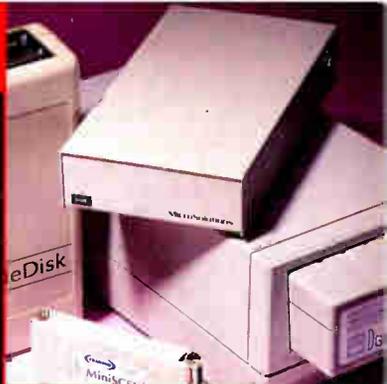


BYTE

THE WORLDWIDE COMPUTING AUTHORITY



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Take the Express Lane

VL-Bus, QuickRing
and PCI raise
the speed limit

4 New Low-Cost Macs

Compaq's Newest
Notebooks

BYTE Pushes
12 File Servers
to the Limit

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23 KENSINGTON CT
HEMPSTEAD NY 11550

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World Radio History



The "Orchard" people are 11 Gateway 2000 employees photographed at P.B. Apple Orchard in Sioux City, Iowa.

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~~\$15~~

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~~\$14~~

~~\$12~~

APPLES TO APPLES, YOU CAN'T BEAT GATEWAY 2000!

With all the price paring going on in the industry, the PC crop looks luscious — but now, more than ever, it's important to compare apples to apples. You can look at two 486SX machines and actually be comparing an apple to an orange. What's inside makes a big difference. Other manufacturers do whatever it takes to hit a price point, and what you thought was a peach may turn out to be a lemon.

The trick is to weed through PC manufacturers to find the one that's perfected the recipe. You need the right ingredients mixed together in just the right way: the smartest

system features, quality components, the company's strength and a reputation for the best, most knowledgeable service.

We'd like to share this recipe to help you peel away the hype and compare performance and features. Apples to apples, you'll find Gateway 2000 is the only company where a bushel is still a bushel. And a dollar buys more today than it did yesterday. That's value. That's the Gateway 2000 difference.

Performance

CPUs

- * Preset your PC for tomorrow's software by choosing a 486 system — i486 CPUs are designed for power-hungry applications.
- * Check for memory cache for optimal processor and memory performance. 64k is your best choice.

Drives

- * Avoid slow cooking — make sure your access times is less than 15ms.
- * Blend in at least 32k of cache
- * RIDE (Rapid Integrated Drive Electronics), Gateway's exclusive disk performance enhancement, will spice up your performance even more.

Video

- * To serve up the best Windows performance, look for coprocessed video.

- * **VRAM vs DRAM:** Don't settle for stale ingredients — VRAM is faster. Remember, add at least 1MB RAM.
- * Add a local bus video for the best video performance, but avoid proprietary local buses.

Features

RAM

- * For the best results, start out with a minimum of 4MB. We recommend 8MB
- * Make sure your machine is expandable to at least 16MB, but look for upgradability to 64MB.

Drives

- * Stir in a bare minimum of 80MB.
- * Add both 5.25" and 3.5" floppies

Monitors

- * Start out with a 14-inch, 1024 x 768 NI color monitor.
- * Upgrade to a 15-inch color monitor with a flat, square, non-glare screen for a larger, brighter viewing area.

Software

- * Your system should include Microsoft® DOS® 5.0 and MS Windows™ 3.1, installed and ready to run.
- * Toss in your choice of free applications software options preinstalled.

Keyboard

- * Add a programmable keyboard with more than 101 keys. Mix in two sets of function keys.

Company

- * With Gateway 2000, you get a financially-sound, proven company with one of the best balance sheets in the industry.
- * Combine Midwestern work ethics and ingenuity with liberal amounts of buying power to bring you the latest technology at an unbeatable price.



**THIS IS OUR IDEA
OF A GOOD DEAL.**



ADDED TEMPTATIONS FROM GATEWAY 2000

Nomad Notebooks

Our small, lightweight Nomad notebook PCs give you desktop performance no matter where you are.

PC Magazine reports, "Geared to low power consumption, Gateway 2000's Nomad line offers excellent battery life, light weight, quality performance, and a highly competitive price."

Computer Shopper added, "The Nomad is far and away the best laptop around for getting the maximum value out of a single battery charge."

"...(it's) clearly the best general-purpose choice (for a notebook computer)."

And our 486 Nomads don't sacrifice performance for portability. You get a bushel basket full of standard features!



The HandBook™

Sometimes a product is so special, it's impossible to compare it to anything else. And that's the way it is with our one-of-a-kind HandBook — a real PC in miniature form!

It weighs just 2.75 pounds and measures 6 x 9 inches. Yet it delivers 286-class performance and speedily runs all your favorite DOS applications with a bright backlit screen, a bonafide 40MB hard drive and a comfortable 78-key keyboard (no chiclet keys). And you get up to 4.5 hours battery life with power management.

Your HandBook arrives with MS-DOS® 5.0, LapLink® XL from Traveling Software, MS PC Works™, and Central Point® Desktop. A serial cable is included for downloading to your desktop.

An Extra Slice For Gateway Customers

Free Application Software

It's ripe for the picking at Gateway 2000! Each Nomad comes with MS Works™, and each 486 desktop or tower system comes with your choice from the option list on the next page.

The 15-Inch CrystalScan 1572FS

A flat, square, non-glare screen reduces distortion around the corners and provides edge-to-edge display — an upgrade option with the purchase of a 386DX or 486 for an additional \$195.

The Gateway 2000 TelePath™ Fax/Modem

A 14,400 bps mode, V.32bis, with 9,600 bps fax capability. Includes WinFax Pro™, Crosstalk for Windows™, Qmodem™ and a free 30-day basic services CompuServe® membership — all for only \$195!

More Software At Great Prices

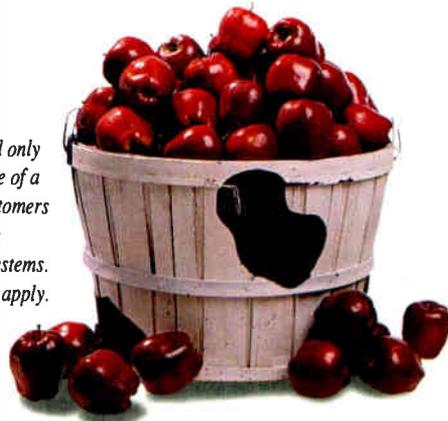
Central Point® Anti-Virus 1.2 for Windows \$75
Central Point Backup™ 7.2 for Windows \$75
The Norton Desktop™ 2.0 and Prisma YourWay 2.0 for Windows (personal information manager) \$95

The Extras — That Don't Cost Extra

- One-year limited warranty
- 30-day money-back guarantee
- Free on-site service to most locations (factory service only for notebooks)
- Lifetime toll-free technical support
- Free BBS lifetime membership
- Payment options — major credit cards and C.O.D. terms; net 30-day credit terms and leasing options are available to qualified commercial customers.

Software options include identical applications contained in retail packages but will not include the retail box. You get all master diskettes and manuals, shrink-wrapped and packaged in a Gateway 2000 box.

Components, peripherals and software are sold only with the purchase of a system, or to customers who already own Gateway 2000 systems. Some limitations apply.



Also available — tape backups, printers and other peripherals. Call for details.

PORTABLES

HANDBOOK

- 286 Class Performance
- 1MB RAM upgradeable to 3MB
- 40MB Hard Drive
- Backlit 7.6" CGA Screen
- Size 5.9" x 9.75" x 1.4", 2.75 Lbs.
- 4.5-Hr.* NiMH Battery & AC Pack
- 1 Parallel/1 Serial Port
- 78-Key Keyboard
- MS DOS 5.0, LapLink XL, MS Works, Central Point Desktop & Serial Download Cable
- Carrying Case

\$1295

NOMAD 325SXL

- 25MHz, 386SXL Processor
- 4MB RAM
- 1.44MB 3.5" Drive
- 80MB IDE Hard Drive
- Backlit 10" VGA Screen, 64 Grays
- Simultaneous Video with 256K
- Size 8.5" x 11" x 1.8", 5.8 Lbs.
- 6-Hr.* NiCad Battery & AC Pack
- 1 Parallel/1 Serial Port
- 79-Key Keyboard
- FieldMouse™ Pointing Device
- MS DOS® 5.0 and Windows™ 3.1
- MS Works™ for Windows

\$1995

NOMAD 420SXL

- 20MHz, Intel® 486SXL Processor
- 4MB RAM
- 1.44MB 3.5" Drive
- 80MB IDE Hard Drive
- Backlit 10" VGA Screen, 64 Grays
- Simultaneous Video with 1MB
- Size 8.5" x 11" x 1.8", 5.8 Lbs.
- 6-Hr.* NiCad Battery & AC Pack
- 1 Parallel/1 Serial Port
- 79-Key Keyboard
- FieldMouse Pointing Device
- MS DOS 5.0 and Windows 3.1
- MS Works™ for Windows

\$2495

NOMAD 425DXL

- 25MHz, Intel 486DXLP Processor
- 4MB RAM
- 1.44MB 3.5" Drive
- 120MB IDE Hard Drive
- Backlit 10" VGA Screen, 64 Grays
- Simultaneous Video with 1MB
- Size 8.5" x 11" x 1.8", 5.8 Lbs.
- 6-Hr.* NiCad Battery & AC Pack
- 1 Parallel/1 Serial Port
- 79-Key Keyboard
- FieldMouse Pointing Device
- MS DOS 5.0 and Windows 3.1
- MS Works™ for Windows

\$2995

DESKTOPS

25MH: 386SX

- Intel 386SX Processor
- 4MB RAM
- 1.2MB & 1.44MB Drives
- 80MB 15ms IDE Cache Drive
- 16-Bit SVGA with 1MB
- 14" CrystalScan 1024 Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 124-Key AnyKey™ Keyboard
- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- MS Works™ for Windows

\$1345

25MH: 486SX

- Intel 486SX Processor
- 4MB RAM
- 1.2MB & 1.44MB Drives
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- 1 Parallel/2 Serial Ports
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- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- Choice of Application Software

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33MH: 486DX

- Intel 486DX Processor
- 64K Memory Cache
- 4MB RAM
- 1.2MB & 1.44MB Drives
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- ATI Graphics Ultra with 1MB
- 14" CrystalScan 1024NI Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 124-Key AnyKey Keyboard
- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- Choice of Application Software

\$2295

50MH: 486DX2

- Intel 486DX2 Processor
- 64K Memory Cache
- 8MB RAM
- 1.2MB & 1.44MB Drives
- 200MB 13ms IDE** Cache Drive
- ATI Graphics Ultra with 1MB
- 14" CrystalScan 1024NI Color VGA Monitor
- 1 Parallel/2 Serial Ports
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- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- Choice of Application Software

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66MH: 486DX2

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- 64K Memory Cache
- 8MB RAM
- 1.2MB & 1.44MB Drives
- 340MB 13ms IDE** Cache Drive
- Ultra Fast Local Bus Video
- 15" CrystalScan 1572 Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 124-Key AnyKey Keyboard
- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- Choice of Application Software

\$2995

66MH: 486DX2 EISA

- Intel 486DX2 Processor
- 128K Memory Cache
- 8MB RAM
- 1.2MB & 1.44MB Drives
- 340MB 15ms SCSI Cache Drive
- 32-Bit EISA SCSI Controller
- 16-Bit SVGA with 1MB
- 14" CrystalScan 1024NI Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 124-Key AnyKey Keyboard
- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- Choice of Application Software
- Tower Model is Standard

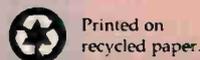
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SOFTWARE CHOICES

- Microsoft® Excel for Windows™ 4.0
- MS Word for Windows™ 2.0
- MS PowerPoint for Windows™ 3.0
- MS Project for Windows™ 3.0
- Borland Paradox® 4.0 and Turbo Pascal 1.5 or C++® 3.1
- The MS Entrepreneur Pack (Works™, Publisher™, Money™ and Games)
- The Windows Programmer Pack (MS QuickC™, Visual Basic, and More)
- MS Office™ (Word, Excel, and PowerPoint) Available as an upgrade replacing any above option.

**Enhanced IDE with RIDE (Rapid Integrated Drive Electronics)

* Battery life was measured using PC Magazine's Battery Rundown Test with power management enabled. Actual results may vary.



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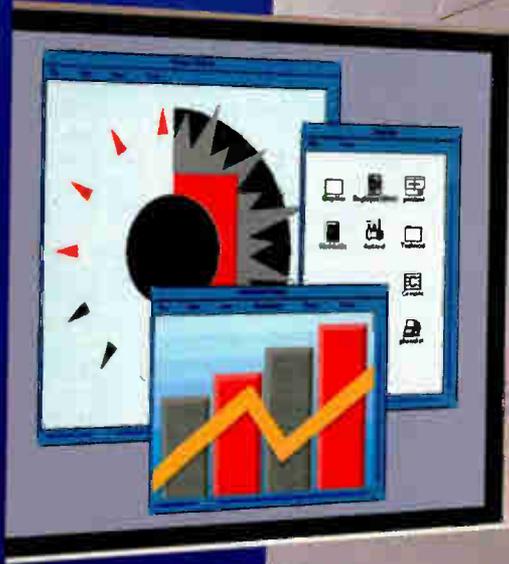
Sales Hours: 7am-10pm Weekdays, 9am-4pm Saturdays (CDT)

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World Radio History

BYTE

October 1992 Volume 17, Number 10

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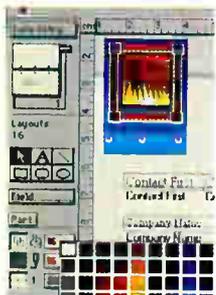
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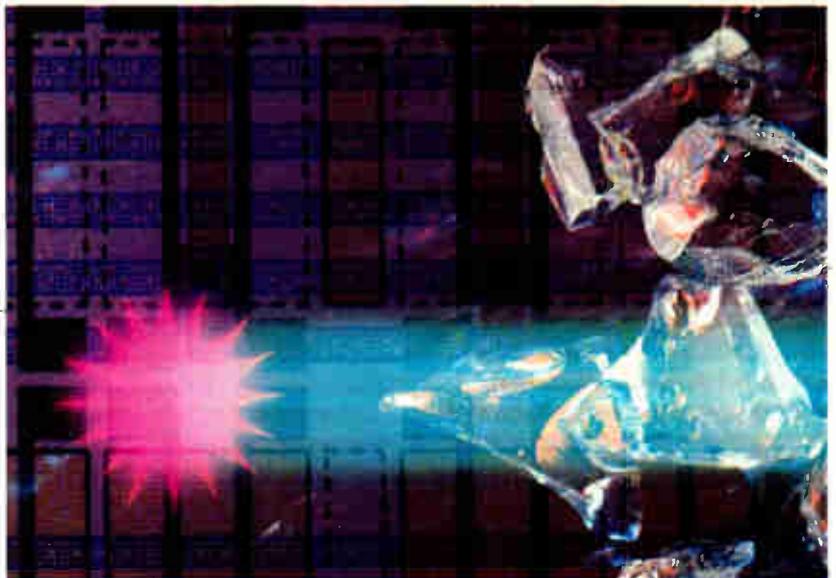
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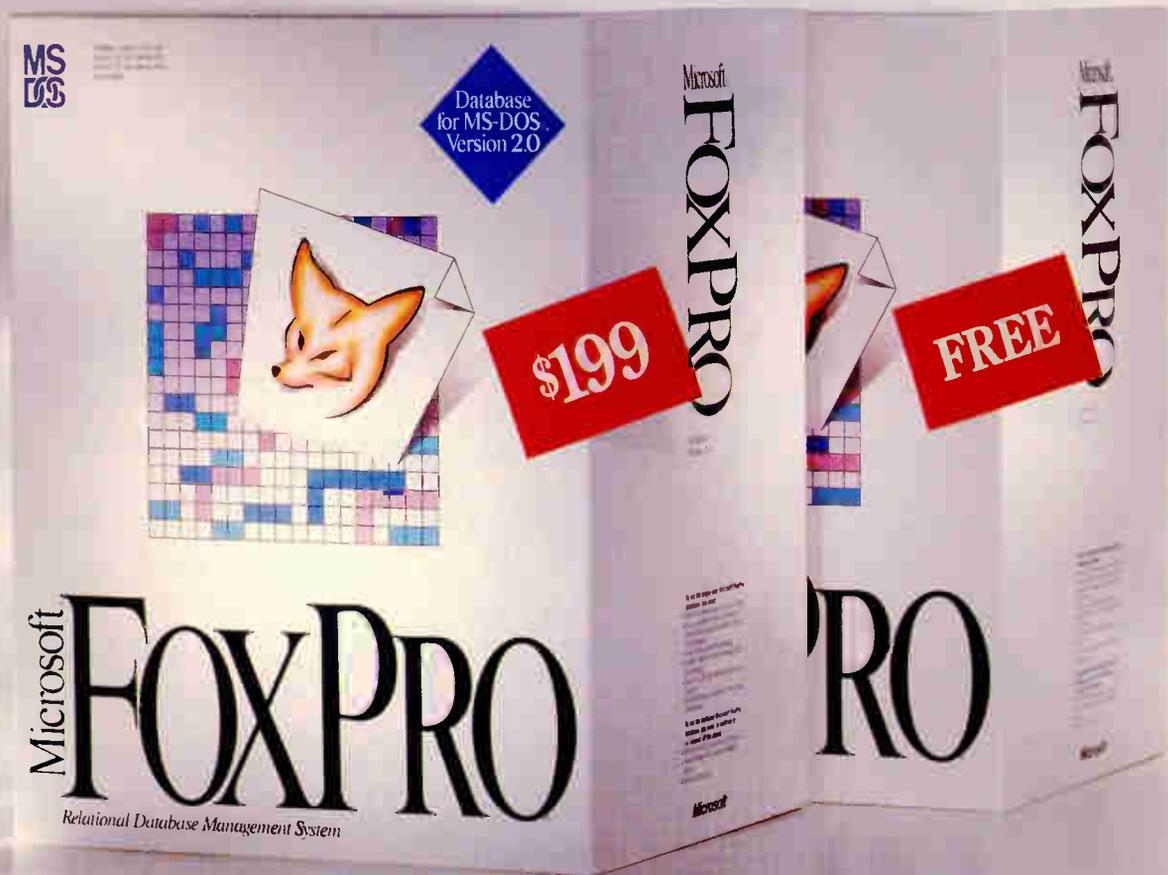
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© 1992 Microsoft Corporation. All rights reserved. Printed in the USA. *Plus \$10.00 freight and applicable sales tax. Reseller prices may vary. **Free; you don't even pay freight. †dBASE IV Benchmarks performed by Micro Endeavors, Inc. DB2 Benchmarks performed by Patrick O'Neil, "The Set Query Benchmark," in "The Benchmark Handbook for Database and Transaction Processing Systems," Morgan Kaufman Publisher, 1991. You must currently be a licensed user of a database product to qualify for this special upgrade offer. To qualify for this offer at your reseller you must bring proof of purchase with you: 1) the original disk from your program, 2) title page of the manual, or 3) a copy of the sales receipt. You must register your copy of Microsoft FoxPro 2.0 to qualify for a free upgrade to version 2.5. (If you get your upgrade disks from Microsoft, you will be automatically registered.) You will then be notified when your free upgrade is available.

