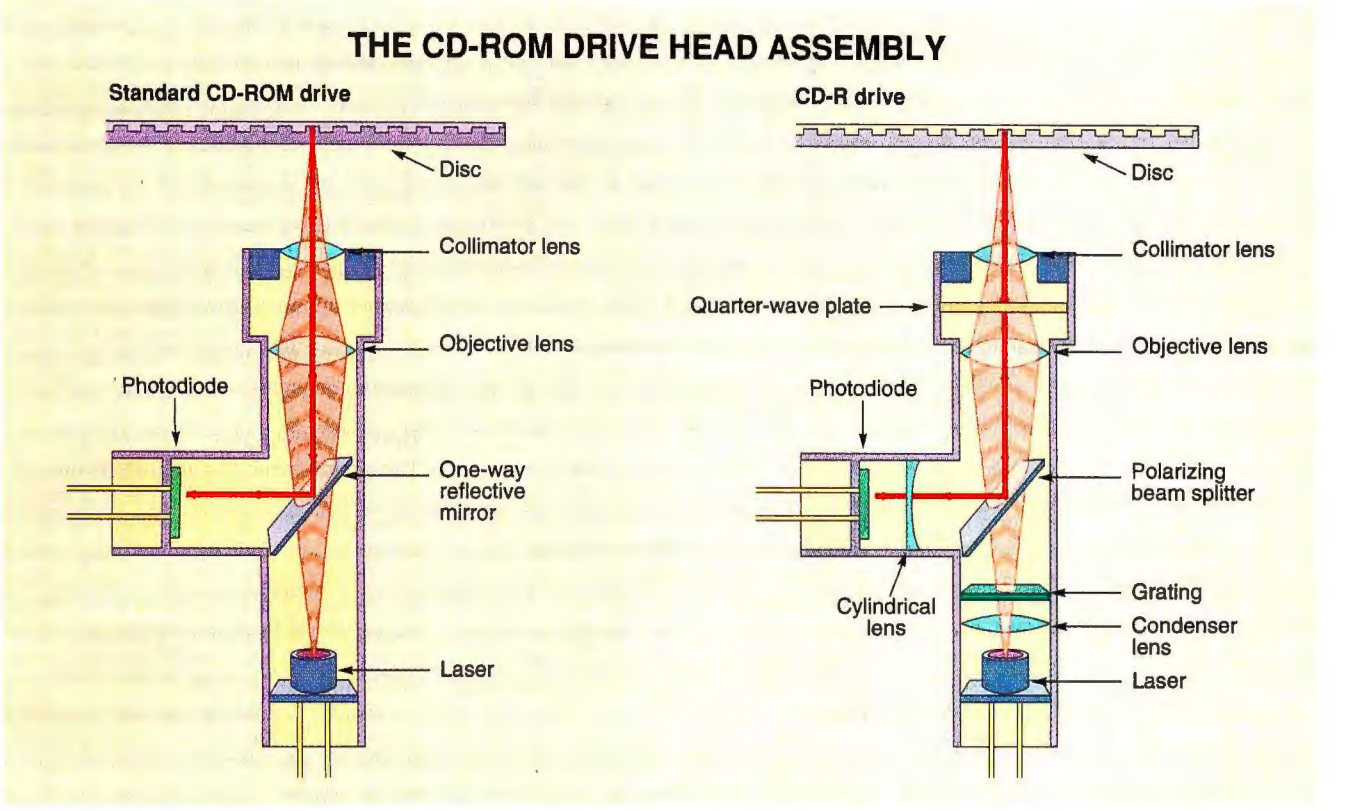

Figure 2: *In standard CD-ROM and CD-R drives, a laser beam passes through a one-way mirror or polarizer and a set of lenses on its way to the disc. Reflected light passes through the lenses and is redirected to a photodiode.*

between one bits.

However, a byte of data stored on disc might have combinations of eight ones and zeros that violate the 3-bit minimum, and multiple consecutive bytes could result in bit patterns that exceed the 11-bit upper limit. To solve this problem, CD-ROM drives use an encoding scheme that converts data bytes into 14-bit patterns called *channel bits*. A 14-bit binary value provides 16,384 bit patterns; more than 256 of these meet the requirements for the CD-ROM encoding format. A one-to-one correlation is then made between each of the 256 binary patterns represented by an 8-bit byte and 256 of the channel bits that meet the CD-ROM formatting requirements. This method, called EFM (eight-to-14 modulation), requires a lookup table to correlate the 14-bit patterns on the disc to their 8-bit data values.

While the use of these 14-bit codes generally supports the criteria for CD-ROM data storage, it also creates a potential problem. When you place multiple 14-bit codes consecutively on disc, it's possible to violate the run-length limits where the codes meet. To alleviate this problem, three *merging bits* are placed between each 14-bit code to ensure that no run-length violations exist.

Standard CD-ROM sectors consist of 2352 bytes organized as shown in figure 4: 12 bytes of synchronization data, followed by a 4-byte header, 2048 bytes of error-corrected data, and a 288-byte segment for ECCs/EDCs.

The sector header consists of three sector-address bytes and a mode byte. Three sector modes are defined for standard CD-ROMs. A mode 0 sector contains all zeros (this sector might represent a blank area in a line-art image). In mode 1, a sector contains 2048 bytes of data plus 288 bytes of ECCs/EDCs. Mode 2 sectors contain 2336 bytes of uncorrected data. If you use the last 288 bytes for data instead of ECCs/EDCs, the amount of data per sector increases to 2336 non-error-checked bytes. This is normally reserved for data that is insensitive to occasional errors, such as

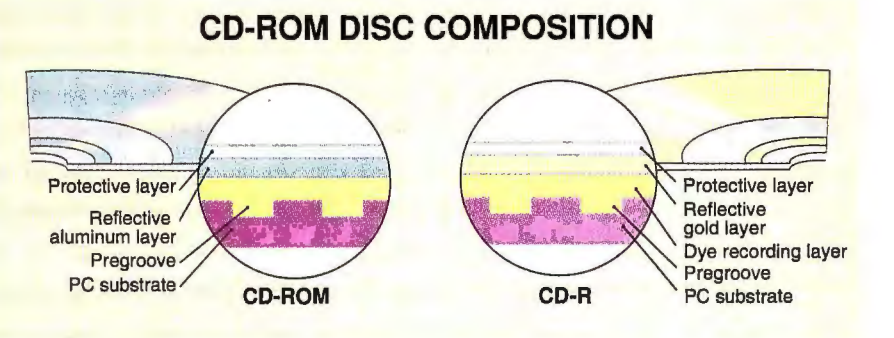

Figure 3: *In a standard CD-ROM disc, a manufacturer impresses a pattern of lands and pits into a transparent polycarbonate substrate, which is backed with a reflective aluminum film, a coat of lacquer, and the vendor's label. The drive reads the disc from the bottom, through the substrate. The substrate layer on a CD-R disc is coated with an organic-dye recording layer, a gold layer, and a lacquer coating.*

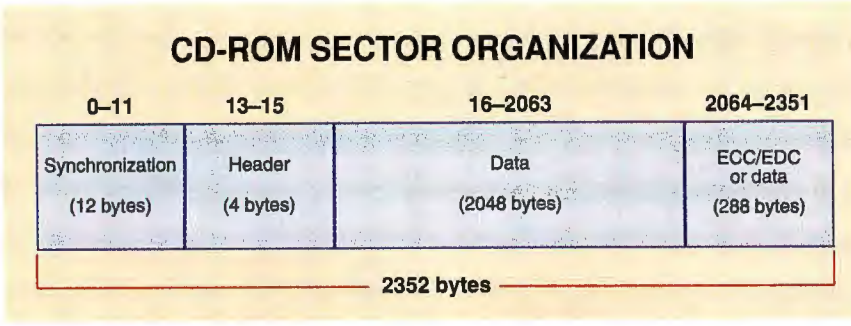

Figure 4: *A typical CD-ROM disc sector can contain either 2048 bytes of error-corrected data or 2336 bytes of uncorrected data. Dispensing with error correction (which is recommended only for more tolerant audio or video data) expands the disc capacity by more than 50 MB.*

digitized audio and video data. For sensitive data, mode 1 error detection is very effective: The likelihood of an undetected error is about 10^{-25}, or about 1 bit per 2 quadrillion CD-ROM discs.

As with audio CDs, CD-ROM discs are generally made using a 60-minute spiral consisting of 270,000 sectors. These discs can, however, be made using up to a 74-minute spiral, with 333,000 sectors. The additional 14 minutes are located on the outer 5 mm of the disc. This area is the hardest to record well and keep clean, so it is often left unused.

Manufacturers cite widely varying CD-ROM disc capacities. It all depends on whether they are using 270,000 or 333,000 sectors and how they perform the calculations. A 270,000-sector CD-ROM disc with 2048 bytes (2 KB) of corrected data per sector has a capacity of 552,960,000 bytes. Some manufacturers round this off to 552 MB or divide by 1 KB (1024 bytes) and round it off to 540 MB. The correct method is to divide by 1 MB (1,048,576 bytes), for a total of about 527 MB of error-corrected data. If you use uncorrected sectors (2336 bytes per sector), the capacity increases to 601 MB. Using 333,000 sectors per disc, the 681,984,000 bytes on an error-corrected disc add up to 650 MB of usable storage, or 742 MB without error correction.

ISO 9660

While the Yellow Book specification now exists to detail the low-level organization of sectors and data on a CD-ROM disc, early CD-ROMs were fraught with system-level incompatibilities because no standard existed for a file structure or higher-level data organization. In response, an ad hoc group of companies, known as the High Sierra Group, defined today's de facto CD-ROM file-format structure.

The High Sierra format quickly became the standard for CD-ROM data storage and established a high level of intersystem compatibility for CD-ROM discs. The ISO adopted it in 1988, with minor modifications, as ISO 9660. ISO 9660 is the least common denominator for CD-ROM discs. It offers interoperability at the expense of platform-specific file-system features, such as the Mac's data and resource forks.

A new standard, called the Frankfurt specification, will eventually augment the Orange Book specification. It will support Unix, OS/2, Macintosh, and Windows NT file-system conventions, as well as incremental update (i.e., multisession) capability for CD-R drives. It won't, however, be compatible with today's CD-ROM software.

Drive Mechanics

The data bits on a CD-ROM disc must pass under the read head at a constant rate, known as CLV (constant linear velocity). Because the sectors on the outer and inner edges of the disc are the same length (see figure 1), achieving a CLV requires changing the rotational speed of the disc as the head position changes. As the head moves farther away from the center, the rotational speed slows; if it didn't, the bits on the outer edge of the disc would go past the read head about three times faster than those near the center. In contrast, conventional hard disks operate at a constant angular (i.e., rotational) velocity, or CAV; as a result, the physical sector sizes grow longer as the tracks get farther from the center.