Trade up to FoxPro 2.0 from other database products for only \$199 and get a free 2.5 upgrade.

If you use dBASE®, Paradox®, Clipper™ or any other PC database, here's an offer you'll want to nab before it's gone forever: Microsoft® FoxPro® database version 2.0 for just \$199, and a free** upgrade to version 2.5 for MS-DOS® or for Windows™ operating systems as soon as it's released.

It's our way of celebrating the Microsoft and Fox merger. And of introducing you to the fastest, most powerful X-BASE solution available. This is a solution that's sure to stay at the head of the database pack, with Microsoft's full commitment.

The fastest PC database.

FoxPro 2.0 gets unequalled results, thanks to superior technology. Our Rushmore™ Query Optimization lets you get the fastest speed of any PC-based database — up to 4 times faster than DB2® and 10 times faster than dBASE IV.*†

The most productive environment.

It's intuitive and graphical to make your life easier. With Relational Query-By-Example (RQBE) you can simplify complex tasks. And with our exclusive Graphical Browse, you can choose the way you view your data.

With the Screen Builder you can quickly design data-entry forms by simply dragging objects into place. And for really quick turnaround, try the Application Generator. It creates complete, fast applications for you — applications you can then customize to fit your needs.

Then there are the other powerful tools like Trace and Debug windows, Project Manager, Menu Builder, Report Writer and Label Writer. With all these tools, you'll write the most powerful, robust apps imaginable.

Is it any wonder that FoxPro 2.0 received the *Byte* Award of Excellence, *InfoWorld* Product of the Year, *PC Magazine's* Technical Excellence Award and *PC Magazine's* Editors' Choice Award, as well as the *Data Based Advisor* and *DBMS Readers* Choice awards?

Your investment is secure.

It's so easy to learn and use, you won't have to worry about losing any time getting up to speed.

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If you're thinking about what'll happen to your applications tomorrow, relax. The applications you build today under Microsoft FoxPro 2.0 will run on Microsoft FoxPro version 2.5 for Windows, MS-DOS, Macintosh® and UNIX®.

Special offer for users of FoxPro.

We have especially good news if you're a registered FoxBASE+ for MS-DOS or FoxPro 1.x user. You can upgrade to version 2.0 for only \$175 with a free upgrade to version 2.5 when it is available.

The Microsoft commitment.

With Microsoft's resources and Fox's expertise, we're even better positioned to develop the best products and support in the industry. We've been meeting with Fox User Groups around the country. We're planning to hold the largest Fox Developers Conference ever in Phoenix this year. And we're keeping the dialog going on the popular CompuServe® forum, FOXFORUM.

Finally, we support the initiative to create an ANSI standard for the X-BASE language. We stand behind Microsoft FoxPro 2.0 with a full 90-day money-back guarantee and great product support.

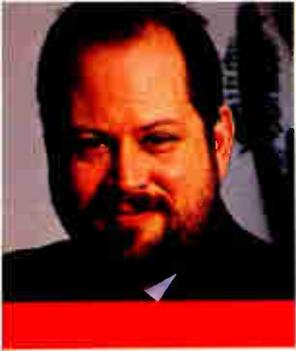
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EDITORIAL

DENNIS
ALLEN

OPEN MARKETS, BETTER COMPUTERS

Who Americans elect as president this November will affect everyone involved with computers throughout the world. The choice will be one that either nurtures the computer market's growth or aborts it, and market growth—not technology alone—is what spawns new and better computer products.

Now, more than ever before, we should be concerned with the future of computing. The computer industry is showing signs of sluggishness, and the current price war has virtually every computer manufacturer retooling for low-cost, low-profit computer systems. The good news is that we'll all benefit from the reduced prices in the short run. The bad news is that this price benefit is eroding R&D budgets as computer makers continue to cut costs to stay price-competitive.

The trouble is that without heavy R&D, technology breakthroughs may be few and far between, and without those breakthroughs, we may never realize the potential of multimedia, parallel processing, and 64-bit computing—to name but a few of the known technology areas. There are also yet-to-be-discovered technology areas whose potential may be lost before it is even known. All that lost potential translates into lost productivity gains for the businesses of the world.

The hope for the computer industry is that there will be market-growth opportunities to spur new investments in R&D. Those opportunities exist in Eastern Europe, South and Central America, China, and other largely untapped markets. Every manufacturer—large or small—recognizes the market opportunities in those countries. Sure, some of those markets are just emerging, but over the next few years, the ability of the computer industry to develop those markets will shape the future of computing.

In this fast-changing world, the challenge is to define how the world trades. Meaningful free-trade agreements are the pathways to developing computer markets, and greater computer markets are the highways to developing computer technology.

If you need proof, consider Brazil. Its government sought to protect its domestic computer industry, and the result was lackluster computers with high prices and a thriving black market for imported systems. Thankfully, all that is changing as Brazil moves toward lifting some of its trade restrictions. Meanwhile, computer mak-

ers are clamoring to get into that market.

Some skeptics would say that bigger markets do not really matter. That's just not true, though. Market potential does matter, because the greater the market opportunities, the greater the reward for innovating. Every businessperson knows that.

Other naysayers call computers "commodities" that can compete only on price. Not so. If you've looked at 486-based systems lately, you know what I mean. If computers are just commodity products, why do you have to worry about which local bus standard a system uses, whether its graphics are VGA- or 8514/A-compatible, whether it has a drive array, and if it does, what level RAID is it? Moreover, if these machines are supposed to be commodity products, why do they all work differently on your network?

There is more on which computers can compete than just price, and there are many problems for which new technology solutions can be developed. It's just a matter of justifying the cost with an adequate market.

Creating new worldwide markets is part of what the U.S. presidential election is all about. There could hardly be greater polarization between the two candidates on the matter of free trade. President Bush has placed free trade and world markets high on his agenda, while Governor Clinton is more concerned with protectionism.

If the world moves toward President Bush's vision of world markets, the computer industry will be ignited by new opportunities, and investment in R&D will prove profitable. As users, we will surely benefit by the richness of innovation from an ignited computer industry.

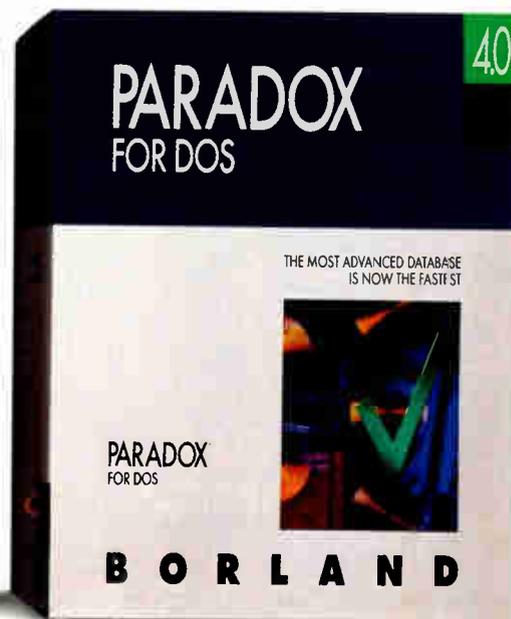
The alternative is to see the computer industry and our potential options take a nosedive during the next five years. Any industry that ever made cuts in R&D fell into decline within five years. And just as surely as the computer industry's R&D budgets are cut, so will be the future of computing.

—Dennis Allen
Editor in Chief

DEMAND PERFORMANCE

Introducing Paradox 4.0 for DOS

*The most
advanced database
is now the fastest*



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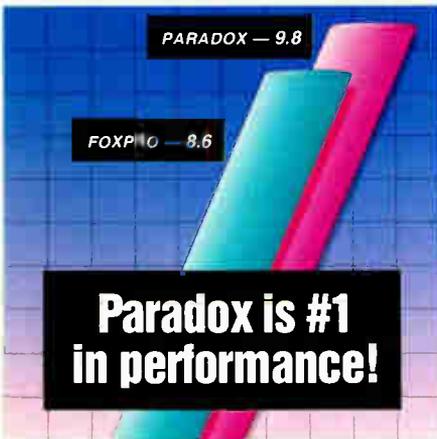
#1 FOR SPEED



Paradox is fastest

NSTL results prove new Paradox® 4.0 is the world's fastest relational database! Thanks to Borland's new WarpSpeed™ performance, Paradox 4.0 sets the standard in performance for both network and standalone use. For you, this means faster answers to queries, faster memory access and faster multiuser applications.

In fact, Paradox 4.0 gives you unparalleled performance throughout all aspects of database management and application development. As NSTL put it, "Paradox is clearly the best all-around product evaluated." It beats FoxPro hands down.



Software Digest's NSTL report rates Paradox highest of all databases tested in Overall Power and Performance.

New Windows-like interface

Our new Windows-like interface makes using Paradox 4.0 more intuitive than any other database. Context-sensitive SpeedBar™ controls give you instant access to your frequently used commands and features. Movable, resizable windows, pull-down menus and mouse support make creating and editing your database simple. And new dialog boxes give you the choices you need in one place, saving time and effort.

The fastest way to get an answer

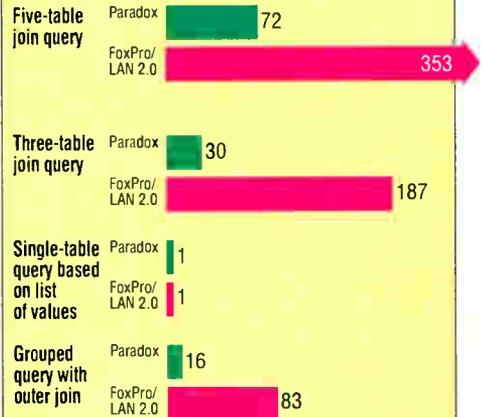
Paradox pioneered Query By Example (QBE), the easiest way to get answers from your database. Now, a built-in query optimizer enhances QBE, automatically finding the fastest path to the answers you're seeking. Plus, multi-table forms and reports make everything from data entry to presentations a snap—all without programming.

WarpSpeed

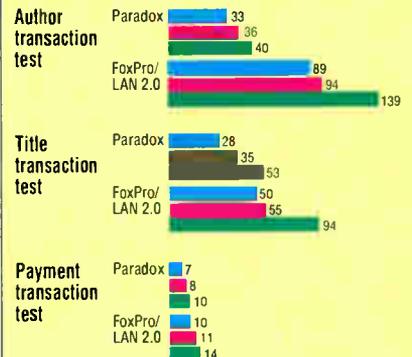
WarpSpeed stands for Wildly Accelerated Relational Performance. It reflects Borland's commitment to performance, and is also an integral part of our dBASE® and InterBase™ development programs.

NSTL tests confirm Paradox 4.0: Quicker than a Fox

Single-user performance tests (in seconds)



Multuser performance tests (in seconds)



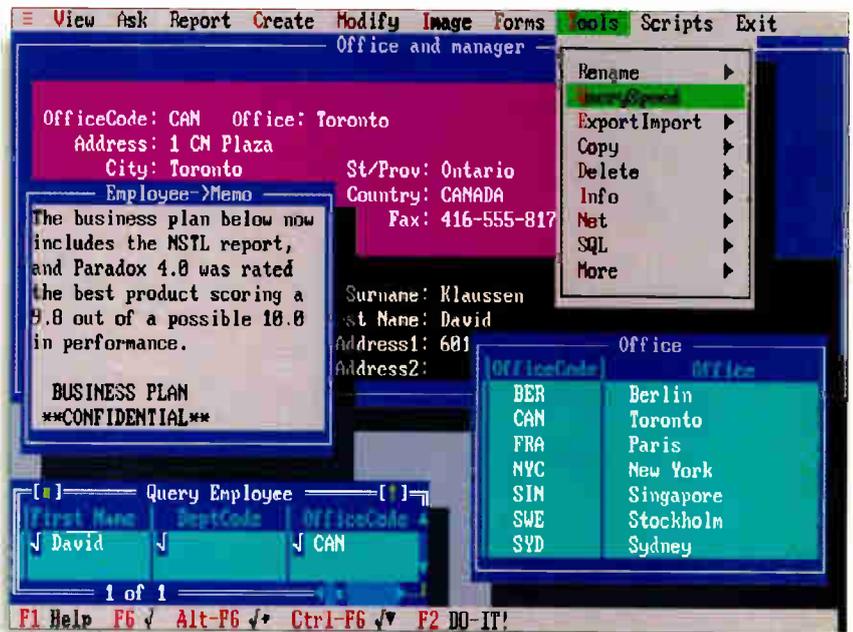
Multuser Legend:

1 station ■ 3 stations ■ 8 stations ■
To test the speed of transaction performance, NSTL designed a database for book order entry. Each record contained an author, a title, an ISBN number, a price and inventory information. The database contained 25,000 books and 5,000 authors.

PARADOX

New memo fields

Paradox 4.0 gives you the power to manipulate data you couldn't manage with ordinary databases. With new variable length memo fields, you have the ability to effortlessly manage large amounts of text information throughout your applications. And you can store anything you want in the new binary field—word processor documents, sound, bitmapped graphics, multimedia data—and then manipulate it under program control. Each can hold up to 256Mb of data per field—up to 4 gigabytes per table! There's no easier way to manage large applications.



◀ With the new Applications Workshop, you can build complete applications that include pull-down menus, mouse support, transparent multiuser edit sessions and more. Best of all, it's simple!

Efficient memory management

Paradox 4.0 gives you the best way to manage memory. VROOMM™ with Turbo Drive™ provides more available memory and more efficient memory utilization. So Paradox 4.0 runs on any 286 PC or above. In addition, Paradox 4.0 can run as a DOS application under the Microsoft® Windows operating environment, thanks to complete DPMI support.

Circle 76 on Inquiry Card (RESELLERS: 77).

DEMAND

The most award-winning database

Since its introduction, Paradox has won more awards for technical excellence and customer satisfaction than *any* other database. Awards from every major computer magazine and periodical from around the world. In addition, in the J.D. Power and Associates® survey,* Borland ranked as the #1 (tied) Application Software Publisher in Customer Satisfaction Among Business Users. All of which has made Paradox the favorite of users and developers alike.



May 28, 1991
Paradox, Version 3.5



March 1992
Paradox 3.5



PARADOX® 4.0
★ ★ ★
Rated # 1
Vol. 9, Number 2
May 1992



PARADOX® SQL LINK



Rated # 1
Vol. 8, Number 2
February 1991



May 1991
Paradox 3.5

Faster network performance

Paradox 4.0 is the fastest multiuser network PC database ever. And it's network-ready right out of the box. Multiple users can read, write and modify data simultaneously. You get all this, plus new automatic group lock security that allows multiple users to share data flexibly, providing dramatically increased performance. Just another reason Paradox 4.0 is the best investment for your business.

Transparent access to SQL data

With Paradox SQL Link (sold separately), you can seamlessly access remote SQL data. You can then work with this data using standard Paradox features such as Query By Example. Paradox does all the translation for you.

Paradox SQL Link completely shields you from the intricacies of PC and database server communications. When you specify an SQL table operation, Paradox SQL Link automatically selects the correct communications protocol, opens up

Paradox Developer's Corner

Powerful, procedural language

The Paradox Application Language (PAL™) lets you create sophisticated Paradox applications quickly. PAL procedures allow for private and global variables, array passing and variable scoping. Paradox 4.0 includes more than 90 new commands and functions.

Powerful UI controls

Easily construct your applications with a robust look and feel using the built-in UI controls: non-modal pull-down menus, dialog boxes (with push buttons, check boxes, radio buttons, pick lists, type-in lines and more), pop-up menus, mouse support and multiple overlapping windows.