The CD-ROM optical head assembly stays a relatively long (1-mm) distance away from the disc, virtually eliminating the possibility of a head crash. The read/write heads of conventional hard disks, in comparison, float a fraction of a micrometer over their disk platters—more than 2000 times closer.

While head crashes are rare, dust is a problem for CD-ROM drives. The guts of a CD-ROM drive are exposed to the outside world each time the user inserts or removes a disc. Accumulating dust on the optical head assembly can reduce the effectiveness of the laser or the photodiode and can cause drive performance to deteriorate or even fail.

Some drive vendors use double doors to minimize the entry of dust into the drive. Others incorporate an automatic laser lens cleaner that dusts off the optical head assembly each time the user ejects a disc. Not all CD-ROM drives have a dust-protection mechanism, however.

Drive Performance

The performance of a CD-ROM drive is measured in *access time*, which is the average amount of time it takes the read head to reposition itself to a new location on the disc and start reading the data. Older drives required as much as a second or longer to perform this operation, while modern drives accomplish this task in well under 400 milliseconds.

Most CD-ROM drives share the same nominal 150-KBps data transfer rate to conform with the Yellow Book's 75-sector-per-second data read-rate specification. This makes access time all the more significant in differentiating the performance of CD-ROM drives—much more so than with conventional hard disks.

CD-ROM drive access times are very large (i.e., slow) when compared to the sub-20-ms access times of most hard drives. The sheer bulk of a CD-ROM optical head's assembly is one limiting factor. Hard drive read heads are small and light, while the laser, lenses, and other CD-ROM head-assembly hardware make it difficult for a CD-ROM's optical head to move quickly.

A more significant performance obstacle is the drive's variable rotation speed. The rotation speed must change depending on the sector being read and its position relative to the center of the disc. The drive might hit the brakes to slow the disc speed to access data at the outer edge of the disc and then go full tilt to access data on an inner track. This *whipsaw effect*—changing disc speed and then waiting for the desired speed change before a read can occur—is the single greatest contributor to a CD-ROM drive's relatively slow access time.

To accommodate multimedia applications, drives with faster data transfer rates have appeared on the market in the past year that offer nearly double the standard 150-KBps rate. Multidisc subsystems offer nearly four times the standard data transfer rate.

continued

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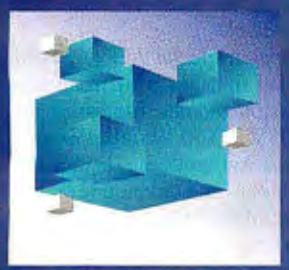

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Faster data transfer rates are accomplished by spinning the disc faster; thus, these faster drives must incorporate heftier motors to quickly accelerate and decelerate the rotation speed of the disc at these higher rpms. Typically, these drives also support the conventional 75-sector-per-second read rate for backward compatibility for playing audio CDs.

To create a smoother—and effectively faster—data transfer rate, some CD-ROM drives incorporate a RAM cache. This allows read-data buffering while the drive sends data to the host processor.

Mixed Media

While standard CD-ROM discs can mix text, audio, and video, synchronization is often disappointing because the data isn't interleaved. One of the first enhanced incarnations of CD-ROM to address this problem was the 1986 Philips/Sony CD-I, or Green Book, specification.

Unlike standard CD-ROM drives, which operate as a computer peripheral, CD-I specifies a complete system, with an integrated computer and NTSC output. One of its most significant enhancements over standard CD-ROM technology is the ability to interleave audio and video information for synchronized playback. CD-I defines a CD-ROM drive's mode 2 sector type with an 8-byte subheader to support additional data types, including interleaved audio and video data.

CD-I calls for a Motorola 68000 processor using the OS-9 RTOS (real-time operating system). The use of an RTOS is necessary to achieve the functional concurrency that is the key to CD-I operation: audio output, video output, and disc accesses occurring simultaneously.

CD-I also incorporates the MPEG (Moving Pictures Experts Group) video compression standard. With an MPEG decompression chip operating in a CD-I drive, video data can be decompressed and sent to the host processor on the fly. Compressing video data frees up storage capacity and effectively increases the playback data transfer rate by outputting more decompressed pixels per sector than a standard uncompressed sector can hold. CD-I does not currently support audio compression.

DVI

DVI was originally developed by General Electric/RCA's Sarnoff Labs and appeared, like CD-I, in 1986. Intel bought the technology in 1987 and announced an Intel/IBM joint venture to exploit the technology in 1989.

DVI is a computer-based peripheral. It's not a complete system, but it is otherwise similar to CD-I. DVI supports interleaved audio and video data for synchronized playback and incorporates video data compression. Running on 80x86-based PCs prevents DVI from using the OS-9 RTOS found in CD-I. Instead, DVI uses its own real-time executive that takes over system resources to accomplish audio-/video-/disc-access concurrency.

Intel developed a special 750 video processing chip set that performs real-time video compression and decompression operations for IBM's 750-based DVI controller board, the ActionMedia II. The IBM board can both play and develop (i.e., premaster) DVI applications.

Intel is working on a special version of its 486 processor that supports DVI. The availability of the new device was uncertain as this article went to press, but it might be on the market by the time you read this. Such a device could allow more economical DVI computers to be produced without external plug-in boards like IBM's

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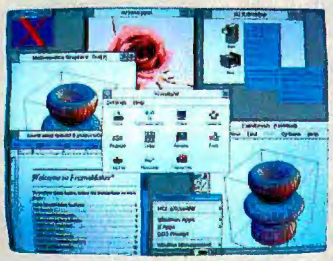

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ActionMedia II.

DVI supports FMV (full-motion video) at frame rates of up to 30 frames per second, at 512 by 482 pixels per frame. With video compression, a maximum of 72 minutes of high-quality FMV (or the equivalent amount of audio) can be placed on a single disc. With adequate processing power, DVI is also capable of supporting 24-bit color images at 1024 by 768 pixels and 30 fps.

CD-ROM XA

Philips, Sony, and Microsoft introduced CD-ROM XA in 1988. CD-ROM XA defines Microsoft's Level 2 standard for CD-ROM and multimedia applications. Like CD-I, CD-ROM XA supports interleaved audio and video data that can be played back in sync, but without the OS-9 RTOS requirement.

CD-ROM XA maintains the standard CD-ROM ISO 9660 file structure and 2048-byte error-corrected sectors. As with CD-I, you can add header information to support additional data types and interleave audio and video data. CD-ROM XA also supports up to 16 parallel audio channels.

CD-ROM XA does not yet support video compression, but it does support audio compression using ADPCM (adaptive differential pulse-code modulation). It supports four different audio-quality levels that trade off storage space for quality and allow the storage of up to 19 hours of audio on a single disc. To support the compressed audio data, either the CD-ROM XA drive or its controller must have an ADPCM chip that decompresses the data as it is read from the disc. CD-ROM XA is not yet widely supported.

Photo CD

Kodak's Photo CD is an interesting application of CD-R technology. The Photo CD system can compress and store up to 100 high-quality photographs digitally on a single disc.

Photo CD uses the same file format structure as CD-I and CD-ROM XA. To produce Photo CD discs, your local photo lab must purchase a Photo CD system.

Photo CD discs are readable on CD-ROM XA and CD-I devices with the appropriate software. They are not readable, however, on a standard CD-ROM drive. Kodak will also offer its own standalone Photo CD reader.

In addition, Kodak has developed its own variation on the CD-R disc. Its discs are similar to other writable discs, but Kodak adds an additional UV-curable durability coating on top of the lacquer layer to increase durability.

The Future

As the price of an entry-level CD-ROM drive has dropped into the $200 range, CD-ROM discs have increasingly become the preferred medium for distributing everything from operating systems to multimedia applications. The advent of CD-R drives that have price tags of less than $10,000 is accelerating this trend by lowering the cost barriers to publishing CD-ROM discs.

Understanding CD-ROM drive designs and the evolving standards is a good place to start if you're looking for the right CD-ROM drive for your needs. ■

Roger C. Alford is a BYTE consulting editor and president of Programmable Designs, a Michigan-based electronics design firm. You can reach him on BIX as "rogera."

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Ease of Use	9.1	8.2	8.2	8.2	7.9	7.6
Ease of Install/Upgrade	8.8	8.0	8.8	7.8	8.1	6.3
Price/Perform Return	9.1	8.3	8.5	7.9	8.1	7.4
FUNCTIONALITY						
Flexibility	9.1	8.8	8.6	8.4	8.4	7.6
Interface Capabilities	8.9	8.9	8.4	8.1	8.7	7.4
Comprehensiveness	9.1	8.8	8.8	8.3	8.7	7.6
User Friendliness	8.9	7.7	8.3	8.1	7.5	7.0
OS Compatibility	9.6	8.4	8.9	9.0	8.8	7.5
PRODUCT SUPPORT						
Documentation	9.0	8.2	8.6	7.4	6.2	6.8
Vendor Training	8.7	7.9	8.0	7.9	7.6	6.7
Problem Response Time	8.8	7.5	7.2	6.8	6.4	6.2
Quality of Vendor Support	9.0	7.8	7.5	7.4	6.9	7.2
Frequency of Releases	8.5	7.5	6.7	6.9	7.7	7.2
Response to User Request	8.8	7.5	7.8	7.6	7.0	6.5
OVERALL SATISFACTION	9.3	8.7	8.5	8.3	8.0	7.6

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	PROGRESS SOFTWARE	BORLAND	INFORMIX	INGRES
PRODUCT FEATURES				
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Ease of programming	8.87	6.74	6.79	6.37
Ability to manipulate data	8.73	7.24	7.14	7.07
Sorting capabilities	8.59	7.24	7.21	7.58
Provision for software security	8.00	6.23	7.00	6.70
Report writing capabilities	7.64	6.54	6.59	6.50
Ease of use of interface	8.13	6.89	6.85	6.50
Software integration capabilities	8.09	6.92	7.20	6.15
Ease of data retrieval	8.89	7.26	7.65	7.04
Satisfaction with product profitability	7.98	6.61	6.79	5.19
Overall quality of product	8.87	6.97	7.35	6.71
PRODUCT FEATURES AVERAGE	8.32	6.82	6.96	6.41
SUPPORT FEATURES				
Provision for customer support	8.20	6.73	6.10	5.44
Charges for training time	6.91	5.79	5.56	4.71
Provision for technical support	7.57	6.14	6.00	5.15
Provision for marketing support	7.04	5.97	5.33	4.04
Documentation & product information	8.62	7.03	6.57	6.00
Frequency of updates & revisions	7.75	6.26	6.05	5.74
SUPPORT FEATURES AVERAGE	7.68	6.32	5.93	5.18
OVERALL AVERAGE	8.11	6.65	6.62	6.00

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BARRY NANCE

AUTOMATIC NETWARE LOG-INS

How to log in to NetWare from your programs without user interaction

Excuse me for hacking this month, but I have good reason. I needed to better understand the dialogue that occurs between Novell's LOGIN.EXE and a NetWare file server. I had to find out how to build a program that would log in a PC to a NetWare file server automatically, without human intervention.

With some disassembly of the NETX.COM program and some help from Terje Mathesen's NETWARE.PAS code from the lans conference on BIX, I untangled the rather convoluted sequence of events that occurs when the file server verifies your log-in password. This month's Software Corner entry is LOGON, a NetWare log-in utility with Pascal source code. LOGON.PAS is written in Turbo Pascal, and you can compile it with Turbo Pascal 3.0 or higher.

LOGON.COM accepts three parameters—server name, user ID, and password. On the version that I actually used for automatic logging, these parameters are hard-coded into the executable file. It almost goes without saying that treating the password as a command-line parameter is a bad idea security-wise. However, the Software Corner version of the program accepts these parameters so you can use it as is; you should strongly consider modifying my code and embedding your log-in parameters directly into source code.

Much of LOGON.PAS deals with uppercasing strings and handling the differences between Pascal strings and the zero-terminated strings the file server expects. LOGON.PAS also locates the entry in the server name table located in NETX.COM corresponding to the server name you specify. This lets LOGON set the correct preferred server before beginning the log-in sequence.

Both NetWare's LOGIN and my LOGON rely heavily on NetWare's undocumented `FileServiceRequest()` function. Subfunction 17h of `FileServiceRequest()` returns an encryption key that LOGON uses, along with a table of encryption keys in the Pascal source code, to encode the password *for verification* by the file server. Subfunction 18h of `FileServiceRequest()` actually performs the log-in. If by chance you run LOGON against an older version of NetWare (or the NetWare shell) that doesn't support encrypted passwords, LOGON reverts to using the `LoginToFileServer()` function that's documented in the DOS technical reference to NetWare system calls.

LOGON.PAS doesn't perform any drive mapping, nor does it attach to additional servers. For the unattended workstation I set up with an automatic log-in, I didn't need extra drives or servers beyond the defaults that NetWare provided. If you would like to map drives or attach to servers from within your code, you may want to get either Novell's DOS reference or my *Network Programming in C* (Que, 1990).

With the LOGON.PAS source code, you should be able to create unattended applications that can log in to any NetWare server. While the source code reveals how the NetWare encryption sequence works, you can't use it for breaking encrypted NetWare passwords. ■

MAC/Tom Thompson

Industrial-Strength Text Editing

BBEdit is a freeware text editor written by Rich Siegel that started life as a bare-bones text editor (hence the name). However, BBEdit has evolved into an industrial-strength text editor offering numerous features found in commercial software. BBEdit can open multiple files, compare differences between files, and search multiple files for text strings. For lengthy multifile searches, the search operation runs in the background, and it pops up a notification dialog box when it's done.

The editor window can display the time the file was last saved, and you can click on several icons to print a file, save it, change the quote style, or lock the text. When you save a file, you can choose the type of line breaks. For all these features, BBEdit takes up only 200 KB on disk and uses only 300 KB of RAM. (You'll have to allocate more RAM to work with bigger files.) BBEdit is an ideal companion for PowerBook users.

UNIX/Ben Smith

A Viewer for X Images

If you have an X Window System–based GUI and work with images, you need `xv`. This is a shareware graphical image viewer and translator for X systems.

You may already have `xgif`, the GIF file viewer that's often distributed with X. But there are some limitations to `xgif`. As John Bradley (the author of both) says: "`xv` probably wouldn't have been written were it not for all the abuse [I received] about the shortcomings of `xgif`."

Version 2.21 of `xv` will display GIF, PBM, PGM, PPM, X11 bit map, and PM images on up to 32-bit X displays. You can correct color mapping, adjust gamma correction, rotate and crop images, and change the aspect ratio. Then you can save out to any supported format. The only shortcoming to `xv` is that it works with images at screen depth; in other words, if you have an 8-bit system, even 24-bit images will be saved at 8 bits.

Editor's note: *Software Corner highlights public domain, freeware, and shareware programs. The programs are available electronically. See "Program Listings" on page 5 for details. We solicit your contributions. We pay $50 for any program we use. Write to: Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

BRUCE D. SCHATZMAN

NEXT-GENERATION OLE

Although OLE has begun to change the way we build and use Windows software, its first incarnation hasn't been trouble-free. You can create systems of communicating applications, but doing so is not always seamless or intuitive. In OLE 1.0, there are several nuances and rules that users don't understand. Moreover, it stores and transmits object data inefficiently, so performance is not optimal. For developers, its large API and state transition logic make adding full OLE support to Windows applications a difficult task.

The forthcoming OLE 2.0 solves the first two of these problems. However, to make OLE-compliant applications more intuitive and faster, developers will be expected to digest a more complex programming model.

As usual, Microsoft is claiming that OLE 2.0 is an evolutionary technology. Although it's true that OLE 2.0 applications will talk to OLE 1.0 applications, OLE 2.0's long-term impact really will be revolutionary. It encourages a document-centered model in which you focus primarily on your data, not on applications. When you're driving, you keep your eye on the road, not on the controls. OLE 2.0 aims to make computing a similarly natural, goal-directed activity.

New Features

For users, the most obvious new feature is *in-place activation*. That means you can double-click on an embedded object and edit or "play" the object without leaving the current window. The user-interface controls of the containing document's window merge with appropriate controls (i.e., menus, buttons, palettes, and toolbars) of the object's server application. When the embedded object loses focus, its server's controls vanish and the containing window reverts to its original appearance. This feature finally provides seamless integration of communicating applications.

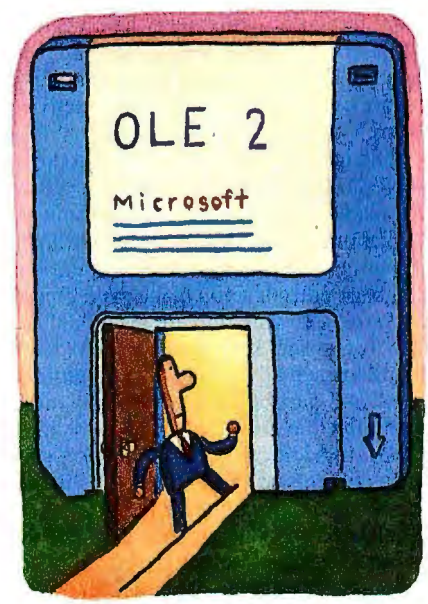
OLE 2.0 supports in-place activation only for embedded objects. Double-clicking on linked objects results in the standard OLE 1.0 behavior—you are sent to a separate application window to interact with the object. Why? Links to an object may exist in more than one document. By requiring a separate window for editing, the system gently reminds you that ownership of the object extends beyond the boundaries of the current document.

Also new in OLE 2.0 is an enhanced drag-and-drop capability that works between or within application windows (or anywhere else a drop is accepted). Because OLE 2.0 supports nested objects, you can also drag objects into or out of other objects.

Another feature enables an OLE 2.0 application to define a callable interface to certain internal functions that it chooses to export. Thus, you'll be able to control such an application from another program or a systemwide script language. The idea isn't a new one. Among today's Windows applications, those that can act as DDE servers are frequently controllable by DDE clients. Hewlett-Packard's NewWave defined a more formal API for doing this kind of thing. Microsoft is betting that the OLE 2.0 mechanism will find broader support than the NewWave API did.

As with NewWave, there will be degrees of support for OLE 2.0. You will have to learn to be discriminating when an application advertises OLE 2.0 compliance.

OLE 2.0 is faster and simpler for users, but it's trickier for developers



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Still to Come

A number of features are described in the OLE 2 specification that will not be available in OLE 2.0. These include the following:

- an extended layout mechanism that supports irregularly shaped objects, not just rectangular ones
- property negotiation, so that an object can adapt its properties to those of its surrounding container
- string searches and spelling checks that "tunnel" inside objects within compound documents, and even within objects embedded in other objects

Tuning the Engine

OLE 2.0 has a new linking model that overcomes some of the limitations that are inherent in OLE 1.0. This model enables links to objects that exist only as embedded items in a document and are not stored as separate files. In OLE 1.0, you can link only to an object that lives in its own DOS file.

The new linking model also improves the persistence of links; that is, there are more ways to copy documents without breaking links. In OLE 1.0, objects are

referenced by way of absolute hard-coded path names that aren't updated when documents move around within the file system. In OLE 2.0, a link persists if only the container document moves, the relative path between the container and the source object stays the same, or the container and object source file are located in the same directory.

To enable this primitive form of link tracking, OLE 2.0 invents a new object reference known as a *moniker*. A moniker is a pointer to an object, and it can be dereferenced whenever the object needs to be located. It's like the path name/object name of OLE 1.0, but it's extended to let applications reference objects nested within other objects. Monikers also support the ability to create interobject links within a document.

Moniker dereferencing works automatically, which simplifies the use of monikers from the programmer's perspective. Once you have an object's moniker, you can find it—even if it's nested several levels deep within another object.

Although the new linking model is an improvement, OLE 2.0 does not guarantee unbreakable links. That's a hard problem to solve efficiently because there are so many permutations involved with combining, nesting, and moving objects within a global namespace spanning directories, local file systems, and networks. Future technology will attack this problem, but don't expect a solution anytime soon.

OLE 2.0 also provides an optimized storage model that offers much more efficient use of RAM and better performance than OLE 1.0. In this new model, an object (or even part of an object) can be loaded from disk into memory only when you want to edit or manipulate the object. In OLE 1.0, all objects in a compound document load into memory in their entirety, regardless of whether you want to activate them.

The new storage model will cut down on RAM usage and significantly speed up the loading of large compound documents containing many objects. It also follows a transactional model that can commit or roll back edits that you make to an object.

Associated with this storage model is a new file format known as a *docfile*. Each docfile is actually a "file system within a file," and part of its structure was modeled after the DOS FAT (file allocation table). In addition to the application-specific contents of the file, docfiles therefore contain object hierarchy information that lets any application identify and enumerate all objects contained in the file. They also contain an extended set of file properties (e.g., the file's author and a description of its contents).

OLE 2.0's performance will also benefit from the ditching of DDE as its IPC (interprocess communications) mechanism. Instead, OLE 2.0 uses a localized RPC (remote procedure call) protocol (in the spirit of Windows NT) to boost the throughput.

The Price of Progress

Naturally, Microsoft had to allow for backward compatibility with applications supporting OLE 1.0. To accomplish this, OLE 2.0 applications must implement a simple version-negotiation protocol that enables them to determine whether an object was created by an OLE 1.0 or OLE 2.0 server. To an OLE 2.0 client, an OLE 1.0 object simply appears as an OLE 2.0 object that does not implement any of the new OLE 2.0 features. Because of this, OLE 1.0 objects don't require any special treatment or handling, and they can be freely mixed with OLE 2.0 objects in the same document.

Unfortunately, OLE 2.0 doesn't offer developers the simple and intuitive model that it offers users. Programmers complained that OLE 1.0 was not easy to implement, and the situation has only worsened. The OLE 2 specification is over 330 pages long, and there are nearly 270 functions in the API. It will take several weeks of solid work before even highly qualified programmers begin to feel comfortable with the programming model. OLE 1.0 veterans will have a head start, but there is a lot of new ground to cover for even the most seasoned developers.