Event-driven extensions

GetEvent() passes keyboard, mouse and/or system events into your procedures for dispatching. Use dynamic arrays to pass dynamically created data structures to procedures. This greatly increases the modularity and reusability of your code.

Leverage Paradox behavior

Build on Paradox's multiuser support for automatic locking, multi-table forms and referential integrity. Define special error-handling procedures to trap and process error conditions, giving you complete flexibility over users' interaction with your custom application.

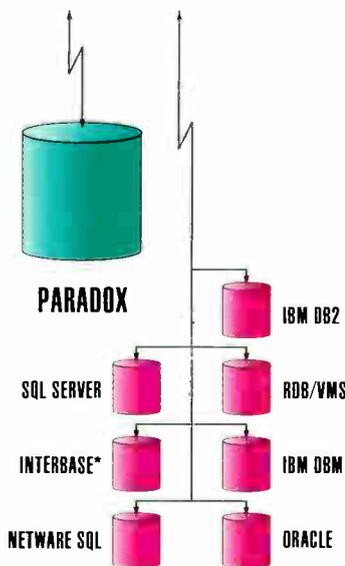
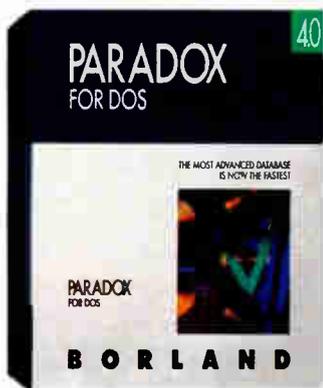


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BORLAND



*Paradox SQL Link supports more industry-standard database servers than any other PC database available. (*And the InterBase SQL connection will be available soon.)*

a communication link, relays statements to the database server and presents the results of your query.

By using Paradox SQL Link, you can now enjoy the benefits of SQL databases without the difficulty of mastering the SQL programming language. In addition, Paradox SQL Link operations follow database server security restrictions.

Borland—the database leader

Borland is the acknowledged leader in PC relational databases. More users and developers trust their data to Borland products than any other company. And an integral part of that trust is Paradox.

Paradox 4.0's power to create and manage sophisticated applications, maintain data integrity, handle large quantities of data, perform complex database operations and connect to corporate data is critical to the success of a database management system today. No other PC database meets this challenge like Paradox 4.0—the most advanced database. Best of all, with Paradox 4.0's 60-day, money-back

guarantee, you can order risk-free today. So demand the best. Demand Paradox!



To upgrade or order, see your dealer or call 1-800-331-0877, ext. 5874 today!

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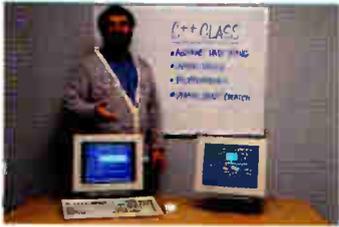
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Craig Menefee
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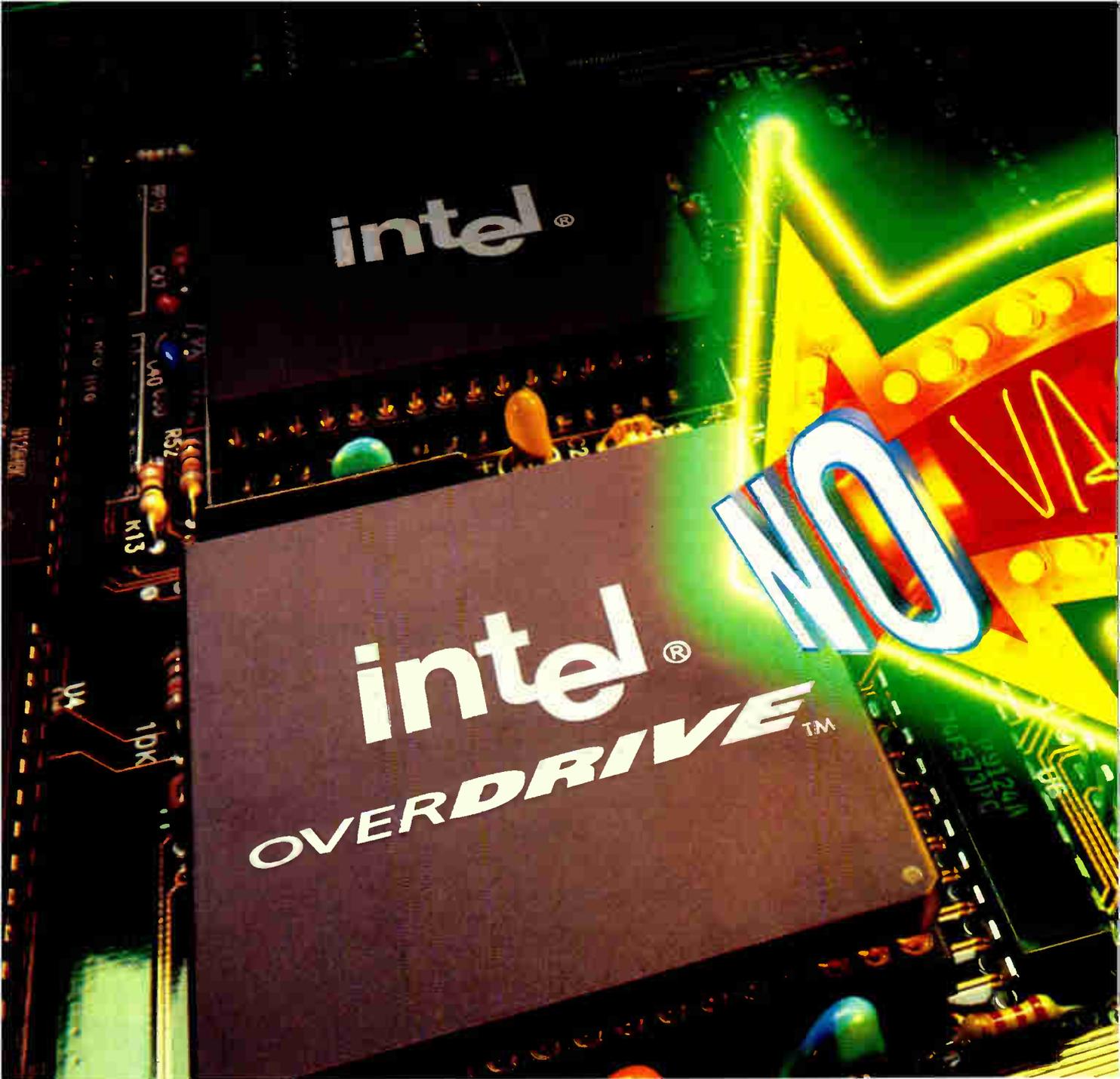
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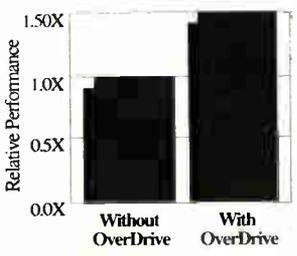
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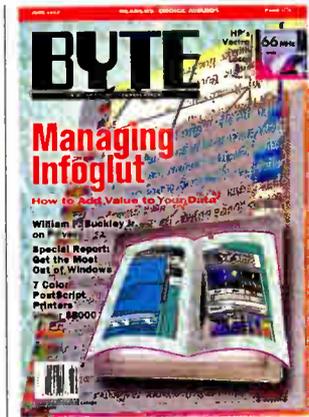
Managing Infoglut

It was with ironic amusement that I gazed at your June cover story entitled "Managing Infoglut" as I readied myself to absorb the 426-page issue.

Marc W. Booth
La Habra, CA

Bravo for Christopher Locke and the other toilers through the technological data dumps. Let's have more on how to add value.

Joseph A. Robinson
San Francisco, CA



Internet Madness

In the June Software Corner, Ben Smith writes that it's tedious to wade through Usenet's 600 news groups. In fact, it's much worse than that. The University of Oslo (Norway) receives about 1900 news groups, the Royal Institute of Technology (Sweden) receives more than 1800, and the most central machine of Usenet, uu.net, carries more than 3300. It's been a long time since there were only 600 news groups on the Usenet.

Nicolai Langfeldt
Asker, Norway

Your editorial and excellent articles on managing infoglut were right on target.

Sid Taylor
Washington, DC

Vexed Question

William F. Buckley Jr.'s "vexed question" ("Reflections on the 'Privacy' Question," June) is not so vexed when viewed not as a matter of privacy, but of the control of information. The presumption should be that the subject of the information has the right to see it and to decide who else sees it. By this principle, there is no conflict between protecting your tax records from the tabloids and having access to your own academic records (which Buckley sees as an invasion of the faculty's privacy, although justified in this case). This was, in fact, the principle applied to Buckley in the case of his medical records; Buckley had the right to deny the Physician Computer Network his records or to permit their use (as he did).

Bruce Lindsey
Austin, TX

William F. Buckley Jr. brings up an interesting problem: the trade-off between privacy and the benefits of shared knowledge. He raises the issue of what has been called *query bracketing*, in which a sufficient number of queries to different databases can lead to a conclusion that violates privacy.

An existing algorithm mitigates this problem. In "Security Without Identification: Transaction Systems to Make Big Brother Obsolete" by David Chaum (*Communications of the ACM*, October 1985), Chaum discusses the use of digital pseudonyms to make database-to-database matching very difficult. For example, if a pharmacy, a test laboratory, and a doctor all use separate digital pseudonyms for the same person, and don't reveal the pseudonyms, privacy is maintained in the face of database query bracketing.

Paul E. Baclace
Sausalito, CA

FDDI Follow-Up

Rick Cook's "FDDI Follow-Ons? Gigabit Networks Coming" (June Microbytes, page 28) neglected to mention ATM, the CCITT standard cell relay protocol for high-speed networks. ATM has recently started to emerge from the laboratory onto the market in terms of components and end products at all levels of networking. ATM may emerge as the third-generation LAN, after CSMA/CD and FDDI (Fiber Distributed Data Interface), because it has been developed specifically to meet the needs of future high-speed heterogeneous networks and will form the basis of broadband ISDN. Finally, IBM's Packetized Lightwave Architecture Network, also mentioned by Cook, can handle both variable-size packets and fixed-size ATM-style cells. Given the implications for the future, perhaps it's time for BYTE to run a series on developments in high-speed networking.

Kevin Rowland
Espoo, Finland

WEB Wonder

Regarding WEB Technologies' DataFiles/16 ("Instant Gigabytes?," June Microbytes, page 45), the company claims to compress all files in excess of 16 to 1. Clearly, however, there are files that cannot be compressed that much.

Let's look at the mathematics. Each byte in a file can have any of 256 possible values, so there are 256^n possible files of length n bytes. There are 256^{1024} , or 1.09×10^{246} , possible files of length 1024, and $2.60 \times 10^{157.82n}$ files of exactly 64 KB.

The point is that, theoretically, only a relatively small number of files can be compressed by even 2 to 1. Admittedly, most of the files wouldn't make much sense if we are talking about, say, text. However, no one could claim that there are only 1.09×10^{246} files of all sizes that make sense. Yet that is essentially what WEB Technologies is claiming.

It's possible that some compression scheme might compress an average text file by 16 to 1 or more, but it would likely require a dictionary of the more common English words. Regardless, the task obviously requires a more sophisticated program to achieve greater compression rates. So a scheme to compress even the 1.09×10^{246} files of all lengths would doubtless take more memory

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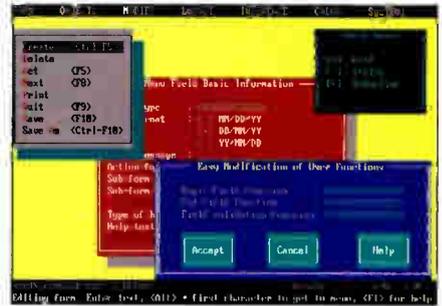
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than any computer has today.

In theory, there is no reason why you could not further compress a file that has already been compressed. However, you would eventually end up with a file that couldn't be compressed further, just based on the number of files of any given length. It may be that WEB found a scheme—like the fractal schemes for graphics—that allows a great deal of compression on certain file types. But there is no way that “virtually any amount of data can be compressed to under 1024 bytes.”

Steven V. Gunhouse
Bowling Green, OH

DataFiles/16 had not been released as this issue went to press. Company representatives still claim to be working on the product, but WEB Technologies' telephone has been disconnected.—Eds.

Expounding on SGML

The articles on SGML (Standardized Generalized Markup Language) in the Managing Infoglut State of the Art section (June) were very helpful. The HyTime standard was mentioned in passing in two of the articles, but I'd like to make the following points:

As of May 1, 1992, HyTime is an international standard (ISO/IEC 10744:1992). HyTime effectively extends SGML, creating an international standard for expressing the address of any information addressable by any means, including by means of any query in any query language or notation. It lets you express any set of relationships, including hyperlink relations, between any set of information objects addressed by any combination of means. And it lets you express the association of rendering instructions (e.g., temporal scheduling, spatial locations, and object modifiers) without arbitrary information objects.

In other words, there is now a standard for representing multimedia and hypermedia documents for certain kinds of layouts and even for project management schedules and dependencies. Now that HyTime has been finalized, these features can be exploited in the ISO Standard Music Description Language, now at the Committee Draft stage.

HyTime pioneers standardized object-oriented document representation by means of a new SGML technique, SGML Architectural Forms. These forms are templates for declaring SGML element types in actual SGML document type definitions. The potential significance of marrying SGML and object-oriented techniques and practices that HyTime represents can scarcely be overestimated.

HyTime has already been implemented in a prototype HyTime Engine developed by TechnoTeacher (Tallahassee, FL). Thus, John E. Warnock's debatable observation in “The New Age of Documents” (June) that the international standards process compromises the practicality or implementability of the standards it produces clearly does not apply to HyTime—or to SGML, for that matter.

The SGML User's Group publishes a newsletter that serves the needs of the HyTime user community. Contact SGML User's Group SIGhyper, c/o TechnoTeacher, Inc., 1810 High Rd., Tallahassee, FL 32303, (904) 422-3574, fax (904) 386-2562; Internet: SIGhyper@tecno.com.

Steven R. Newcomb
Chairman, SGML User's Group SIGhyper
Tallahassee, FL

Mathcad vs. Mathematica

I was profoundly disappointed in your May review of Mathcad 3.0 (“What You See Is What You Solve: Mathematica and Mathcad for Windows”). The review contains sweeping generalizations and opinions, without indicating any particular biases of the reviewer.

For example, the statement that “Mathematica is certainly a hard act to follow, and Mathcad doesn't even try” indicates that the reviewer does not understand the market for each product. It's a misleading statement because Mathcad is not trying to follow Mathematica. Mathcad's positioning is quite different.

Mathcad is an easy-to-use, general-purpose productivity tool for the broad range of technical professionals who make up 90 percent of the technical market. This market ranges from electrical, chemical, mechanical, and civil engineers to students from middle school through higher education. Mathematica, on the other hand, is targeted to the other 10 percent of the technical market: primarily theoretical physicists who need to perform very complex and involved equations.

The reviewer cites as a negative Mathcad's display of equations using symbols (i.e., regular math notation), thereby sacrificing portability except for display purposes. The ability to work with equations the way they appear in a book and the ability to export equations that look like real equations are among the features that have made Mathcad the industry leader. Also, the reviewer is wrong in stating that Mathcad is not portable. Version 3.1 is quite portable and completely file compatible among Windows, Unix, and (soon) Macintosh. You can easily swap files transparently between environments.

David A. Blohm
President and CEO
MathSoft, Inc.
Cambridge, MA

The intention of the review—which I thought was highly favorable vis-à-vis Mathcad—was not to make a head-to-head comparison of Mathcad and Mathematica. In fact, I stated that Mathcad and Mathematica are not really comparable. Mr. Blohm misunderstood my statement about Mathematica being a hard act to follow. These are two very different products, aimed at different types of users; the review makes that point clearly. My objective was to bring out the main features and strengths of the two products, which are often lumped together in the same category of “math software.”

It is true that Mathcad 3.1 is quite portable and completely file compatible across platforms. Editors at BYTE were briefed on the changes coming with 3.1, but the review went to press before 3.1 was available. A summary of Mathcad 3.1 subsequently appeared as a News item in June.—Nicholas Baran



The correct telephone number for MicroNet Technology, Inc. (“The BYTE Lab Tests Six Disk-Array Subsystems,” August) is (714) 837-6033; fax (714) 837-1164. ■

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Intel Reveals Tantalizing P5 Details

When Intel's P5 microprocessor is released early next year, the new chip will maintain full compatibility with the 486 and eventually deliver four to 10 times the performance, claim Intel engineers. Thanks to its superscalar architecture, parallel-integer pipelines, intelligent branch predictions, and improved floating-point math, the first version of the P5 will crunch more than 100 MIPS at its clock speed of 66 MHz. That's about twice as fast as a 66-MHz 486DX2.

These and other details of the P5 were revealed at Stanford University's Hot Chips Symposium this summer. Cautious and cagey, two Intel engineers prefaced their talks with legal statements mandated by corporate attorneys and were sometimes hissed at for dodging technical questions. But the eager audience of engineering students and observers from rival companies got a tantalizing glimpse at the inner workings of the new CPU.