The ball will really start rolling when there are class libraries and development tools that can encapsulate the OLE 2.0 functionality. Such tools and libraries will greatly simplify OLE 2.0 programming and encourage less advanced developers to take the plunge into OLE development.

Complexity notwithstanding, a number of programmers have been actively coding with the OLE 2.0 SDK (Software Development Kit). The first generation of OLE 2.0 applications could be available as early as this summer. It will take time for ISVs (independent software vendors) to fully exploit OLE 2.0, though, so you shouldn't expect to see a large number of applications until the first quarter of 1994. By then, the move to document-centered Windows computing should be in full swing. ■

Bruce D. Schatzman is an independent systems consultant in Bellevue, Washington. You can reach him on BIX c/o "editors."

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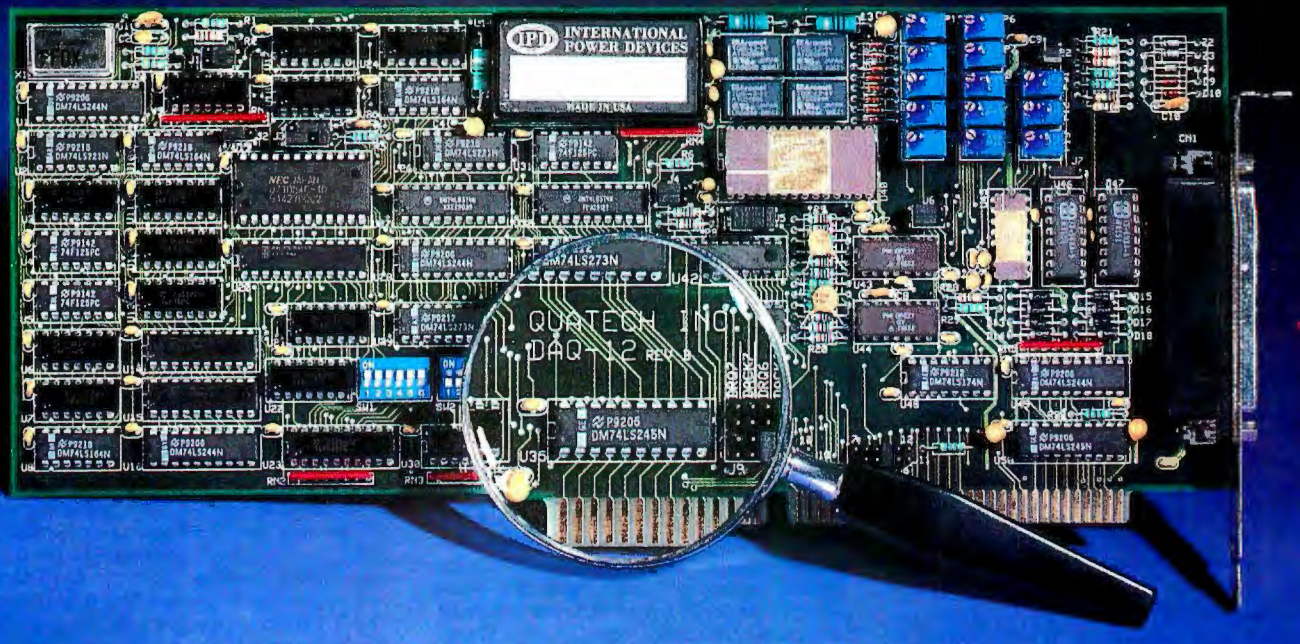

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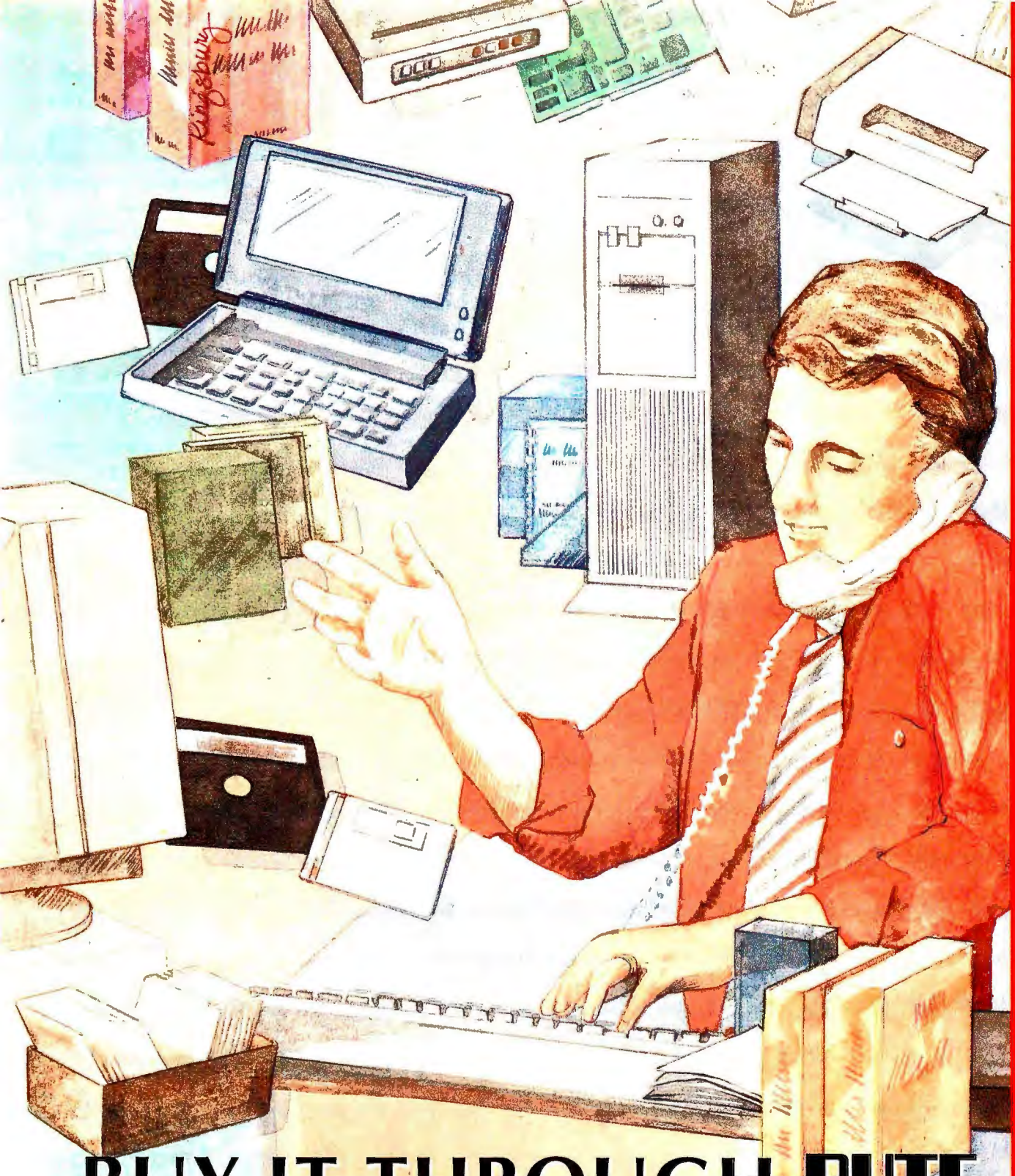

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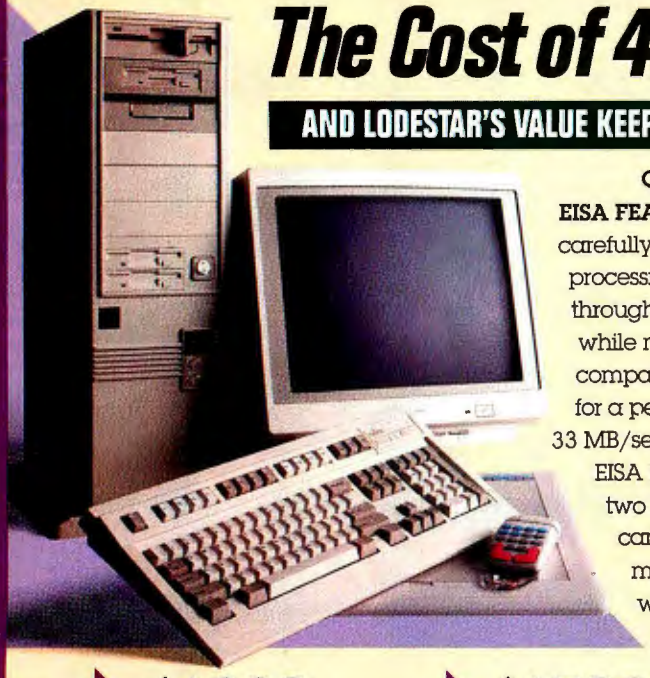

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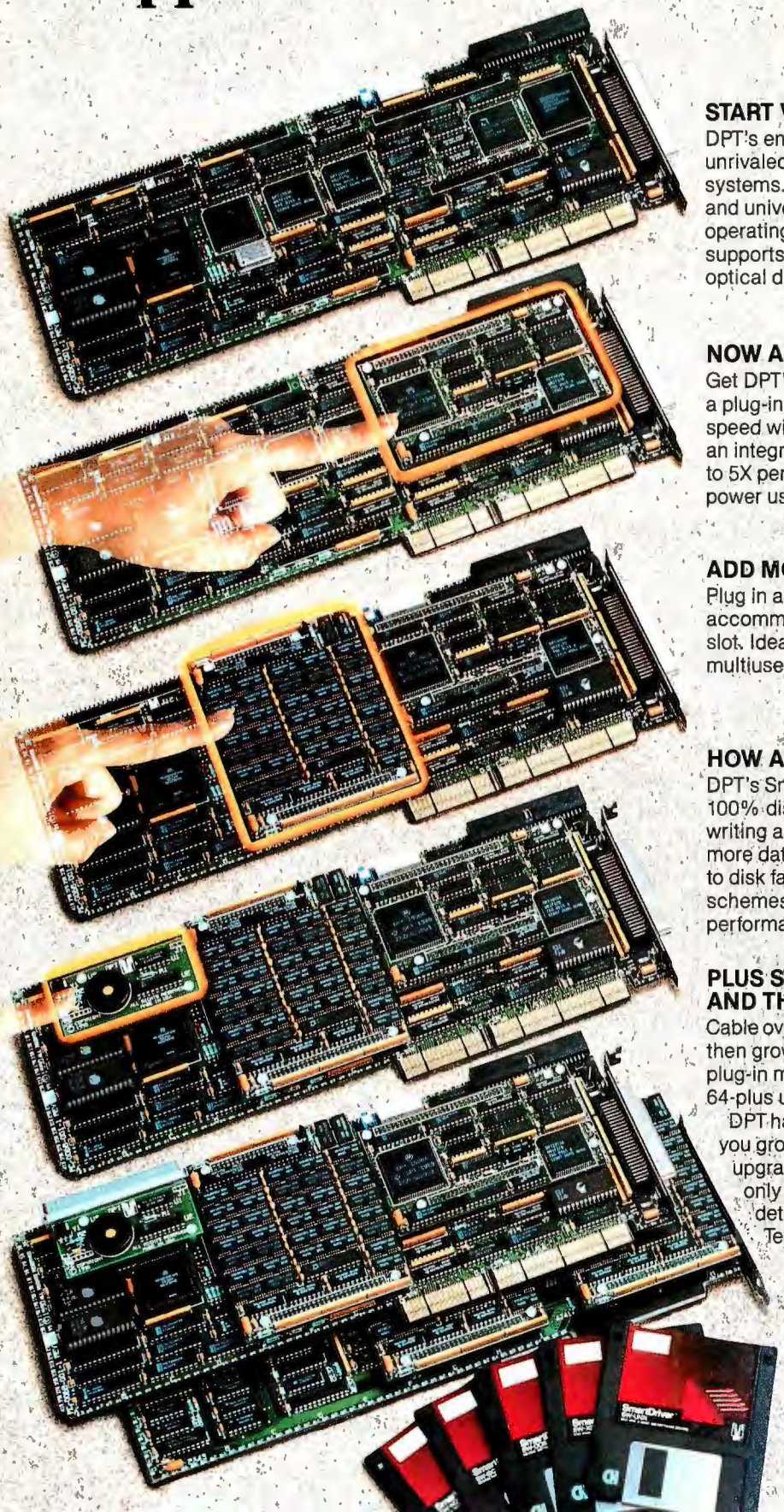