While the 486 uses 1-micron technology to pack 1.2 million transistors on a chip, the P5 uses 0.8-micron technology and has 3 million transistors. Although the P5 is the successor to the 486, it won't be called the 586. Instead, Intel is running a contest for employees to suggest a new name.

At Stanford, one of Intel's presentations revealed that the P5's integer pipeline resembles that of the 486, but it is split into two parallel pipes. After prefetching and partially decoding an instruction, the P5 decides if the instruction can be executed in parallel with the next instruction that follows. If the P5 doesn't detect any dependencies, the two instructions are dispatched along parallel pipes for execution.

An instruction-issue algorithm in the P5 dispatches consecutive instructions along separate pipes only if the instructions meet the following conditions: both are considered simple instructions (mostly ALU, JUMP, and MOV operations), the first instruction is not a JUMP, and the destination of the first instruction is neither the source nor the destination of the second instruction. Intel says that more than 30 percent of all instructions meet these conditions and execute in parallel. Although that may not sound impressive, the theoretical limit is 50 percent—that is, if half of all instructions were dispatched along each of the two pipes.

Two other key parts of the integer unit are a branch target buffer and a dual-access data cache. The branch target buffer predicts the outcome of branches; if correct, the branch executes without delay. Intel says the penalty for incorrect predictions is more than offset by the hits. The dual-access cache handles both data and addresses from the twin pipes and contains logic for resolving address dependencies.

The FPU has three dedicated arithmetic units—a multiplier, a divider, and an adder—plus an eight-stage pipeline that's integrated with the integer pipeline but includes two more execution stages. Although all floating-point computations execute in a single pipe, they work concurrently with the dual-access cache. As a result, the pipeline achieves one-cycle throughput. Under certain conditions, the FPU may stall for three cycles. However, Intel says these exceptions are so rare that none occurred in the SPECmark benchmark.

Although the FPU is tuned for double-precision memory-to-register operations (the most common type expected), Intel says that single-precision and register-to-register operations are just as fast. New algorithms for transcendental computations are said to yield results that are more correct than previous Intel FPUs.

For backward compatibility, the P5 maintains the 80x86 eight-register stack and uses the top register as an accumulator. To avoid logjams, the registers are shuffled by executing the FXCH (F-exchange) instruction in parallel with other operations. This ensures that the next value to be manipulated always resides at the top of the stack.

—Tom R. Halfhill

NANOBYTES

It was a day in July of surprising announcements: Texas billionaire Ross Perot announced he would not run for the office of president of the U.S., and Ken Olsen, co-founder and president of DEC (Maynard, MA), shocked the industry by announcing he would retire effective October 1. (A week later, DEC announced it had absorbed an operating loss in its fiscal fourth quarter of about \$188 million, and it would also take for that quarter a restructuring charge of \$1.5 billion.)



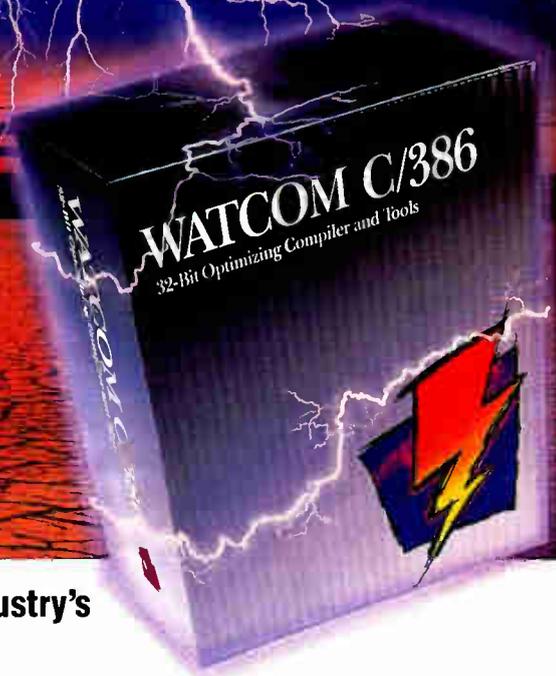
DEC's board of directors has approved **Robert Palmer** to succeed Olsen as the head of the company.

Palmer, co-founder of chip start-up Mostek and recently the head of DEC's computer chip division, will assume the title of president and CEO. Pier Carlo Falotti, president of DEC's European operations, also resigned from DEC. □

More employee layoffs and plant closings are on the way for **DEC**. Analysts estimate the company will lay off between 15,000 and 20,000 people. Nikki Richardson, manager of DEC's corporate information group, said that DEC plans to reduce its total occupied floor space by an extra 2 million sq. ft. this year, an area that is equivalent to about 35 U.S. football fields, including the end zones. □

DEC has licensed **Cambridge**, U.K.-based IXI's X.Desktop, a desktop manager for the X Window System. DEC intends to ship the package on all its workstation products, including systems running Ultrix and OSF/1. □

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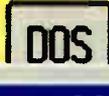
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Intel's User Upgrade: A ZIF Socket Helps

Intel wants end users to join the upgrade fun, too. Unlike Intel's DX2 processors, which are targeted at PC manufacturers, Intel is selling the newest addition to its Overdrive product line through the retail channel. The Speed Doubler 25-50, a clock-doubler chip, directly replaces 25-MHz 486SX or 486DX processors. Unlike earlier members of the Overdrive family, this chip does not require a separate vacant Overdrive socket. It is user installable and directly replaces the existing 486DX or 486SX chip. Intel will sell the new Overdrives at \$699 (50-MHz version) and \$899 (66-MHz version).

Despite Intel's claims of an easy installation process, the 50-MHz direct Overdrive processor isn't always the type of upgrade you'd want to undertake yourself. Removing the massive 486 chip, even with the special chip puller that Intel provides, is a job best left to an experienced technician, especially if your system is not built with a ZIF (zero-insertion force) socket; otherwise, you could damage your processor or motherboard.

The 486DX Overdrive won't be suitable for every PC; you should verify at your local computer store that your system has been certified. Also make sure

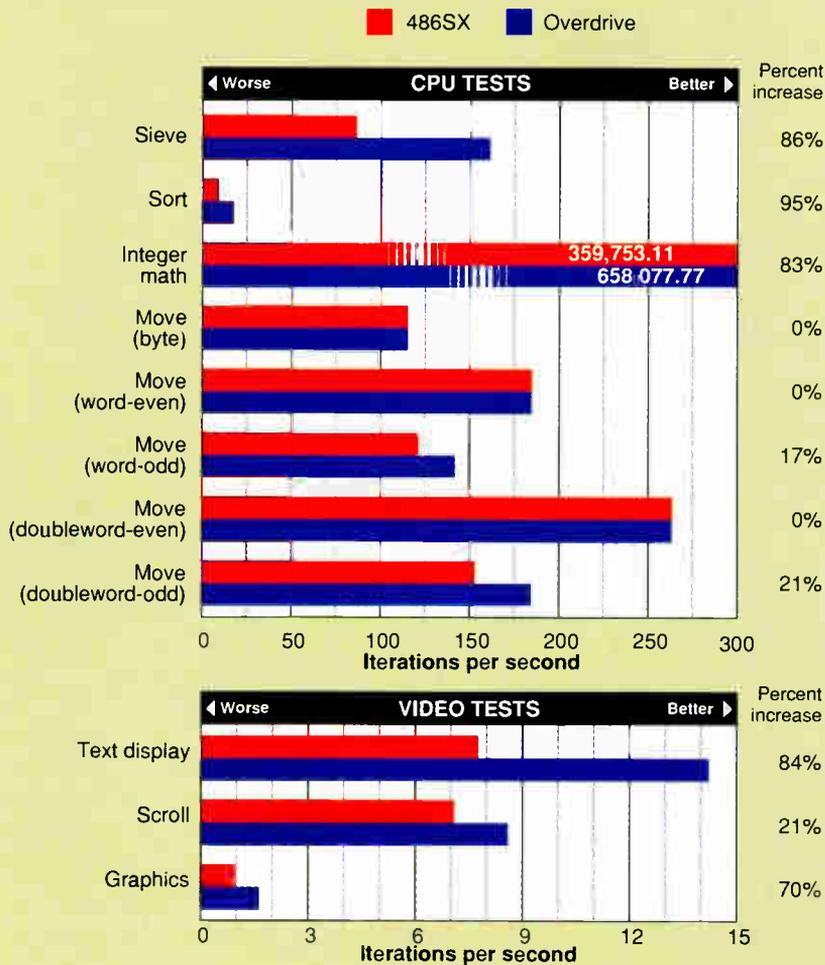
NANOBYTES

Judging by the exhibits at the August MacWorld Expo, any preaching that Apple does to users about the benefits of its QuickTime file format will be preaching to the choir. At the show, practically every demonstration of a multimedia or an animation product trumpeted the product's QuickTime compatibility. QuickTime will soon begin appearing on other platforms as well. As reported in the August Microbytes, Silicon Graphics is supporting QuickTime on the Indigo workstation. Apple also showed a Windows player for QuickTime.

In keeping with the cross-platform compatibility theme for QuickTime, Apple will work with Avid Technology (Tewksbury, MA), a leader in digital media for broadcast-level video production. Avid and Apple said that they will work to eventually converge Apple's QuickTime and Avid's Open Media Framework to provide a single media-integration standard. OMF provides a standard for moving professional-quality digital video with accompanying audio through a network in a device- and system-type-independent format. Endorsed by 30 vendors, including Silicon Graphics, Avid first announced OMF in April at the National Association of Broadcasters convention. □

Du Pont Pixel, the maker of high-end hardware and software for accelerating 3-D graphics and image-processing operations on Sun Sparcstations, announced at SIGGRAPH '92 that it has ported Silicon Graphics, Inc.'s famed Iris GL 3-D programmer's interface to SPARC systems. Developers can recompile programs written for SGI's workstations using the Sun compilers and the Du Pont Pixel library. Nth Graphics (Austin, TX) also offers a solution for porting applications to SPARC platforms. Bill Glazier, manager of graphics technology licensing at SGI, said over 20 major vendors have now licensed Open GL. □

BENCHMARKS FOR SPEED DOUBLER 25-50



The BYTE Lab benchmarked the DX Overdrive on a Dell 486D/25, which does not contain secondary cache (the Overdrive processor delivers the best results in systems with at least 64 KB of secondary cache). Higher numbers indicate better performance.



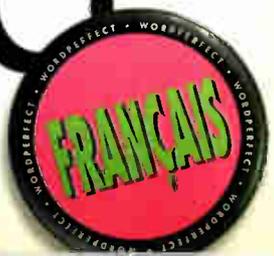
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| OB67432 | K101 | 101-key enhanced keyboard (90-day warranty) | 49.95 |

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| OB67467 | JE1030A | 200 watt 8088 | 89.95 |
| OB19545 | JE1036 | 200 watt 286/386/486 | 89.95 |
| OB19570 | JE1038A | 250 watt 286/386/486 | 99.95 |
| OB65728 | JE1039A | 300 watt 286/386/486 | 149.95 |

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- Call for information on controller cards.

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 - Requires host IDE adapter
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|----------|-------------|----------|-------|----------|
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| OB14066 | CP30084 | 80MB | 25ms | 359.95 |
| OB14074 | CP30104 | 120MB | 19ms | 429.95 |
| OB14120 | CP3204 | 200MB | 16ms | 699.95 |

Controllers

IDE Disk Drive Adapter Cards



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- Interfaces two IDE hard drives to system
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Part No.	Product No.	Description	Price
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OB10250	ADP20F	16-bit hard/floppy adapter	39.95
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- UL listed

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 - One-year warranty
- | Part No. | Product No. | Price |
|----------|-------------|---------|
| OB40774 | 356KU | \$99.95 |



Additional Internal Floppy Disk Drives

- One-year warranty
- | Part No. | Product No. | Description | Price |
|----------|-------------|------------------|---------|
| OB17099 | FD55B | 5.25" TEAC 360KB | \$89.95 |
| OB17101 | FD55G | 5.25" TEAC 1.2MB | 99.95 |

Floppy Controllers

- One-year warranty
- | Part No. | Product No. | Description | Price |
|----------|-------------|---------------------------|---------|
| OB19617 | JE1043 | 88/286/386/486 two-drive | \$49.95 |
| OB19668 | JE1049 | 88/286/386/486 four-drive | 59.95 |

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OB42251	511000P-80	18	1MB 80ns	\$5.99
OB42219	511000P-10	18	1MB 100ns	\$5.49

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OB41523	41256A9B-80	256K SIMM 80ns	\$16.95
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- One-year warranty

Part No.	Product No.	Price
OB67459	VG700	\$99.95

Additional Cards

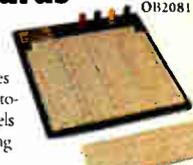
Part No.	Product No.	Function	Price
OB19596	JE1040	8088 floppy controller	\$19.95
OB19705	JE1050A	8088/286/386/486 monochrome graphics adapter	49.95
OB19781	JE1058S	8088/286/386/486 Super VGA	\$159.95
OB19801	JE1060	8088 I/O	49.95
OB19828	JE1062	8088/286/386/486 RS232 serial (16450 UART)	29.95
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OB19844	JE1065	80286/386/486 I/O	49.95
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OB19908	JE1076	80286/386/486 multi I/O w/floppy controller	69.95
OB19975	JE1080	8088 memory expansion half card	49.95
OB29313	RAMQUEST	8088/286/386/486 Orchid 32MB memory card	154.95

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OB39511	25M10F	10-foot DB25-pin male to female cable extension	9.95
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OB18420	GC25F	DB25-pin female slim line gender changer	4.49
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OB20722	JE23	6.50 x 2.125	830	0	6.95
OB20757	JE24	6.50 x 3.125	1,360	2	12.95
OB20773	JE25	6.500 x 4.25	1,660	3	17.95
OB20790	JE26	6.875 x 5.75	2,390	4	24.95
OB20811	JE27	7.250 x 5.750	3,220	4	32.95

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World Radio History

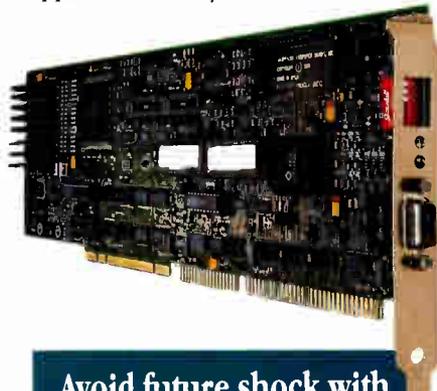


Hauppauge announces an end

Modular Local Bus PC's from Hauppauge Computer Works

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The 486M PC's bust the 8-MHz I/O bottleneck by using a local bus with a direct connection from the Intel 486 CPU chip to the graphics processor. There's also up to 1 MByte of CPU cache RAM and lots of system memory (from 4MB to 64MBytes). Features you can afford today. Features you'll appreciate in the years ahead.

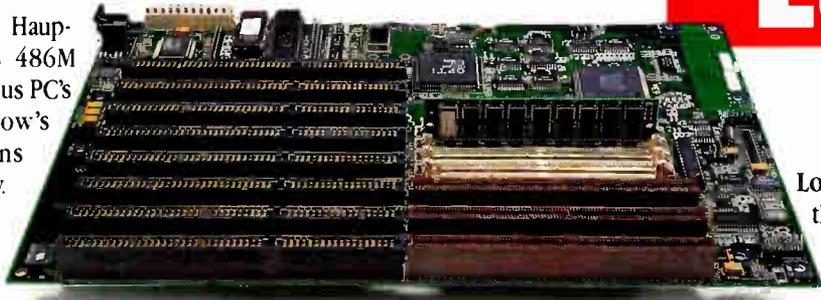


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The Modular LocalBus improves PC performance

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Module upgrade. As new generations of CPU chips come to market, CPU upgrade will not always be possible. The Hauppauge LocalBus is designed as a 64-bit bus to allow upgrades to future CPU generations with maximum performance.



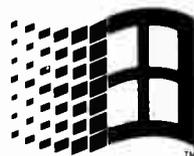
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1.2MB, 1.44MB floppy disk drives
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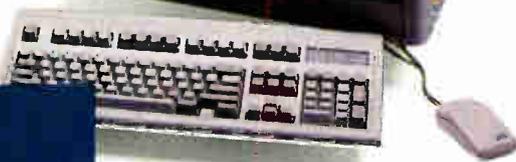


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1.2MB, 1.44MB floppy disk drives
2 serial, 1 parallel
Maxiswitch 101 keyboard, mouse



50MHz 486M PC \$2895

Full speed Intel 486DX-50 CPU
128K cache, expandable to 1MB
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Cyrix Wins Against Intel; the Mostek Ghost

A federal judge has ruled that SGS-Thomson has the right to make, use, and sell processors incorporating intellectual property of Intel, including but not limited to FasMath coprocessors that SGS-Thomson is producing for chip maker Cyrix. If the decision of U.S. District Judge Paul Brown in Sherman, Texas, is upheld, it could have implications in a similar suit between Intel and Cyrix regarding the production of Cyrix's 486-compatible processors, which SGS-Thomson is also producing.

The Intel/SGS-Thomson suit, filed in January in the federal district court, started out as a dispute between Cyrix and Intel over the alleged infringement by Cyrix's math coprocessor of an Intel patent. Although Cyrix designed the coprocessor, SGS-Thomson actually produced the chip.

Part of Cyrix's defense (Cyrix's primary defense is that its products do not infringe Intel patents) in the case against Intel was that SGS-Thomson manufactured the coprocessor under a license from Intel. When Intel disputed SGS-Thomson's rights under the license agreement, SGS-Thomson intervened in the lawsuit. SGS-Thomson contended it had the right to make the processor because it had inherited the rights to a cross-licensing agree-

ment signed in 1977 between Intel and Mostek. (In 1980, Mostek was sold to United Technologies and was later resold in 1985 to Thomson Components.)

Judge Brown ruled that because SGS-Thomson is the successor to the rights of Mostek, the manufacture and sale by SGS-Thomson of products under the 1977 agreement exhausts the patent rights of Intel. It's ironic that Mostek is brought back into semiconductor industry news via the legal path.

As in the mid-1980s, when Mostek suffered heavily due to the influx of competition from Japanese chip makers, the company again symbolizes the state of an industry. Mostek is now but a minimal part of SGS-Thomson's overall operations—even the Mostek name was removed from company letterhead a few months after its 1985 acquisition.

SGS-Thomson erased the name, but it still held Mostek's cross-licensing agreements. It now appears that Mostek's legal documents, particularly the ones it signed with Intel, were the company's most important assets for SGS-Thomson: Legal suits and countersuits in the semiconductor industry are sadly as important to a chip company's survival as they are to its ability to innovate.

—David Andrews

U.K. Study: VDUs Safe for Pregnant Women

LONDON—A study funded by the U.K.'s Health and Safety Executive into the dangers of VDUs (Video Display Units) for pregnant women concludes that women who use a VDU during pregnancy are no more likely to have a miscarriage than those that don't use one. The results, which are based on data gathered from 450 women, found no correlation between computer usage and the likelihood of a miscarriage. The report concludes, "For

many women who use VDUs in their jobs, this finding provides reassurance."

The study was conducted at the Medical Research Council's Epidemiology Monitoring unit at the London School of Hygiene and Tropical Medicine. The study, entitled "Spontaneous abortion and work with VDUs," was written by Eve Roman, Valerie Beral, Margo Pelerin, and Carol Herman.

—Andy Redfern

Codec Adds Support for QuickTime CD-ROM Feature Films

BOSTON—Apple has licensed SuperMac Technology's Compact Video codec technology to allow 2 hours worth of QuickTime movies to be stored on a CD. SuperMac said that the codec can compress QuickTime movies playing in up to a 320- by 240-pixel video window at a full-motion 30 fps. Adding the codec to the

QuickTime scheme should be rather simple once Apple chugs out the appropriate code to users: You can select the compression method that QuickTime uses from a dialog box. Apple now has a way to deliver feature-length films on CD-ROM for use on a QuickTime-equipped Mac.

—Larry Loeb

NANOBYTES

Quorum Software Systems (Menlo Park, CA) has resolved the lawsuit it filed against **Apple** on May 11. Quorum filed suit after Apple asserted that Quorum had violated Apple's intellectual property. Apple then revoked Quorum's Certified Developer status. Terms of the settlement were not disclosed, but Quorum's Apple developer status will be restored. With the lawsuit out of the way, Quorum can develop and sell its products without fear of legal action from Apple. □

Maybe one day **AT&T** will sue the world. The company has through Unix Systems Laboratories extended a lawsuit against **Berkeley Software Design, Inc.** (Falls Church, VA) to include the regents of the University of California, including Governor Pete Wilson. USL seeks to permanently enjoin the regents and BSDI from developing, promoting, reproducing, and distributing computer software products that USL says is based on, copied from, or derived from proprietary Unix operating-system software, except as authorized by agreements between the regents and USL or AT&T. AT&T claims that in contravention of these license agreements, the regents have permitted the Computer Sciences Research Group of the University of California to widely distribute to persons who are not authorized licensees of USL, computer operating-system software known as Networking release 2. Developers in the Unix community respond that they have been asking AT&T for years if the company claims any rights to the Networking release 2 software and AT&T refused to answer.

According to one developer, AT&T's claim of a conspiracy to release the AT&T software is "outrageous, considering that there were people at U Cal that were trying their damndest to avoid this type of thing." Stay tuned. □

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Product Actuals - 1989

	LPs	CDs	Tapes	Total
Units	19,499	34,678	23,597	77,774
Price	\$0.75	\$1.40	\$1.05	\$1.07
Sales	\$14,624	\$48,549	\$24,777	\$87,950
COGS	\$13,671	\$24,314	\$16,544	\$54,529
SG&A	\$1,462	\$4,855	\$2,478	\$8,795
Total Cost	\$15,134	\$29,168	\$19,022	\$63,324
Profits	(\$509)	\$19,381	\$5,755	\$24,627

Eastern Forecast - Pdt A

	1989	1990	1991	1992
% Sales	100.00%	100.00%	100.00%	100.00%
Sales	100.00%	100.00%	100.00%	100.00%
COGS	81.57%	79.63%	77.77%	77.77%
SG&A	12.00%	12.00%	12.00%	12.00%
Total Cost	93.57%	91.63%	89.77%	89.77%
Profits	6.43%	8.37%	10.23%	10.23%
Tax	2.70%	3.52%	4.30%	4.30%
Net Income	3.73%	4.86%	5.93%	5.93%

Variance Report by Product Eastern Region -- 1989

	Actual	Plan	Variance
LPs			
Units	19,499	21,344	(1,845)
Price	\$0.75	\$0.75	\$0.00
Sales	\$14,624	\$16,008	(\$1,384)
Cost of Goods Sold	\$13,671	\$13,058	\$613
Selling & Admin.	\$1,462	\$1,921	(\$459)
Total Cost	\$15,134	\$14,979	\$155
Profits	(\$509)	\$1,029	(\$1,539)

	Actual	Plan	Variance
CDs			
Units	34,678	30,200	4,478
Price	\$1.40	\$1.40	\$0.00
Sales	\$48,549	\$42,280	\$6,269
Cost of Goods Sold	\$24,314	\$18,476	\$5,838
Selling & Admin.	\$4,855	\$5,074	(\$219)
Total Cost	\$29,168	\$23,549	\$5,619
Profits	\$19,381	\$18,731	\$650

	Actual	Plan	Variance
Tapes			
Units	23,597	26,100	(2,503)

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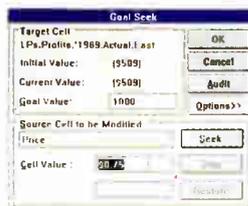


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PC Magazine, August 1992

These are the notebooks you've been waiting for — whether you need a 25MHz 386SX like our 325NXL or a 25MHz 486 like our 425CXL. As *Computer Buying World* said, "CompuAdd Express' 325NXL has most of the extras every notebook should have." So does the 425CXL. And they've got performance, too. *PC Magazine* gave the 325NXL high marks on video and graphics benchmarks and on battery life tests — "the third-highest score of the 70 systems tested."

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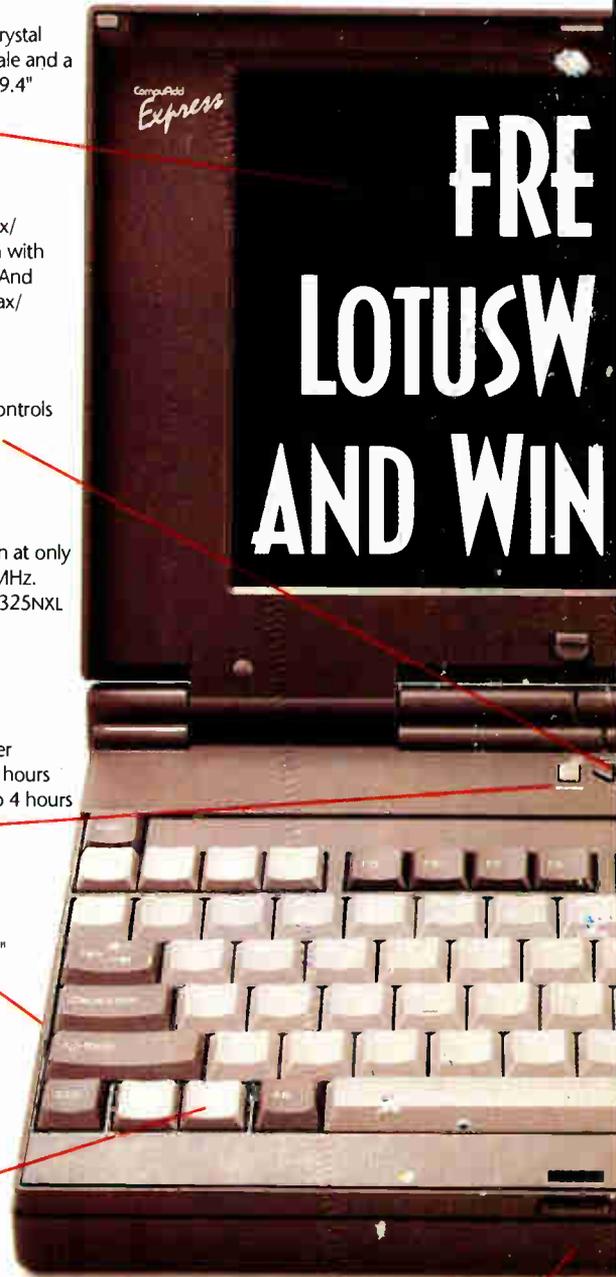
Most notebook microprocessors run at only 16MHz or 20MHz. Ours run at 25MHz. 425CXL contains Cyrix CX486SLC; 325NXL contains AMD 386SX.

Sleep button and built-in power management logic for up to 3 hours battery life on the 425CXL; 3 to 4 hours on the 325NXL.

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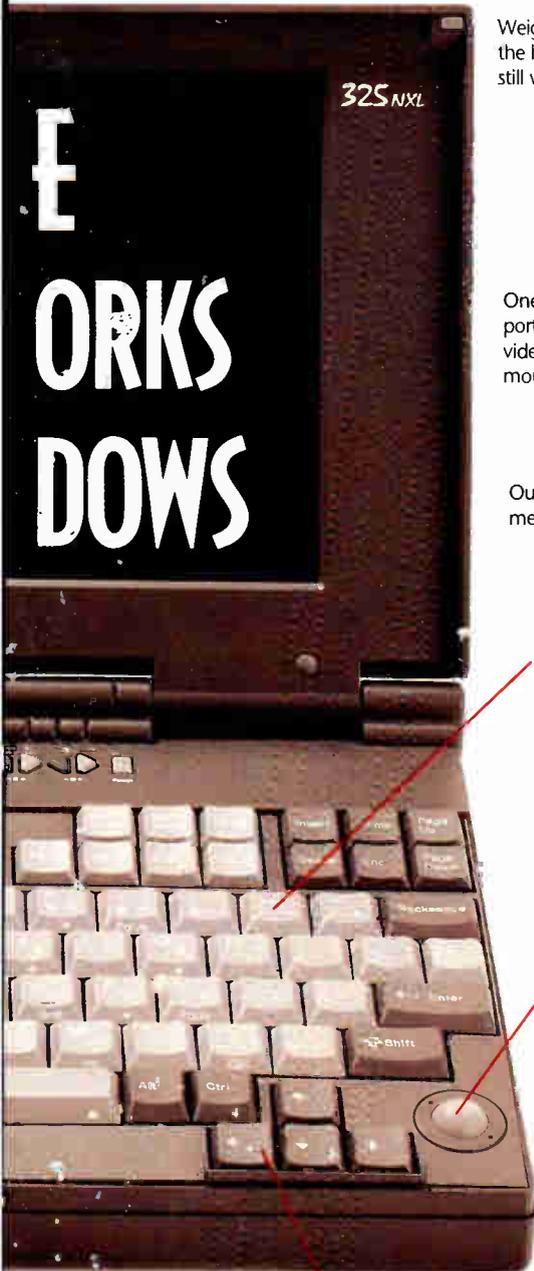
	Express 325NXL	Dell 325N	CompuDyne 386SKL/25	Gateway 325SXL	Austin 386SX/25	PC Brand 386SX/25
MSDOS/WIN	Yes	Yes	Yes	Yes	No	Yes
HD SIZE	80	60	60	80	60	60
WT w/ADAPTER	6.6 LBS	7.6LBS	7.6LBS	7.1LBS	8.7LBS	8.8LBS
RAM	4MB	4MB	2MB	2MB	1MB	2MB
FAX/MODEM	Yes	Option	Option	Option	Option	Option
GRAY SCALE	64	32	64	64	32	32
ZDIGIT RUNDN	5hr 28min	5hr 12min	3hr 26min	5hr 41min	4hr 48min	2hr 45min
BLT N TKBALL	Yes	No	Yes	No	No	No
PRICE	\$2,095	\$2,098	\$1,806	\$2,095	\$2,293	\$1,944

"The clear winner... with its terrific balance of performance and extras."
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August 1992

Based on *PC Magazine* Survey. August 1992

PRICE — REALLY TOUGH TO BEAT."

Computer Shopper, August 1992



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425CXL includes a math coprocessor; 325NXL contains socket for Cyrix FasMath™ 83587 math coprocessor

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Our FREE carrying case has a shoulder strap and pockets. Pack adapters, diskettes and other supplies.

Inverted "T" arrow keys are in the lower right hand corner, where they belong.

Express 325NXL Everybody loves our notebooks' features. *Computer Shopper* wrote that "The built-in 2,400bps fax/modem is snazzy" and called the keyboard, sliding door covering ports and general design "an admirable piece of work." *PC Magazine* wrote: "The Lexmark keyboard is comfortable to use. Large and prominent function keys are ranged along the top, and the cursor keys are in an inverted-T layout just left of the trackball." *Computer Buying World* also praised the keyboard, which it said "is remarkably well laid out."

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Express 425CXL The 425CXL has all the terrific features that made its 386 partner so popular. But it has extra speed, thanks to its Cyrix CX486SLC microprocessor.

This processor is smaller than other 486 chips, so it fits easily into a portable computer. It uses less power than other 486 chips, so you're less likely to run out of juice in the middle of a big job. Yet it has a built-in cache. And the 425CXL contains a math coprocessor, so applications that use floating point instructions are swift indeed.

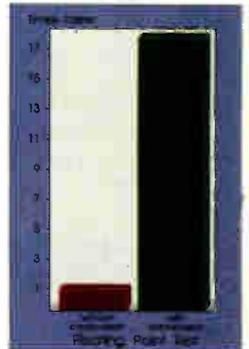
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The 425CXL has a built-in math coprocessor. You can add one to your 325NXL. So programs that use floating point instructions run 17 times faster than an equivalent system without a coprocessor. Test: PC Tech FFT.

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World Radio History

IBM May Spin Off Personal Systems Division

At press time, sources said that IBM was expected to announce the reorganization of its Personal Systems LOB (line of business) into at least one subsidiary wholly owned by Big Blue. Most likely headed by current Personal Systems LOB president James Cannavino, such a company would include desktop systems ranging from the low-end PS/1 to the high-end RISC System/6000 workstations. While the spun-off company would probably take along AIX development, sources have reported that OS/2 may stay behind—perhaps in a subsidiary all its own.

Rumors of the decision circulated for months amid news of IBM competitors' price reductions and product introductions. While IBM sources revealed only that IBM has been considering many options to make the Personal Systems LOB more efficient, other sources close to IBM confirmed that the spin-off had been delayed since mid-summer.

One reason why IBM may spin off OS/2 in a different direction, said sources, is that many IBM executives believe the option to preinstall Microsoft Windows on selected PS/2 models may boost sales in certain channels. At press time, while OS/2 was preinstalled only on PS/2 Models 57SLC and 56SLC, loyalty toward the operating system has understandably kept IBM from preinstalling Windows on PS/2s. "The OS/2-Windows connection has been muddying the waters for too

long," said one contact.

Analysts note that recent IBM PC price reductions were made only after several other major PC vendors had announced price cuts. And the new line of low-end PCs IBM was expected to announce in September is months behind similar product offerings by Dell, Tandy, Compaq, and several other vendors.

It is exactly this kind of sluggish response to rapidly changing market conditions that IBM executives are seeking to eliminate. What remains to be seen is how much more lithe and efficient the Personal Systems division would be if it were to gain more autonomy, either as a wholly owned subsidiary or as an independent company such as Lexmark. Despite IBM chairman John Akers' best efforts to decentralize operations, the many levels of IBM management continue to prevent the Personal Systems business from reacting quickly to its competition.

Whichever option it chooses, IBM hopes the result will be a company that can swim faster in this fluid market than Cannavino's LOB so far has shown. "A \$9 billion company is still going to have a tougher time bringing out a product than a \$750 million company," said Cliff Friedman, an analyst for the New York firm Bear Stearns. "But [the Personal Systems spin-off] will help. If structured properly, it will make them a more competitive company."

—Ed Perratore

European Portable Workstation Project Launched

LONDON—The ESPRIT (European Strategic Programme for Research in Information Technology) has appointed Cambridge-based computer manufacturer Acorn to head its latest project. The POWER (Portable Workstation for Education in Europe) project is set to run for three years and is charged with building a portable computer with speech input and wireless networking specially suited for education and training needs. The machine will be based around Advanced RISC Machines' RAM processor—the device at the heart of Apple's Newton.