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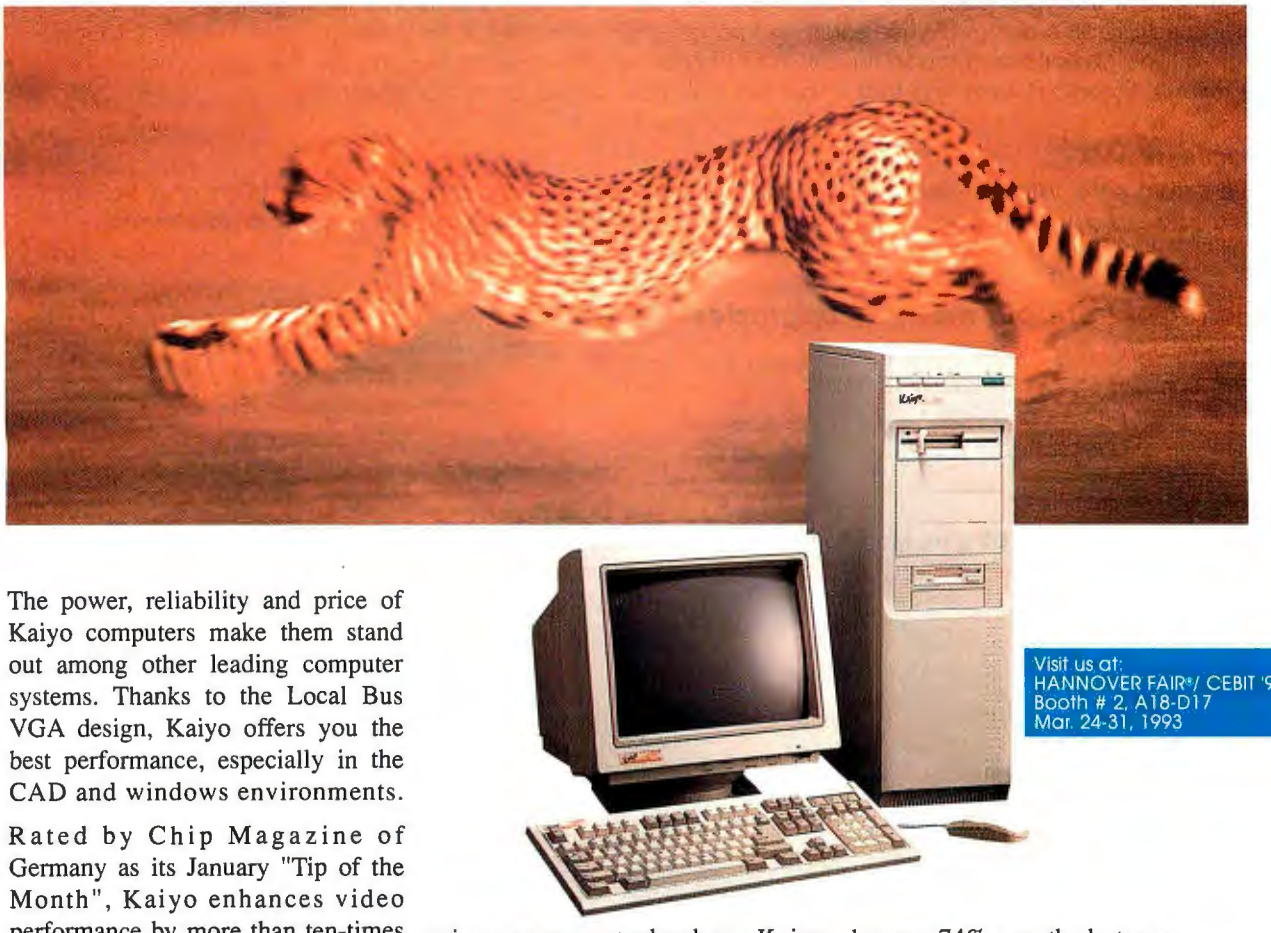

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		500780-005	$118
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Powermate 386/33E, 486/25E	2MB	OP-410-5101	$188
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T2000 SXE/T2200SX	2MB CARD	PA2000U	$89
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T3100 SX	2MB BRD	PA8308U	$88
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T3200 SX	2MB MOD	PA8307U	$88
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T3200	3MB BRD	PA7137U	$148
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	4MB CRD	PA2007U	$198
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Deskpro 386/16	1-2MB	108069-001	$248
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	1MB	108071-001	$98
	4-8MB	108070-001	$469
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Deskpro 386-20E; 25E	4MB	113645-001	$218
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Deskpro 386M,486M, Systempro LT	2-64MB	129160-001	$358
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	2MB	118689-001	$89
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	8MB	128877-001	$318
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	1MEG MOD	118303-001	$89
	2MEG MOD	118304-001	$129
Compaq SLT386	4MEG MOD	118305-001	$175
Compaq Lte 286	1MEG BRD	117081-001	$79
	2MEG BRD	117081-002	$99
	4MEG BRD	117081-003	$218
Compaq Lte 386/20	1MEG MOD	121125-001	$98
	4MEG MOD	121125-002	$198
Compaq Lte Lite/20, 25	2MEG MOD	129769-001	$138
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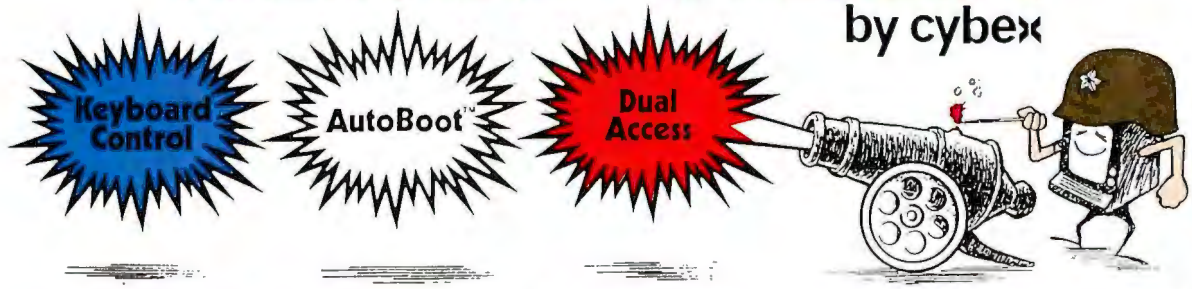

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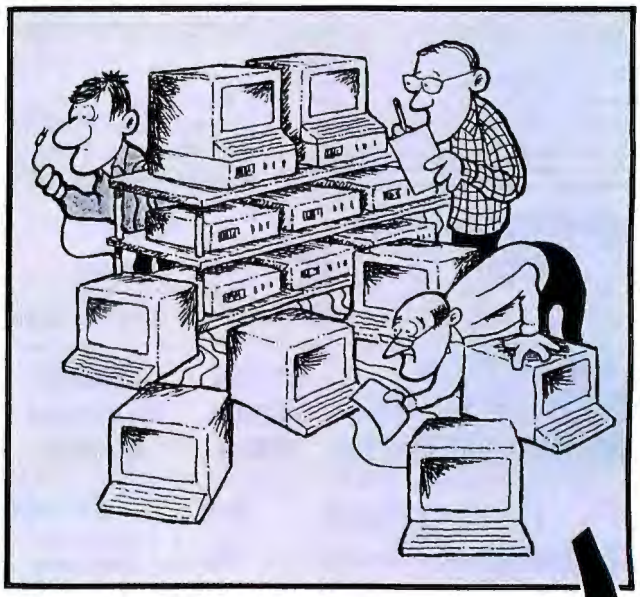

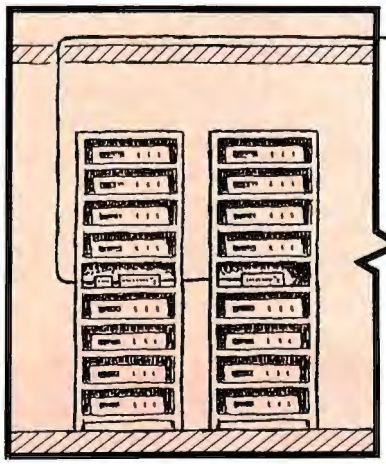

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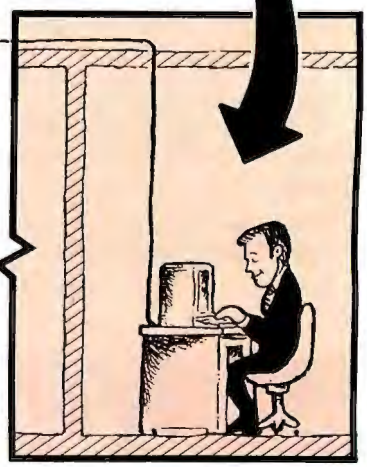

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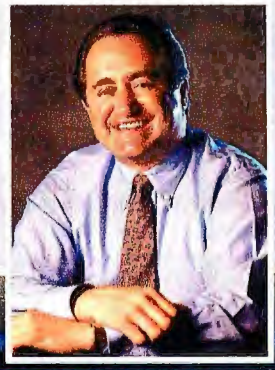