Although details of the final machine's specification are sketchy, the CPU will obviously be an ARM processor. Other ARM chips are likely to be developed especially for system power saving. OPSIS, a French optoelectronic component de-

signer, has a small, low-power LCD that it probably can scale up for use as the system screen. Pluricom, a Portuguese wireless networking specialist, will provide the networking facilities, especially in the area of wireless communications.

The Belgium-based speech-recognition and compression company Lernout & Hauspie probably will contribute voice input, control, and memo-taking facilities. Although Acorn has its own operating system for the ARM processor called RISC-OS, the inclusion of Italian firm Etnoteam in the project points to a joint development of system software. Portugal's University of Aveiro is also a partner. Although ARM has yet to set a detailed timetable, the project will unlikely create any tangible results in the first 18 months. ■

—Andy Redfern

NANOBYTES

Financial management software can be useful in helping you organize your personal business affairs, but the problem is that you often have to spend time at the keyboard performing the tedious task of entering data from credit-card statements every month. To help solve that problem, **Intuit** (Menlo Park, CA, (415) 322-0573) is working on a program that is designed to slash data-entry time by means of a new Intelli-Charge Credit Card tracking feature. The new tracking feature automatically enters credit-card charges via floppy disk or downloaded by modem into the Quick-**en** register. The first credit card that will support the new service is Visa. □

The latest word from **Next Computer** is that it plans to release **NextStep 486**, the port of the workstation company's system software to the Intel platform, late in the fourth quarter of this year and possibly in early 1993. A spokesperson for Next Computer said that the company should begin beta testing of NextStep 486 sometime in October or November. □

At press time, **IBM** was putting the finishing touches on its big push into the commercial Unix arena, an expansion of the RISC System/6000 workstations' original marketing thrust toward the scientific and research community. In addition to announcing new high-end models in its workstation and server line, IBM was expected to announce at the September Unix Expo in New York new on-line transaction-processing software designed for commercial AIX applications, such as banking, ATMs (automatic teller machines), and reservations. This new Unix software fulfills IBM's January 1991 announcement that it will support the Open Software Foundation's DCE (Distributed Computing Environment). ■

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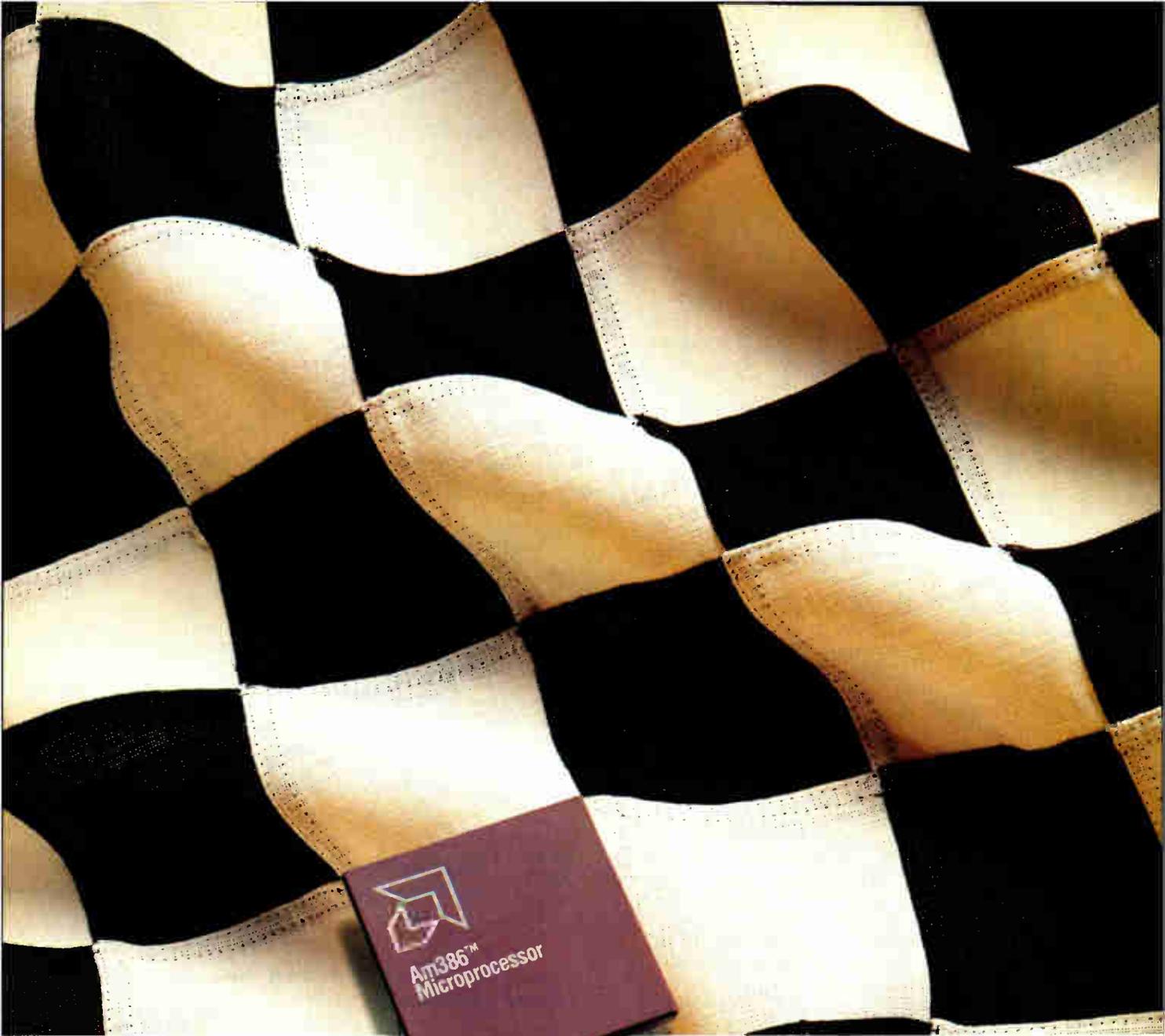
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IN THE LAND OF THE DOUBLE BYTE

TOKYO—No matter where you happen to be in the world, political reporters all look the same. Not long ago, for example, Japan's Prime Minister Miyazawa was giving a speech in a building down the street from my office on Tokyo's Nami-ki Avenue. When the PM's press corps came bounding out of vans to follow their man, it occurred to me that they were look-alikes of the American "boys on the bus" who followed George Bush and Bill Clinton last fall. They had the same blue blazers and wrinkled khakis, the same nondescript ties worn loosened at the neck, and the same look of wry cynicism as they whipped out their miniature tape recorders to record the familiar phrases one more time.

Still, there was something missing from this picture, and it took me a while to put my finger on it. The computers! Unlike their counterparts in the U.S., Europe, and elsewhere, not a single one of the Japanese reporters was equipped with a personal computer to file a story. I later asked my friend Koizumi-san, a technology correspondent for Japan's biggest daily newspaper, why he and his colleagues didn't use laptop computers. "Computers—they're much too slow," he said. "It takes so long to enter a sentence! It's just faster to write your story out in longhand and call it in to the paper by dictation."

Of course, no speaker of English or any other Western language could say that. Any halfway-decent two-finger typist can produce text faster on a keyboard than by writing in longhand, and sending text via modem from a computer is infinitely faster than dictating. But Japan's written language is so unbelievably complex that, even today, the basic chore of entering text into a machine remains a relatively cumbersome job. A great deal of ingenuity has been devoted to making this task easier, and Japanese computer companies have done some remarkable things in this area. But the very nature of the language still poses a formidable barrier to writing.

Once you understand the difficulty of dealing with written Japanese, you can begin to understand some of the basic differences in computing on the two sides of the Pacific. It is largely the language difference that explains why Japan has been so far ahead of the U.S. in the quality of its graphical displays (and thus in video-game technology). It is also largely the language difference that explains why the Japanese, for all their technological smarts, have yet to make a dent in the software industry. And the language difference is the main reason that so many successful American software houses have de-

clined—despite the urging of no less a crusader than Microsoft CEO Bill Gates—to move into the fast-growing Japanese market.

Japan's written language is a testament to the cultural adaptability of the nation, with elements from the Roman, Arabic, Chinese, and indigenous Japanese alphabets all freely mixed in together. The result is a writing system that employs not just 26 letters, or 260, or even 2600, but rather 6000 or more separate symbols.

In addition to the 26 Roman letters, the Japanese have two different alphabets of their own, each with 47 kana, or letters. On top of that, Japanese writing employs the same ideographic characters used in China; basic literacy requires about 2000 of these kanji characters, and better-educated folks employ 6000 of them or so.

Since each of the kanji is an individual word with its own meaning and pronunciation, the only way to learn to read Japanese is to memorize these characters, one by one. The education authorities have developed a highly systematic methodology to ensure that every student masters all 1941 "daily-use kanji" by the end of high school.

Teaching computers how to handle such a complex system has proved even tougher. On the display side, for example, standard Western methods of character display are simply inadequate for the task. In the West, the ASCII standard permits up to 256 distinct symbols in a single 8-bit byte; that's more than enough to support 26 lowercase letters, 26 uppercase letters, and a full complement of punctuation and diacritical marks. But it's not nearly enough for Japanese writing.

Initially, Japanese computers used the ASCII character set, forcing the Japanese to do all their computing in English. That is one of the reasons why personal

The Japanese are overcoming the kanji hurdle. So why aren't American software vendors jumping in?



computers were slower to develop in Japan than elsewhere. Eventually, the Japanese developed their own coding system that employs two 8-bit bytes: this "double-byte code," or DBC, permits up to 65,000 individual symbols, each encoded using Japan's version of ASCII, the JIS (Japanese Industrial Standard) code.

Since kanji tend to be more complex graphically than Roman letters—a single character can have as many as 25 different strokes—they are harder to replicate with pixels on a screen. It was this need that prompted Japan's computer makers to develop sharper display standards than the ones used by American firms early in the computer revolution, and the Japanese have stayed ahead ever since. The enhanced display power of Japanese equipment also made it possible for Japanese video and computer-game companies to develop much more elaborate graphics than their American counterparts.

But it's one thing to handle kanji in memory or on a display screen; it's something else entirely to design a keyboard that can be used to input literally thousands of distinct characters. Some early Japanese computers did have kanji keyboards—great banked contraptions with row upon row of input keys—that looked something like a Wurlitzer organ on steroids. These devices proved cumbersome to build and all but impossible to use. Clearly a different approach was required.

The big Japanese computer firms responded with a rather elegant solution: automatic kanji conversion. Today, Japanese computers all use a fairly standard QWERTY keyboard, sometimes with just one more row of keys than a Western computer keyboard has. On this keyboard, the writer types a Japanese word phonetically, using either Roman letters or the Japanese phonetic symbols, the kana. The computer then displays on the screen each of the kanji or kanji combinations representing the sound that was typed. The writer picks the kanji character he or she had in mind, and that character is included in the text.

For example, say that you type the word *kanji*. This word has at least six different meanings in Japanese. In addition to "Chinese character," *kanji* can also mean "feeling," "secretary," "supervisor," a particular kind of smile, or an ancient historical era. Each meaning is represented by a distinct combination of kanji characters.

When you push the keyboard's Convert key, the computer automatically displays on the screen each of the six words that are pronounced "kahn-jee." You then enter a number to choose the one you want, and that word is added to your sentence. Since kanji conversion is a two-step pro-

cess, it is obviously slower than straight typing. That's why reporters like my friend Koizumi-san find computers too slow for writing their stories, at least on deadline.

Because Japan's language is full of homonyms, kanji conversion is a rigorous software challenge. I recently saw a demonstration of the VP-2100, Fujitsu's mighty supercomputer, which had been programmed to translate from Japanese to English. Just to be nasty, somebody asked

Today, conversion programs are strong at judging from context which kanji you have in mind.

it to translate the sentence "Kisha no kisha wa kisha de kisha shita." Each *kisha* in that sentence is a different word. It actually took the computer longer to decide which kanji combinations to use for each *kisha* than it took to produce the English translation: "The reporter from your company returned to the office on the train."

But Japanese electronics companies have made enormous strides in making their kanji-conversion software faster and smarter. The showplace for this conversion software is a Japanese breed of machine known as a Wah-Puro. (The name is an abbreviation of the phrase "wah-doe purosessah," the Japanese pronunciation of "word processor.") A Wah-Puro is a cross between a typewriter and a laptop computer, with surprisingly high-powered printing and formatting capabilities built in. About a dozen makers produce scores of different Wah-Puro models, and one of the chief areas of competition is the speed and sophistication of the automatic kanji conversion.

Today, automatic conversion programs are surprisingly strong at judging from context which kanji you are likely to have in mind when you type in a particular phonetic combination. My 4-pound, \$450 Sharp Wah-Puro guesses correctly about 80 percent of the time. I can now type a complete sentence in phonetic Japanese using the standard QWERTY keyboard of my Wah-Puro, press the Conversion key,

and watch this ingenious machine reproduce my sentence in kanji and kana.

In fact, automatic conversion programs, both on Wah-Puro and personal computers, are so powerful now that there's a backlash against them in the Japanese education establishment. The argument is familiar to anybody who's seen American teachers railing against the use of calculators in math class. Just like the American kids who don't bother learning the multiplication table because they can always get the answer from a calculator, there are evidently some Japanese kids who don't bother learning their kanji. Hey, if all I have to do is type in the word in Roman letters and my Wah-Puro will find the right kanji for me, why should I spend all those hours learning how to write these complicated 25-stroke characters?

Despite the achievements of the Japanese Wah-Puro and personal computer makers in dealing with the inherent problems of their labyrinthine language, the kanji factor stands as a significant subconscious barrier that has kept many successful American software houses out of the lucrative Japanese market, the second-biggest PC market in the world.

There's no question that American software can compete in Japan. Virtually every Japanese PC is built around a microprocessor from the Intel 80x86 family. MS-DOS (most commonly in a Japanese version called DOS-V) is the most common operating system. As of this writing, the best-selling application program in Japan is Lotus 1-2-3; the fastest-growing software is Microsoft Windows, and its popularity obviously opens the door for many more U.S. software programs.

But countless American software firms have stayed away. This is a matter of considerable frustration for the most important figure in software, Microsoft's Gates. "I'm crusading to get people into the Japanese market," he said on a trip to Tokyo a few years back. "I have talked to hundreds of software companies about this. These are guys who are writing some very sophisticated code, but they say, 'I don't know how to write in double-byte, so I can't deal with kanji.' And I say to them, 'Look, there are standard algorithms for this. There are established methods for writing to double-byte. Kanji make things more complicated, but you can make computers handle those complications. Look, the Japanese do it every day.'" ■

T. R. Reid is Tokyo bureau chief for the Washington Post and author of a syndicated personal computer column. You can reach him on BIX c/o "editors" or on CompuServe at 76703,726.

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▲ File servers supported	8	8	1
▲ Print queues supported	32	32	8
▲ Ports	1	4	2
▲ Encrypted password support	yes	yes	no
▲ On-the-fly configuration and status reporting	yes	yes	no
▲ Suggested retail price	\$595**	\$695***	\$695

(*Time to transfer a one-page graphics file from the print queue to an HP LaserJet III printer; **Ethernet version; ***Ethernet 3+1 version)

encrypted password support, automatic and forced ECONFIG, preferred server designation, SPX protocol for on-the-fly status reporting, as well as automatic reconnect after the file server is down.

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386SL/25	Intel 80386SL-25 MHz, 64 K CPU cache Advanced SL power management, Optional 80387SX co-processor	as above	80	3+	\$1,899 \$70/mo*
486SX/25	Intel 80486SX-25 MHz, Built-in 8K CPU cache	4 standard, 8 & 20 options	80	2.5+	\$2,199 \$81/mo*
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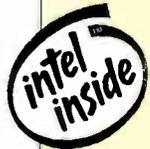
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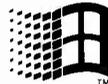
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386DX/33	Intel 80386DX-33 MHz	2 standard 32 max	80	as above	as above	\$999 \$37/mo*
486SX/25	Intel 80486SX-25 MHz Built-in 8K CPU cache	as above	105	1.2 & 1.44	16 bit SVGA card, 14" 1024 x 768 SVGA Color Monitor	\$1,299 \$48/mo*
386DX/33 CACHE	Intel 80386DX-33 MHz 64K CPU cache	4 standard 32 max	105	as above	16 bit SVGA card, w/ 1MB video RAM & Hi-Color Support, 14" 1024 x 768 SVGA Non-Interlaced Multisync, Color Monitor	\$1,499 \$56/mo*
486DX/33 CACHE	Intel 80486DX-33 MHz 128K CPU cache	4 standard 64 max	130	as above	as above	\$1,799 \$67/mo*
486DX/50 CACHE	Intel 80486DX-50 MHz, 128K CPU cache New Double Clock CPU	as above	130	as above	as above	\$1,999 \$74/mo*
486DX/50 CACHE	Intel 80486DX-50 MHz 128K CPU cache, True 50 MHz CPU	8 standard 64 max	210	as above	as above	\$2,499 \$89/mo*
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World Radio History

Apple's Performas: Macs for the Home

TOM THOMPSON AND TOM R. HALFILL

Apple changes its marketing strategy to reach first-time buyers via mass marketing

notebook line (see the text box "The PowerBook 145" on page 53).