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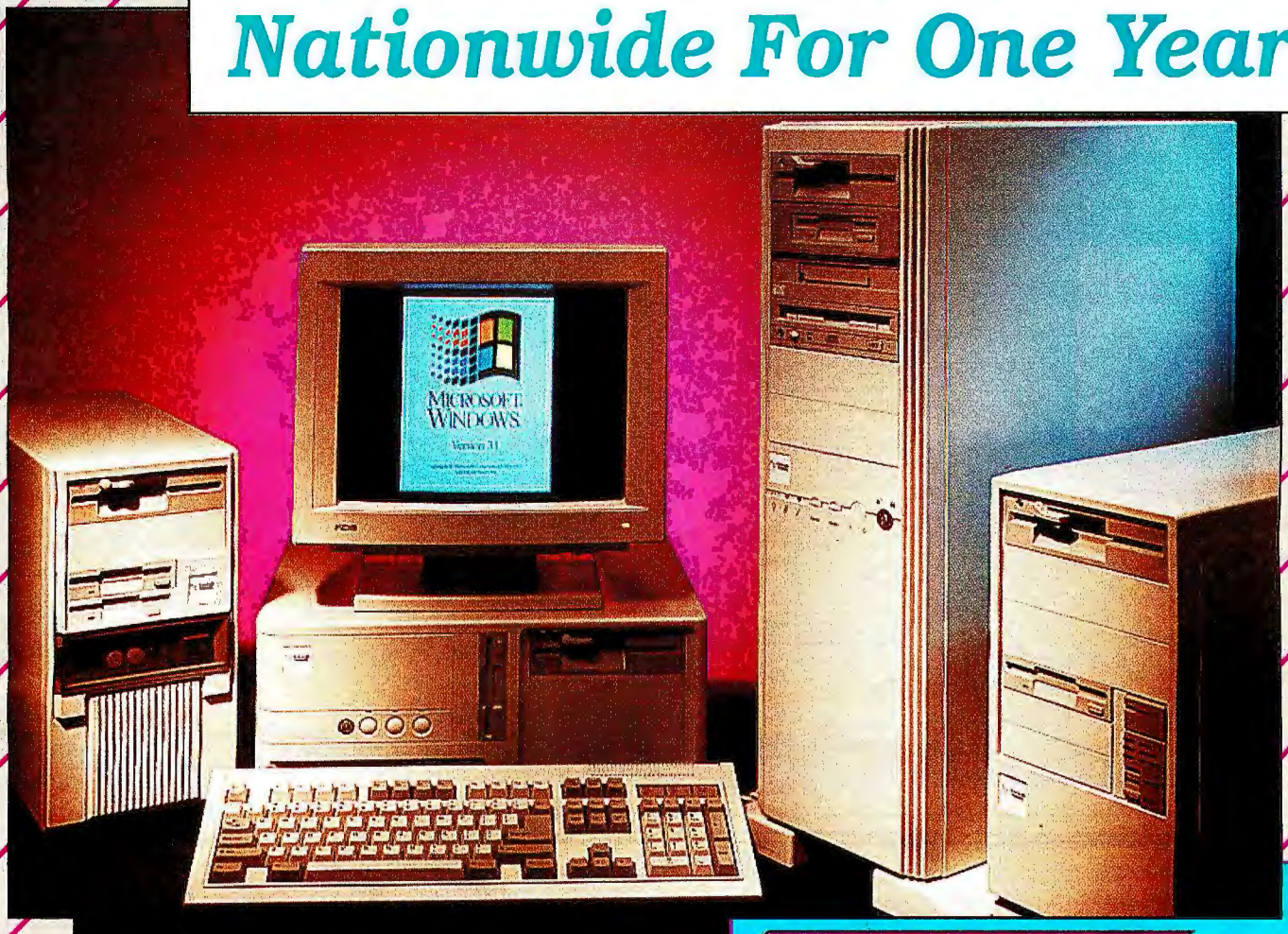

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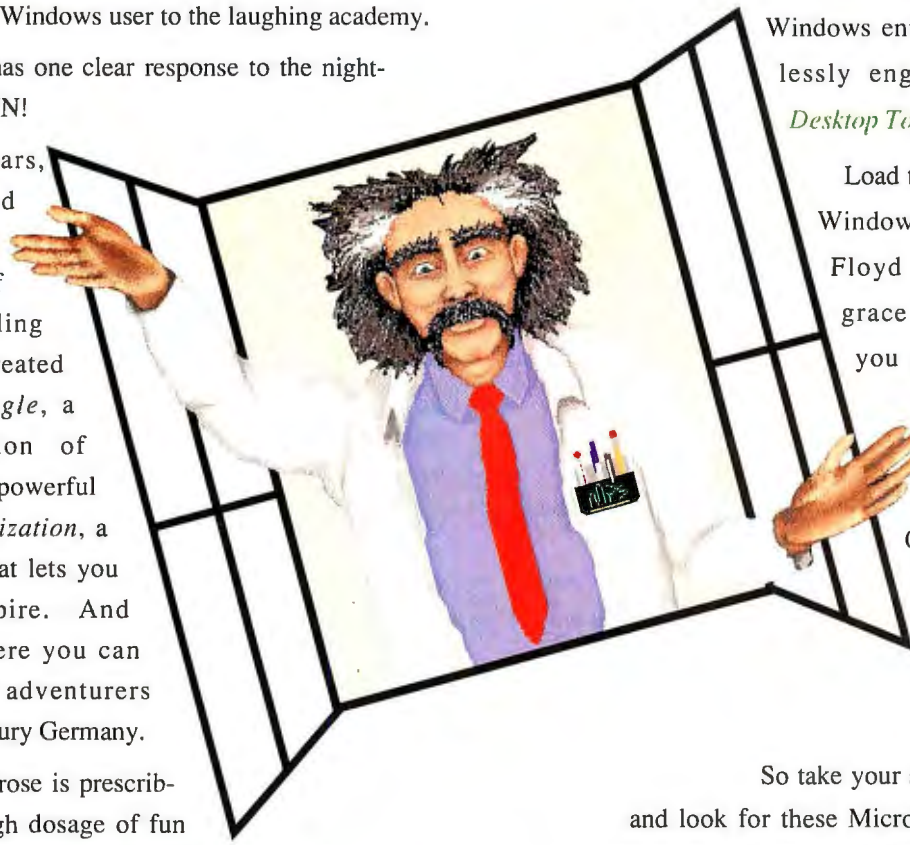

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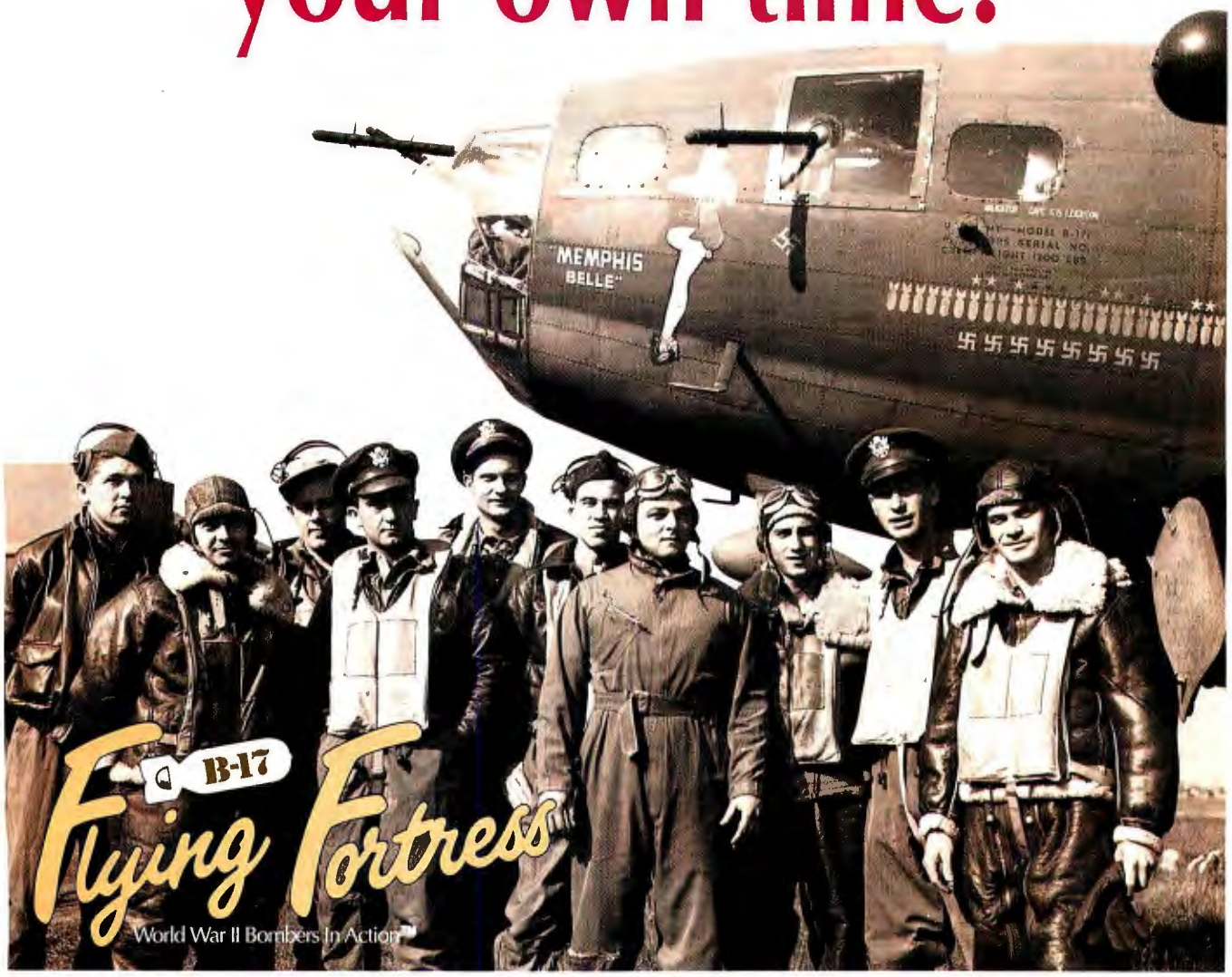

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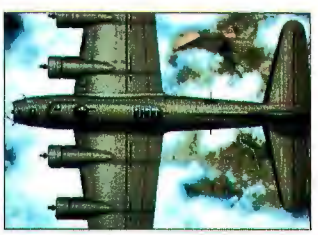

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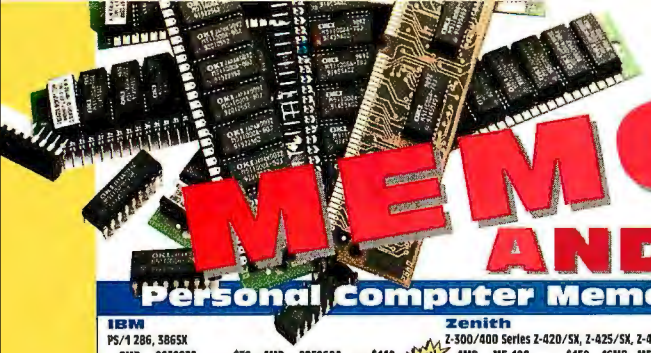