Mass-market channels are so important to Apple's strategy because the Performas are targeted at a challenging subset of the consumer market: first-time buyers. Out of 95 million U.S. households, Apple has identified 7 million that can afford a Performa but have never owned a home computer. Apple's ambitious goal is to con-

In 1985, Apple chairman and CEO John Sculley declared that Apple sold "computers for use in the home, not home computers." That ambiguous position has now changed—sort of. Apple is selling its new Macintosh Performa line of home computers through mass-market channels nationwide. In other news, Apple ratcheted up the processing power in its midrange

vince those holdouts that the time is ripe to not only buy a computer, but to buy a Mac.

Of course, the question of what exactly is a home computer has bedeviled manufacturers for years. Apple's answer is that a home computer is a fully functional Mac that's slightly repackaged and sold just about anywhere but a computer store. According to Apple's market research, novices are afraid of computer stores. Thus, the Performas are appearing at 1600 mass-market outlets, such as Sears, Silo, Office Depot, and Office Max. For now, though, Apple won't sell the systems at discount stores or warehouse clubs.

The Mac Performa line comprises three machines: the low-end Performa 200, the midrange Performa 400, and the high-end Performa 600. Two of these systems aren't new: The Performa 200 and 400 are actually the Mac Classic II and LC II, respectively. Except for new names, the only differences between the computers are minor revisions to System 7.0 and some bundled software.

The top-end Performa 600, which at press time was scheduled to ship in late October, is the only genuinely new model in the lineup. It has the same dimensions as a Mac IIci, but with important differences. It's also priced at about \$2500, which is much higher than the \$1000 barrier sometimes regarded as the upper limit for a true mass-market consumer product.

The Performa 600

Because the Performa 200 and 400 are hardware-identical to the popular Classic II and LC II, we'll focus on the Performa 600 and contrast it to the Mac IIci where applicable. The Performa's 68030 processor is clocked at 31.33 MHz (versus the IIci's 25 MHz) on a 32-bit bus. While the 68882 FPU is standard equipment on the Mac IIci, there's only a socket for it on the Performa 600. The Performa 600 will come with 4 MB of RAM soldered to the main logic board, and it's expandable to 68 MB using 16-MB SIMMs in four sockets.

It has the usual three NuBus slots (not a NuBus 90 implementation, as in the Mac Quadras) and an *accelerator slot*, which is different from the IIci's cache slot. Also present is a 160-MB hard drive, 8-bit sound I/O with a microphone, and the usual complement of external SCSI, LocalTalk, serial, and ADB (Apple Desktop Bus) ports.

Typical of a computer targeted for the home, the Performa 600 doesn't have a



The Mac Performa 600 is the only genuinely new model in the Performa line.

built-in Ethernet port. There's a big 5¼-inch half-height bay at the front of the computer, where you can add an optional CD-ROM drive or an extra high-capacity hard drive. Like the IICI, the Performa has built-in video, but it's improved in two ways.

First, the Performa's video frame buffer lives in 512 KB of VRAM (video RAM), while the IICI's buffer resides in a bank of main memory. The Performa's VRAM eliminates the bus-contention performance hit that occurs on the IICI when the processor and video circuitry vie for the same chunk of memory. Second, the Performa's VRAM is expandable to 1 MB (by swapping the two 256-KB SIMMs for 512-KB SIMMs). This provides 16-bit-deep images (displaying 32,768 colors) on 640-by-480-pixel resolution monitors, versus only the 8-bit-deep image (256 colors) available on the IICI's video.

The Performa 600 comes in two configurations. The base model has 4 MB of RAM and 512 KB of VRAM. The "multimedia" version has 5 MB of RAM and 1 MB of VRAM. It fills the 5¼-inch bay with Apple's new CD-300i CD-ROM drive. Apple's CD-300i doubles the rpm when reading data to achieve a high transfer rate of 300 KBps, but slows down to normal speeds when playing audio discs. The CD-300i can also read multisession Kodak Photo CDs, and Apple provides software to view these images. The 16-bit color depth enables the display to accurately reproduce the Photo CD images.

Since the advent of the Mac LC and IISI, sound input has become the standard for all Macs, and the Performas are no exception. Disappointingly, the Performa 600 uses an upgraded version of the Mac LC's sound ASIC (application-specific IC) for recording and generation, rather than the more full-featured Enhanced Apple Digital Sound Chip found in the Mac Quadras and PowerBooks. Thus, the Performa 600 has no stereo output, except for an audio pass-through to the sound jack for the CD-ROM drive. The computer's 8-bit monaural audio can, however, be mixed during output with the stereo audio CD sound.

The Performa 600's accelerator slot is nearly identical to the Mac IICI's cache slot, but it lacks the cache control lines. Therefore, the Performa requires intelligent cards that have their own microprocessor, controller, and memory. Apple believes that most 68040 accelerator cards for the Mac IICI should work with little or

The PowerBook 145

When Apple introduced the PowerBook line, it provided three systems to match users' varying needs. At the low end is the PowerBook 100, with a 16-MHz 68000 processor and a supertwist LCD screen. The PowerBook 140 occupies the midrange with a 16-MHz 68030 processor and a supertwist LCD screen. Covering the high end is the PowerBook 170, with a 25-MHz 68030 processor, a 68882 FPU, and a razor-sharp active-matrix screen.

Sales were split almost evenly among the three computers, with two-thirds of the buyers opting for the more powerful 68030-based notebooks. Mac users obviously demand desktop performance out of their PowerBooks.

To accommodate this demand, Apple is beefing up its midrange computer line by introducing the PowerBook 145. Essentially, it has the heart of the PowerBook 170 (a 25-MHz 68030) but the face of a PowerBook 140 (a supertwist LCD screen). Apple decided not to pump up the price along with the power: A system with 4 MB of RAM and a 40-MB hard drive costs \$2399. By contrast, a similarly equipped PowerBook 140 costs \$2999, while a PowerBook 170 with the same RAM and storage costs \$4299. The PowerBook 145 thus moves the midrange notebook line to 25-MHz performance levels while reducing the price. Not surprisingly, with the PowerBook 145's winning price/performance combination, Apple has retired the PowerBook 140.

no modification in the Performa 600.

Performa buyers will be offered two new 14-inch monitors instead of Apple's current 12-inch RGB color monitor, a 512-by-384-pixel oddball that causes problems for some color applications that expect a 640-by-480-pixel screen. One of the new monitors, known simply as the Performa Display, is a low-end replacement for the 12-inch monitor; it supports 256 colors at 640 by 480 pixels with a 0.39-mm dot pitch. The higher-end Performa Plus Display supports 32,000 colors at 640 by 480 pixels with a 0.29-mm dot pitch. It also emits less ELF/VLF radiation, conforming to the SWEDAC MPR-2 standard.

With the Performa line, Apple is departing from its practice of announcing suggested retail prices. The street prices will probably range from about \$1250 for the Performa 200 to \$2500 for the CD-equipped Performa 600. The 14-inch monitors will probably cost \$350 to \$450.

Get the Works

A key element in Apple's bid to attract novice buyers is bundled software. All Performas come with a special version of System 7.0 and some application programs preinstalled on the hard disk. The idea is to

provide a complete plug-and-play package while minimizing the number of decisions that buyers must make at the critical moment of purchase.

The Performa-specific system software offers a friendlier substitute for the Finder and a simplified application launcher. Performa users see a new Desktop with colored patterns when they boot up the computer. The Finder is actually hidden behind this customizable backdrop. A new window labeled "Application Launcher" contains several buttons resembling icons. These buttons launch applications with a single click.

One of the buttons, Apple Backup, is a utility for backing up the hard disk onto floppy disks. Another button launches At Ease, a new security program intended to make it safer to share the computer with other users, especially children. (See the text box "Child-Proofing Your Mac" on page 54.) For more advanced file management, the regular Finder is still accessible from a menu.

The bundled applications vary according to deals between Apple and the chain stores. Apple says this lets retailers customize their bundles. Some chains may bundle programs not found on Performas

Child-Proofing Your Mac

One way to justify the high price of a home computer is to share it among the family. Unfortunately, this reasoning breaks down when your children are at that age where dragging documents into the Trashcan and emptying it just to see the sides of the Trashcan icon bulge and straighten fascinates them. You'll be fascinated, too, when you discover what happened to several hours of work you left on the Mac.

To solve this problem—and consequently get a Mac Performa under your roof—Apple software engineers crafted a new interface shell called At Ease, which requires System 7.0. Whereas the Finder (itself an interface shell) allows you unrestricted access to most of the Mac, At Ease's goal is to limit access to critical files while not hampering ease of use. At Ease does this by consolidating selected applications into an Applications "folder" and a Documents "folder." Those files not selected when you configure At Ease simply don't appear.

Buttons represent applications or doc-



At Ease restricts access to the computer while providing a friendly interface. Note the lack of the Mac Desktop and Trashcan icons.

uments, and a single mouse-click launches the application or opens the document (see the screen). If you have more than one screen's worth of applications or documents, a dog-ear with an arrow appears on the corner to let you click on and switch to the next screen of icons. When you save a file, it appears as a new button in the Documents folder. The software has a setting that forces you to save your file to a floppy

disk, useful when you don't want numerous users swamping the Mac's hard disk with files, such as in a classroom.

At Ease lets you run several applications at once, and you can easily switch between them. However, no amount of clicking gets you to the traditional Mac Desktop to view the hard disk and tamper with its files. Nor is there a Trashcan icon present, so you have no ready way to delete files. The Control Panels folder doesn't appear in the Apple menu, so you can't alter important system settings, either. The File menu has a selection that lets you switch into the Finder, but you can block this access to others with a password.

At Ease is composed of the shell application and a Control Panel, which you use to configure how At Ease operates. You can set whether At Ease or the Finder launches when the computer starts up, designate what applications appear in the Applications folder, set the Finder access password, select the floppy disk for storage, and designate which new documents appear as buttons in the Documents folder.

sold at competing stores, and this will influence street prices. However, all Performas are expected to have a Works-style package that includes a word processor, a spreadsheet, a telecommunications program, a paint program, and a flat-file database. The CD-ROM version of the Performa 600 will come bundled with several CD titles.

Apple on a Limb

Apple's newfound determination to sell Macs to the masses is a long-overdue strategy. We're thankful that Apple made no attempt to cripple the Performas, as IBM did in 1983 with the PCjr. But it's surprising that Apple made so little effort to differentiate the Performas from regular

Macs, to the point of merely renaming two of the three computers in the lineup. And the prices, by consumer standards, are stratospheric.

Apple hopes that software like At Ease will help justify the cost by promoting the sharing of the computer in the household. Can Apple succeed where others have either failed or feared to tread? ■

Tom Thompson is a BYTE senior technical editor at large and an expert on the Macintosh. You can contact him on BIX as "tom_thompson" or on AppleLink as "T.THOMPSON." Tom R. Halfhill is BYTE's senior news editor in San Francisco. You can contact him on BIX as "halfhill."

THE FACTS

Mac Performa 200, 400, 600

(no suggested retail prices)

Mac PowerBook 145

with 4 MB of RAM and a 40-MB hard drive, \$2399;
with 4 MB of RAM and an 80-MB hard drive, \$2799

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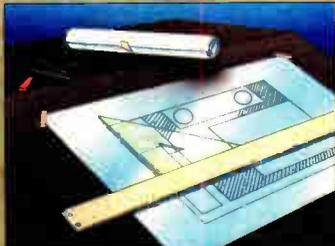
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An Almost-Perfect Printer/Plotter

My first thought as I took the ProTracer out of its shipping carton was, "Here is something of quality." The packaging was detailed with paper tabs protecting hard-to-see points of contact on the case. Strips of tape, each tabbed on one end for easy removal, held everything in place inside a hermetically sealed, water-proof plastic bag, probably good to 50 fathoms.

I was not surprised, therefore, to find an impeccably designed printer. The ProTracer is flawlessly executed, with every line meeting exactly where it should with uncommon elegance and precision. Without a blemish inside or out, the ProTracer's appearance alone indicates that this is a product that is well worth its price.

The ProTracer printer/plotter is based on a Canon ink-jet engine and prints on any stock up to 17 inches wide. It has a versatile paper path, accepting manually fed single sheets from the front and continuous perforated stock from the back. For even greater flexibility, you can install optional automatic sheet-cut feeders for 8½ by 11-inch (A size) through 17- by 22-inch (C size) stock.

The printer includes emulation modes for the Epson LQ-1050 and IBM Proprinter XL24E. Optional plug-in cards—each about the size of a credit card—allow HP 7585 HPGL (Hewlett-Packard Graphics Language) and PostScript emulation. Although these options are modestly priced, both of them require that you install additional (optional) memory as well.

Interfacing the ProTracer is easy. You can use a standard Centronics-type parallel port, a serial port, or both. Using both lets two computers share the printer without the hassle of a switch box. It's a neat, useful concept, especially in small, congested offices. In single computer installations, you can use the parallel port for normal printing. You then set your CAD system to use the parallel port for printing and set the serial port for plotting, a configuration that is a major convenience when switching paper sizes or modes of printing.

The disk supplied with the ProTracer includes a printer setup and control pro-



gram and ADI (Autodesk Device Interface) drivers for AutoCAD. The setup program provides complete control of the printer in a well-structured, Windows-like environment, essentially making the printer control panel redundant. I ended up using the setup program more often than the printer buttons.

The plotter throughput is where the ProTracer really shines, trouncing both laser printers and full-size plotters in speed. To compare performance, I printed a floor plan that completely filled an 8½ by 11-inch page. It took 4 minutes, 34 seconds using my Panasonic KX-P4450 laser printer, but only 1 minute, 44 seconds using the ProTracer and the optional HPGL emulation card. (I should note here that my HPGL card was an engineering prototype; according to Pacific Data Products, the production models will be substantially faster.)

The ProTracer loses the race with standard text, however. It took me 1 minute, 13 seconds to print a full single-spaced page, compared with only 20 seconds when I printed it on the laser printer using unidirectional printing.

For applications where plotting on large-format stock is important, the ProTracer is exceptionally attractive. Full-featured plotters, such as the HP DraftPro, are priced at \$3500 and up, about \$1000 more than a fully equipped ProTracer. And they are much slower, generally taking 30 minutes or more to plot a C-size drawing compared to about 5 minutes with the ProTracer. The only fly in the ointment is that

the ProTracer can't do colors...not yet, at any rate. But then, neither does my laser printer.

The target audience for this product is obviously engineering, drafting, and architectural offices. Pacific Data Products, with its typical conservative candor, suggests that the ProTracer is useful for "draft"-quality plots. In fact, the output is quite satisfactory for any monochrome (i.e., black) engineering or architectural drawing. Sure, if you look closely you'll find very minor blemishes, but you'll see the same thing with regular pen plotters as well.

After using the ProTracer for just a short while, I'm quite willing to suffer with the acceptable print/plot quality, pocket the major difference in price, and enjoy the huge increase in performance over a standard plotter. HP and other plotter manufacturers are going to weep over the ProTracer, mark my words.

Pacific Data Products has produced a beautifully crafted, economical, and exceptionally versatile printer/plotter. It's ideally suited as a personal plotter in a technical environment, offering a unique combination of features that allows easy setup and exceptionally versatile output. And to sweeten the pot even more, the ProTracer not only comes with a 60-day return privilege, it also includes a one-year warranty with replacement parts shipped overnight.

—James M. Hansen

THE FACTS

ProTracer

\$1499

memory-expansion card: 2 MB.

\$299; 4 MB, \$499; 8 MB, \$899

HPGL emulation card, \$399

PostScript emulation card, \$499

Pacific Data Products, Inc.

9125 Rehco Rd.

San Diego, CA 92121

(619) 552-0880

fax: (619) 552-0889

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FileMaker Pro 2.0 Unites the PC and Mac

I feel like a keyboard virtuoso. Here I sit: a PC to the right of me, and a Mac to the left of me. Both are running beta versions of **FileMaker Pro 2.0**. But it doesn't take many years of practice to create elegant works of...er...database art with these database programs.

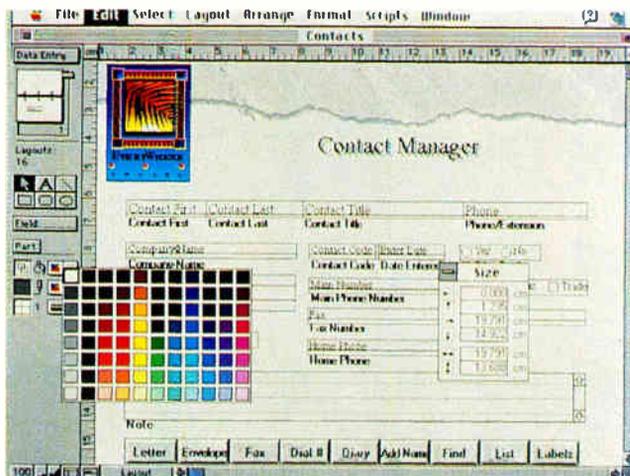
Even though I do my day-to-day work on a PC, I have always had a soft spot in my reviewer's heart for Claris's FileMaker. Although up until now the program has been available only on the Mac, its ease of use and power were almost enough of a temptation to move my database work to the Mac platform. Almost.

I don't have to make that hard choice any longer, because Claris continues its move into the Windows market. FileMaker Pro 2.0 for Windows runs on my PC, and both versions—Windows and Mac—add a raft of new features that make the packages even more powerful.