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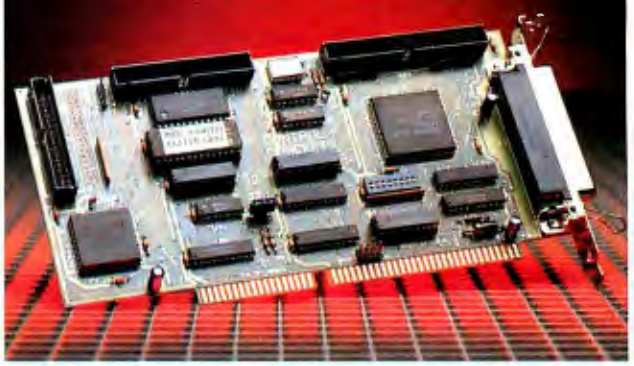

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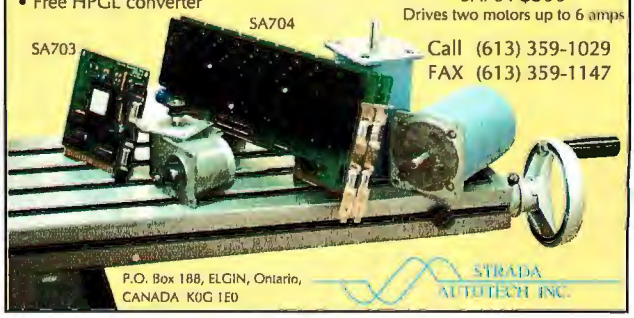

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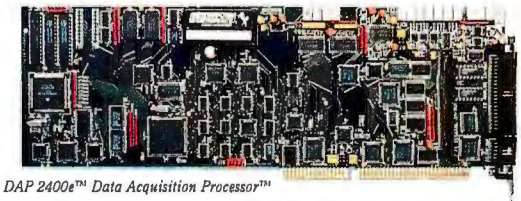

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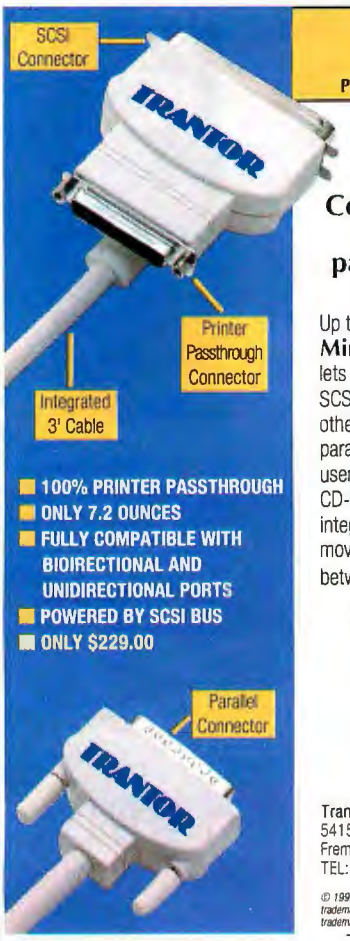

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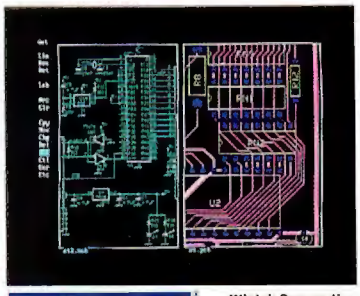

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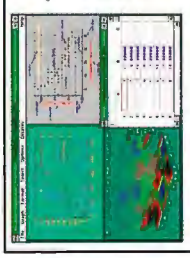

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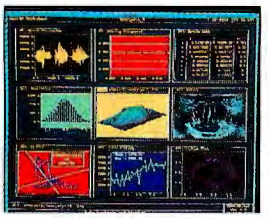

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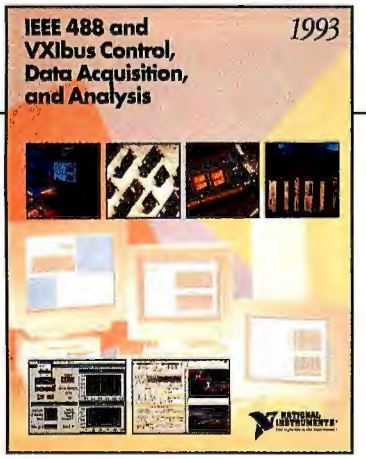

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3 ☐ Adminstration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?
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8 ☐ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ☐ Yes 11 ☐ No

D. What operating systems are you currently using? (Check all that apply)
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13 ☐ DOS + Windows 16 ☐ MacOS
14 ☐ OS/2 17 ☐ VAX/VMS

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19 ☐ 26-50 21 ☐ 100 or more

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March 1993 86 96 99

Product Category Information

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Accessories/Supplies	1
Add-in Boards	2
Bar Coding	3
Communications/Networking	4
Computer Systems	5
Data Acquisition	6
Disks & Optical Drives	7
Diskettes/Duplicators	8
Fax Boards/Machines	9
Graphics Tablets/Mice/ Pen Input	10
Keyboards	11
LAN Hardware	12
Laptops & Notebooks	13
Mail Order	14
Memory/Chips/Upgrades	15
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia	19
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
Tape Drives	23
UPS	24

Software

Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
Mail Order	35
Mathematical/Statistical	36
Miscellaneous Software	37
On-Line Services	38
Operating Systems	39
Programming Languages/ Tools	40
Security	41
Shareware	42
Software Duplication	43
Spreadsheets	44
Unix	45
Utilities	46
Windows	47
Word Processing	48

General

Books/Publications	49
Recruitment	50
Miscellaneous	51

Inquiry Numbers 52-233

52	78	104	130	156	182	208
53	79	105	131	157	183	209
54	80	106	132	158	184	210
55	81	107	133	159	185	211
56	82	108	134	160	186	212
57	83	109	135	161	187	213
58	84	110	136	162	188	214
59	85	111	137	163	189	215
60	86	112	138	164	190	216
61	87	113	139	165	191	217
62	88	114	140	166	192	218
63	89	115	141	167	193	219
64	90	116	142	168	194	220
65	91	117	143	189	195	221
66	92	118	144	170	196	222
67	93	119	145	171	197	223
68	94	120	146	172	198	224
69	95	121	147	173	199	225
70	96	122	148	174	200	226
71	97	123	149	175	201	227
72	98	124	150	176	202	228
73	99	125	151	177	203	229
74	100	126	152	178	204	230
75	101	127	153	179	205	231
76	102	128	154	180	206	232
77	103	129	155	181	207	233

Inquiry Numbers 234-408

234	259	284	309	334	359	384
235	260	285	310	335	360	385
236	261	286	311	336	361	386
237	262	287	312	337	362	387
238	263	288	313	338	363	388
239	264	289	314	339	364	389
240	265	290	315	340	365	390
241	266	291	316	341	366	391
242	267	292	317	342	367	392
243	268	293	318	343	368	393
244	269	294	319	344	369	394
245	270	295	320	345	370	395
246	271	296	321	346	371	396
247	272	297	322	347	372	397
248	273	298	323	348	373	398
249	274	299	324	349	374	399
250	275	300	325	350	375	400
251	276	301	326	351	376	401
252	277	302	327	352	377	402
253	278	303	328	353	378	403
254	279	304	329	354	379	404
255	280	305	330	355	380	405
256	281	306	331	356	381	406
257	282	307	332	357	382	407
258	283	308	333	358	383	408

Inquiry Numbers 409-590

409	435	461	487	513	539	565
410	436	462	488	514	540	566
411	437	463	489	515	541	567
412	438	464	490	516	542	568
413	439	465	491	517	543	569
414	440	466	492	518	544	570
415	441	467	493	519	545	571
416	442	468	494	520	546	572
417	443	469	495	521	547	573
418	444	470	496	522	548	574
419	445	471	497	523	549	575
420	446	472	498	524	550	576
421	447	473	499	525	551	577
422	448	474	500	526	552	578
423	449	475	501	527	553	579
424	450	476	502	528	554	580
425	451	477	503	529	555	581
426	452	478	504	530	556	582
427	453	479	505	531	557	583
428	454	480	506	532	558	584
429	455	481	507	533	559	585
430	456	482	508	534	560	586
431	457	483	509	535	561	587
432	458	484	510	536	562	588
433	459	485	511	537	563	589
434	460	486	512	538	564	590

Inquiry Numbers 591-765

591	616	641	666	691	716	741
592	617	642	667	692	717	742
593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1182	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1278	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
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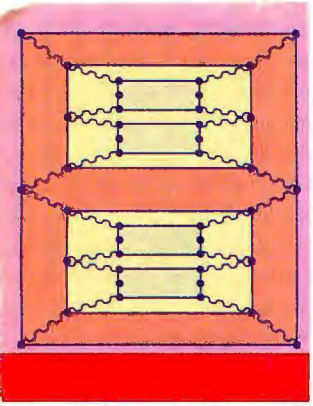

STOP BIT

CLIFFORD A. PICKOVER

FRACTAL FANTASIES

Computer-generated fractal patterns are everywhere these days. From squiggly designs on computer-art posters to illustrations in the most serious of physics journals, interest continues to grow among scientists, artists, and designers.

Mathematician Benoit Mandelbrot coined the word *fractal* in 1975 to describe an intricate-looking set of curves, many of which were never seen before the advent of computers, with their ability to quickly perform massive calculations. Fractals often exhibit *self-similarity*, which means that various copies of an object can be found within the original object at smaller scales. The detail continues for many magnifications, like an endless nesting of Russian dolls within dolls. Some of these shapes exist only in abstract geometric space, but others can be used as models for complex natural objects like coastlines and blood-vessel branching.

Fractals can create an infinite playing field for board-game designs

Interestingly, fractals provide a useful framework for understanding chaotic processes and for performing image compression. The dazzling computer-generated images can be intoxicating, motivating students' interest in math more than any other mathematical discovery in the last century.

When most people hear the word *fractal* they rarely think of applications beyond the kinds just mentioned. Recently, however, I found myself drawn to their use in game playing. You might like to program software to play it or simply use a board drawn on paper.

The board for the Fractal Fantasy game consists of a fractal nesting of rectangles within rectangles interconnected with wiggly lines, as shown in the artwork above. There are always two rectangles within the rectangles that encompass them, and the degree of nesting can vary.

Beginners play with only a few nested rectangles, while grand masters play with many recursively positioned rectangles. One can imagine tournaments lasting for days, with breaks only for eating and sleeping. The playing board illustrated here is called a *degree 2* board, because it has two different sizes of rectangles within the large bounding rectangle. Beginners usually start with a degree 1 board, and grand masters have been known to use a degree 20 board. One player uses white playing pieces (or *stones*); the other uses black. Each player starts with a number of stones equal to two less than half the number of vertices (i.e., dots) on the board.

For the board here, each player gets 19 stones. With alternate moves, the players begin by placing a stone at points on the black dots that are empty. As they place stones, each player attempts to form a row of three stones along any one of the vertical sides of any square. This three-in-a-row assembly of stones is called a *googol*. When all the stones have been placed, players take turns moving a stone to a neighboring vacant space along one of the wiggly or straight connecting lines.

When a player forms a googol (either during the alternate placement of stones at the beginning of the game or during alternate moves along lines to adjacent empty points), that player takes any one of the opponent's stones on the board and removes it from the board. (In some versions of this game, an opposing stone can't be taken from an opposing googol.) A player loses when he or she no longer has any stones or cannot make a move.

Mathematicians and philosophers will no doubt spend many years pondering a range of questions, particularly for boards with higher nesting. Computer programmers will design programs allowing the board to be magnified in different areas, permitting the convenient playing at different size scales. They'll all wish they had fractal consciousness, allowing the contemplation of all levels of the game simultaneously.

Is there a best opening move or overall strategy? If the large bounding square has a side 1 foot in length, what is the total length of lines on the board? If an ant were to start anywhere on the board and walk to cover all the lines, what would be the shortest possible route on the board? How many possible board arrangements are there? How large would a degree 100 board have to be for the smallest squares to be seen? How many playing stones would be used? What length of time would be required to play such a bizarre game? I welcome comments and discoveries from readers. ■

Clifford A. Pickover is an IBM research staff member at the IBM Thomas J. Watson Research Center in Yorktown Heights, New York. His latest book is Mazes for the Mind: Computers and the Unexpected *from St. Martin's Press. You can reach him on BIX c/o "editors" or on the Internet at cliff@watson.ibm.com.*

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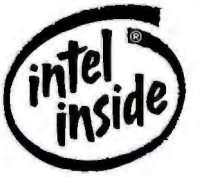
E NEW DELL 333s/L
6" SX 33 MHz SYSTEM

EASE: $44/MO.
MB RAM
20 MB (17 ms) HARD DRIVE
ISA EXPANSION SLOTS
GA 800 MONITOR
4", 800 X 600, .39mm)
NE FLOPPY DRIVE (3.5" OR 5.25")
MS-DOS 5.0

OUR FASTEST 386SX.
(Don't let it fool you. Actually, it's a lot faster than a speeding bullet.)

GUARANTEED RESPONSE.
Amazingly easy to use, and includes comprehensive documentation. But if you ever have questions, call us. We guarantee you'll talk to an expert within 5 minutes, or if you prefer, we'll call back within an hour.*



READY TO ROCK 'N' ROLL.
Intel isn't the only thing in this system. Everything can be custom configured: modems, network adapters, and critical software.

E NEW DELL 425s/L
6 SX 25 MHz SYSTEM

EASE: $55/MO.
MB RAM
70 MB (17 ms) HARD DRIVE
ISA EXPANSION SLOTS
JPGRADEABLE PROCESSOR
ACCELERATED LOCAL BUS VIDEO
WITH 512 KB VIDEO RAM
UP TO 11 MILLION WINMARKS)
VGA 1024I MONITOR
14", 1024 X 768, .28mm)
NE FLOPPY DRIVE (3.5" OR 5.25")
MS-DOS 5.0

UP TO 65% QUICKER MAINTENANCE.
It's easy to get into this computer. Just loosen a couple of thumbscrews for easy access to the modular chassis.

UP TO 2.6 TIMES THE VIDEO PERFORMANCE.
With our new accelerated local bus video revving up your screen, who needs a VCR?

GUARANTEED COMPATIBILITY.
Our computers are network-compatible with Novell, Banyan, and UNIX® systems. And we're the only company with a written compatibility guarantee.*

E NEW DELL 433s/M
C6 SX 33 MHz SYSTEM

EASE: $74/MO.
MB RAM
70 MB (17 ms) HARD DRIVE
ISA EXPANSION SLOTS
PGRADEABLE PROCESSOR
CCELERATED LOCAL BUS VIDEO
WITH 1 MB VIDEO RAM
UP TO 19 MILLION WINMARKS)
SVGA 1024I MONITOR
14", 1024 X 768, .28mm)
NE FLOPPY DRIVE (3.5" OR 5.25")
MS-DOS 5.0

UP TO 160% FASTER VIDEO.
Faster PageMaker redraws and lightning-quick Windows™ repaints. Speed freaks, rejoice.

GREATER UPGRADEABILITY.
You can upgrade all the way to the top 486, the 66 MHz DX2. You'll even be able to add the Pentium technology from Intel.

SYSTEM PERFORMANCE BOOSTED 29%.
With our new optimized cache as an option, you can give your system a boost whenever you want.

E NEW DELL 466/ME
86 DX2 66 MHz SYSTEM

EASE: $111/MO.
4 MB RAM
170 MB (17 ms) HARD DRIVE
4 EISA EXPANSION SLOTS
2 ISA EXPANSION SLOTS
JPGRADEABLE PROCESSOR
ACCELERATED LOCAL BUS VIDEO
WITH 1 MB VIDEO RAM
UP TO 29 MILLION WINMARKS)
ULTRASCAN™ 14C MONITOR
14", 1024 X 768, .28mm, NI)
NE FLOPPY DRIVE (3.5" OR 5.25")
MS-DOS 5.0

UP TO FOUR TIMES FASTER DATA TRANSFER THAN ISA.
You get a 32-bit EISA expansion bus that transfers data at up to 33 megabytes a second. To understand what it does for your computer, drink about eight million cups of coffee.

GUARANTEED ACCOUNTABILITY.
We're the only computer company to guarantee*–in writing–compatibility, fast response to your questions, and quick service.^ Two-thirds of the FORTUNE 500 companies rely on us. So should you.

GOOD NEWS FOR THE POWER HUNGRY.
It's easy to upgrade to the top 486, the 66 MHz DX2. If you're still power hungry, you can add Pentium technology — the next generation from Intel.

E NEW DELL 433/T
86 DX 33 MHz SYSTEM

EASE: $91/MO.
4 MB RAM
230 MB (16 ms) HARD DRIVE
3 ISA EXPANSION SLOTS
UPGRADEABLE PROCESSOR
ACCELERATED LOCAL BUS VIDEO
WITH 1 MB VIDEO RAM
UP TO 19 MILLION WINMARKS)
SVGA 1024I MONITOR
14", 1024 X 768, .28mm)
NE FLOPPY DRIVE (3.5" OR 5.25")
MS-DOS 5.0

UP TO 18% FASTER SYSTEM PERFORMANCE.
Good thing you don't have to worry about the highway patrol.

33% MORE SLOTS.
With eight slots, you can add the network and communication cards you need for a great low-cost server.

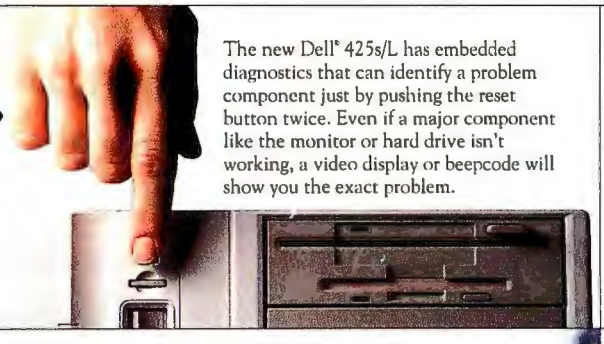
UP TO 86% MORE DISK CAPACITY.
Our floor-standing model has a disk capacity of up to three gigabytes. Talk about mind-expanding performance...

Each system is custom-built. With 18 different models in our new 486 line — covering 25 MHz, 33 MHz, 50 MHz, and 66 MHz — you can configure just the system you need. In fact, with our complete line of storage, memory, graphics and connectivity products, we can build over 15,000 different configurations.

FIVE EASY PIECES.

DELL INTRODUCES THE WORLD'S EASIEST PC TO TAKE APART. THAT LETS YOU SAVE TIME. SAVE ENERGY. SAVE FRUSTRATION. AND AS ALWAYS, SAVE A TON OF MONEY.

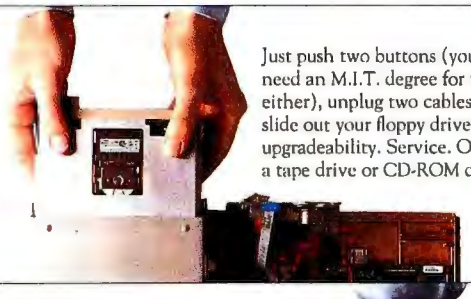
1.



The new Dell® 425s/L has embedded diagnostics that can identify a problem component just by pushing the reset button twice. Even if a major component like the monitor or hard drive isn't working, a video display or beepcode will show you the exact problem.

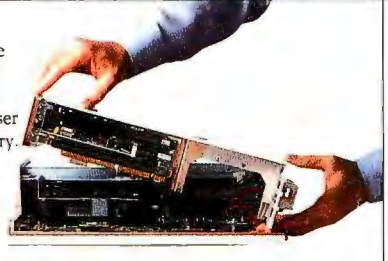
2. The new Dell 425s/L then comes apart easily by first taking out two thumbscrews and removing the chassis cover. That's right, you don't need a hammer. Crowbar. Or a chainsaw.

3.



Just push two buttons (you won't need an M.I.T. degree for this either), unplug two cables, and slide out your floppy drives for easy upgradeability. Service. Or to add a tape drive or CD-ROM drive.

4. Then all you do is remove one tiny, little screw and pull out the entire card cage to add different user upgrade options like video memory. You can also add cache. Add Pentium™ technology. Change the processor. Or even swap out the systemboard. A child could do it. Or even your boss.



5.

If you want to get to your hard drive for easy maintenance or for an upgrade, just take out another screw, unplug two cables, and snap it out. And if there's a problem call us and we guarantee within five minutes you'll be talking to a trained specialist.* A service which has helped make us a FORTUNE 500® company in seven short years. It's really that simple. Almost as simple as picking up the phone. So call us.

THE NEW DELL 425s/L
i486™ SX 25 MHz SYSTEM

NEW LOW PRICE
$1,499

- LEASE®: $55/MO.
- 4 MB RAM
- 170 MB (17 ms) HARD DRIVE
- 3 ISA EXPANSION SLOTS
- UPGRADEABLE PROCESSOR
- ACCELERATED LOCAL BUS VIDEO WITH 512 KB VIDEO RAM (UP TO 11 MILLION WINMARKS)
- SVGA 1024I MONITOR (14", 1024 X 768, .28mm)
- ONE FLOPPY DRIVE (3.5" OR 5.25")
- MS-DOS® 5.0

ALSO AVAILABLE WITH 33 MHz i486 SX, 33 MHz i486 DX AND 50 AND 66 MHz i486 DX2 AND THOUSANDS OF OTHER CONFIGURATIONS.

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