Of course, it's not just a matter of choosing a platform. Many business users have computer networks that include both Macs and PCs. In these cross-platform installations, sharing data has become a major concern and a major problem, creating a hot market in utilities that convert disparate file formats into something that "foreign" machines can read. There are no such problems with databases created with either version of FileMaker Pro 2.0; files are completely compatible at the binary level across the Mac and PC platforms.

Both versions of FileMaker Pro 2.0 are network-ready out of the box, licensed for up to 25 users. If they're set up on a server in a multiuser configuration, files are automatically updated across the network and even across platforms. Plainly, Claris has set up these packages for the way that business works today. But stand-alone computer users shouldn't fret; FileMaker Pro 2.0 is full of power that any user can take good advantage of.

Whether you think that GUIs are the computer gods' gift to mankind or a curse, you have to admit that they've taken the market by storm. They have enforced a graphics-oriented way of interacting with the world of your computer. After working with both versions of FileMaker Pro 2.0 for several weeks, I've become nonplussed by how very close Windows and the Mac



Desktop are. Except for the little apple in the upper left-hand corner of the Mac screen, it's difficult to tell which platform I'm working with.

Claris has put a huge amount of effort into making the two versions work almost exactly alike, while retaining the unique advantages of each platform. The company has succeeded, in spades. (A Claris spokesperson told me the applications share 85 percent of common code, with the remaining 15 percent given over to the idiosyncrasies of each GUI.)

What really sets FileMaker Pro 2.0 apart from the behemoths of the database market (i.e., dBase, Paradox, FoxBase, and Oracle) is that it lets users—even rank beginners—create sophisticated and powerful applications without the need to call in a high-priced database consultant. The key is FileMaker Pro's versatility. Most sophisticated database managers require you to do a great deal of preplanning, deciding exactly which fields you need and the exact number of characters designated for each. In the real world, things change; but most database managers aren't set up for change. FileMaker Pro 2.0 is a different beast. You just start entering field names. If you need to go back and change them later, no problem.

One of the thoughtful features of FileMaker Pro 2.0 is that you don't have to enter a length for data fields. There's none of the usual flipping through your Rolodex trying to figure out which client has the longest name. Each field can contain up to 64,000 characters. This presents some intriguing possibilities, such as storing form letters in your database.

Of course, there's much more. With

built-in drawing tools, you can customize the look and feel of on-screen forms and even integrate images using graphics files. FileMaker Pro 2.0 automatically creates indexes for all words as they're entered. The end result is incredibly fast searching and sorting.

If you're an advanced database aficionado, Claris hasn't forgotten you. There's a wide range of advanced features (e.g., Boolean searches and scripts), all accessed from a graphical object-oriented interface. These are packages that will give your mouse a thorough workout.

FileMaker Pro has one of the largest and most loyal networks of developers who design custom applications. That's sure to increase with the availability of the Windows version. If you don't want to create a database application yourself, chances are it's available. With FileMaker Pro 2.0 for Windows and the Mac, the two computers in my office are finally on speaking terms.

—Stan Miastkowski

THE FACTS

FileMaker Pro 2.0 for Windows \$399

System requirements:
A 386SX or higher PC is recommended with Windows 3.0 or higher and a hard drive; 4 MB of RAM is recommended.

FileMaker Pro 2.0 for Macintosh \$399

System requirements:
A Mac Classic, SE, LC, II, Portable, PowerBook, or Quadra with System 6.0 or higher and a hard drive; 4 MB of RAM is recommended.

Claris Corp.
P.O. Box 58168
Santa Clara, CA 95052
(800) 544-8554
(408) 727-8227

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- ✓ A Pattern Code Security System (PCS) enabling parallel processing of multiple calls by the Linkable Protection Module.
- ✓ A Virus Detection option that can be incorporated in the protected program to check whether it has been infected by a virus or tampered with in any way.
- ✓ Several HASP keys can be daisy-chained.



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- **Spain** PC Hardware, Tel: 3 493193
- **Switzerland** Opag AG, Tel: 61 7112245
- **Taiwan** Tecco Ltd., Tel: 02 555 9676
- **Turkey** Mikrobeta Ltd., Tel: 4-677504

* CT Magazine, May 1990.

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Circle 63 on Inquiry Card.

World Radio History

Amstrad's Low-End Bid for the Portable Market

BRENTWOOD, ENGLAND—U.K.-based Amstrad has announced a Z80-based notebook computer, some 15 years after the launching of the Z80. Although it seems astonishing that a major PC vendor should announce a machine based on such old technology, Alan Sugar, Amstrad's managing director, believes his company will sell between 200,000 and 300,000 machines in the first year.

The 2-pound **Amstrad Notepad NC100** includes 64 KB of SRAM (static RAM); the only other storage is provided by a PCMCIA 2.0 slot (unfortunately, it's memory only). The machine is shipped with a number of standard applications, including a word processor, a simple card-file database, a time manager, a calendar, a BASIC interpreter, and a terminal emulation program. The 80-column, 8-row super-twist LCD sits in a raised bezel above the multicolored 64-key keyboard.

Amstrad has built ease of use into its notebook, the key to which is a row of colored buttons on the bottom left of the keyboard. These buttons let you task-switch among the three main applications, as well as letting a new user immediately understand the on-screen instructions. "Hit F10"



has a PC novice scouring the keyboard, whereas "Press the red key" is easily understood. Using my evaluation unit, a PC novice rather quickly created a short document in the word processor by following the simple on-screen instructions.

The Protex word processor was developed for Amstrad by Arnor, a U.K. company with versions of its word processor on the PC, Atari ST, and Amiga. The software is full-featured, with a 50,000-word spelling checker, and it uses the same file format as Protex on other platforms.

The card file is simple, offering just four fields for storing name, address, phone,

and fax information. The diary facility is more complete, including alarms, events, and international time zones. The BASIC interpreter is a version of BBC BASIC that offers some limited user programming facilities.

Sugar says the company believes the key to the success of the NC100 will be the friendliness of the software. He is backing his words with the promise that "if you can't use this computer in 5 minutes, you'll get your money back," a statement that's being included in the company's ads.

—Andy Redfern

THE FACTS

Amstrad Notepad NC100
about \$300 (£170)

Amstrad plc
169 Kings Rd.
Brentwood
Essex CM14 14ER
U.K.
44-277-228888
fax: 44-277-211350
Circle 1056 on Inquiry Card.

ScanMan Color: Handing It to Logitech

About two years ago, Logitech stood by while numerous vendors trumpeted the release of their hand-held color scanners. The company waited to examine these products—and accompanying second-sourced software that often fit like a borrowed suit—and finally released its own color product. The result, the \$699 **ScanMan Color**, shows that Logitech's time was well spent.

Announced in June, the product that hit the shelves in September is a 24-bit model, which translates into more than 16.7 million colors the hardware can sense. Gray-scale scanning, which you can do without converting from color (conversion is another route), gets you 256-gray-scale sensitivity. And if you plan OCR (optical character recognition) work despite hand scanners' inherent limitations

for text accuracy, a line-art mode is available, too.

Software included is Logitech's Windows-based FotoTouch Color, an expanded version of the software included with other Logitech scanners. Closely integrated is the company's ScanMan Color software, which forms the interface between image editor and scanner. Owing to the product's compliance with the multivendor TWAIN (Toolkit Without An Important Name) protocol for incorporating graphics into documents, FotoTouch will accept images from ScanMan Color and any product written to this API.

Installing the ScanMan Color is a welcome improvement over the old IRQ (interrupt request) game that has vexed users of most older models. True, you may need to change DIP switches on the 16-bit board

to keep the base I/O address from conflicting with other devices. The default setting of 280h, in fact, initially conflicted with my Artisoft LANtastic network card. From there, however, the software automatically finds an available IRQ. If you forget the I/O address you've set, a software installation test routine lets you select each possible setting on-line until the software recognizes the hardware.

On the scanner itself are a resolution switch in 100-dot-per-inch increments up to 400 dpi and a contrast dial. A topside indicator lights a steady green when you're scanning at the proper speed or blinks if you're rushing.

Operating the ScanMan Color is refreshing in that it requires none of the 30- to 90-second warm-up that is the bane of typical hand-scanner use. The software

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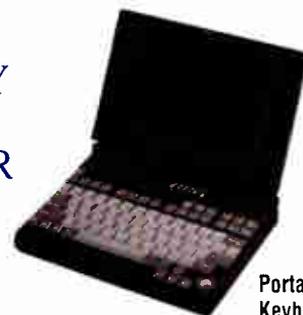


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needs several seconds to display the image once you've scanned it—it is Windows-based, after all—but the hardware remains at the ready.

The FotoTouch Color software is the magic of the scanner package. All the image-retouching features you'll find elsewhere are present, but a welcome addition is the ability to customize the panel of editing tools along the side. Easily accessible sliding switches allow you to adjust your scanned image's tone control, color balance, and enhancements for smoothing edited images. A color wheel and gray-scale bar let you change the foreground and background. Viewing options are aplenty. And if you want to export the image, your choices include BMP, PCX,

EPS, GIF, and four varieties of TIFF.

Throughout my testing with various graphics and text images, the ScanMan Color performed admirably; the usual hitch, editing a 24-bit image on standard VGA, is hardly the scanner's weakness. Even the stitching of four passes of a single large image—the hand scanner's traditional stumbling block—proved to be little trouble.

If you plan heavy OCR work, you're still better off with a desktop scanner. But if you'll be scanning graphics for desktop publishing or presentations with the occasional text scan, go with the product from a company that has learned from others' mistakes.

—Ed Perratore

THE FACTS

ScanMan Color
\$699

System requirements:
A 386SX with VGA graphics, Windows 3.0 or 3.1, 4 MB of RAM, 5 MB of free disk space, and a mouse.

Logitech, Inc.
6505 Kaiser Dr.
Fremont, CA 94555
(510) 795-8500
fax: (510) 792-8901

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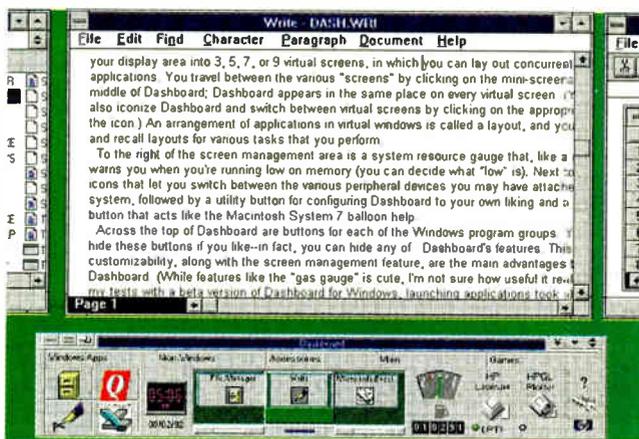
HP's Push-Button Dashboard for Windows

Suppose you're a Windows user, but you don't like the Program Manager that comes with it. You'd like a different method of switching between tasks, arranging your program groups, and so on.

Dashboard for Windows is a new shell/utility that lets you do just that. Developed by the NewWave division of Hewlett-Packard, Dashboard provides many of the same functions as the Program Manager and adds some new ones, while taking up less of your desktop and system resources. In these days of massive programs, every little bit of RAM that you can save helps.

In its maximized state, Dashboard for Windows is a horizontal panel, as shown in the screen above. At the far left are Quick Launch push buttons (between one and 32) that let you start your most commonly used programs with a single click. Next to those is a customizable alarm clock that will remind you of an appointment or start an application at a specific time.

Dashboard's most interesting feature is extended screen management, which allows you to stretch your display area into three, five, seven, or nine virtual screens, in which you can lay out concurrently running applications. You travel between the various "screens" by clicking on the mini-screens in the middle of Dashboard; Dashboard appears in the same place on every virtual screen. (You can also iconize Dashboard and switch between virtual screens



by clicking on the appropriate part of the icon.) An arrangement of applications in virtual windows is called a layout, and you can save and recall layouts for various tasks that you perform.

To the right of the screen management area is a system resource gauge that, like a gas gauge, warns you when you're running low on memory (you can decide what "low" is). Next to the gauge are icons that let you switch between the various peripheral devices you have attached to your system, followed by a utility button for configuring Dashboard to your own liking and a help button that acts like the Macintosh System 7.0 Balloon Help.

Across the top are buttons for each of the Windows program groups. You can hide these buttons if you like—in fact, you can hide any of Dashboard's features. This customizability, along with the screen

management feature, are the main advantages to using Dashboard. In my tests with a beta version of the software, launching applications took about the same time as it did from the Program Manager, which lets you perform most of the other functions of Dashboard, albeit differently.

Arranging applications, utilities, and resources on your desktop is a bit like arranging furniture. The space defines much of what you can do, and people's tastes vary. If you need a utility to supplement the Program Manager, Dashboard for Windows deserves a look. ■

—Kenneth M. Sheldon

THE FACTS

Dashboard for Windows
\$99

System requirements:
Windows 3.0 or higher.

Hewlett-Packard Co.
974 East Arques Ave.
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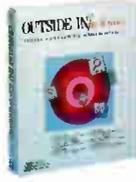


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Lahey F77L-EM/32

Industry leading 32-bit FORTRAN Language System includes Phar Lap's 386DOS-Extender. This VCPI, XMS, and DPML compliant extender enables users to access up to 4GB and operate in the MS Windows DOS box. The extender is royalty-free and includes virtual memory support. New with Version 5.0: 32-bit debugger, arrays beyond 16MB, compression linker, and 486 optimizations. Support for popular VAX, IBM VS, and 90 features.

List: \$1195 Ours: \$1015
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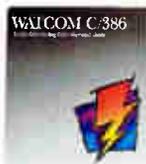
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List: \$895 Ours: \$719
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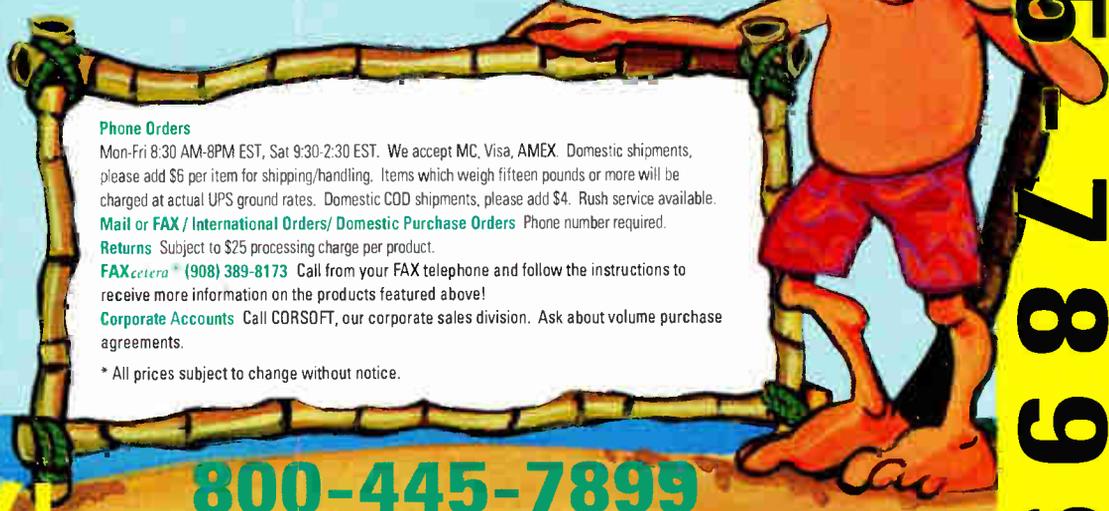
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Minitower Multimedia

The minitower MPC-I 486-33 puts multimedia capabilities at your fingertips. The unit has 4 MB of RAM (expandable to 32 MB), 64 KB of cache memory, two floppy drives, a 120-MB hard drive, and an NEC Intersect CD-ROM drive with an access speed of 280 ms.

A Media Vision Pro Audio Spectrum 16-bit card provides audio for two 20-W external speakers from Acoustic Research, and an ADI 14-inch noninterlaced Super VGA monitor comes with a 16-bit graphics board with an S3 graphics accelerator chip set, DOS 5.0, Windows 3.1, and a 400-dpi high-resolution bus mouse round out the package.

Price: Base unit, \$3985.

Contact: Clover Computer Systems, Inc., 1430 Koll Cir., Suite 102, San Jose, CA 95112, (408) 436-0444; fax (408) 436-0494.

Circle 1271 on Inquiry Card.

Keyboard Computer

A keyboard that's a complete 33-MHz 386SX system, the PC-101 includes 1 MB of DRAM (expandable to 16 MB) with auto-sensing memory capability. A slot for an 8- or 16-bit network card lets you connect the unit to your LAN for use as a workstation. The unit has controllers for a 1.44-MB floppy drive and an IDE hard drive,



DataBusiness's PC-101 puts 33-MHz 386SX power in a keyboard.



Clover Computer Systems' MPC-I has real-time window manipulation and a chroma key for overlaying finished live images on a VGA screen.

and it has a built-in palm rest.

Internal interfaces on the system include three parallel and two serial ports, as well as two built-in video ports that can support 1024- by 768-pixel-resolution Super VGA, EGA, CGA, or Hercules monochrome graphics. Speaker volume control is also built in. External interfaces encompass ports for a PS/2 mouse, a bar code reader, a scanner or a light pen, and floppy or tape drives.

Price: \$1495.
Contact: DataBusiness Systems, 4630-102 Campus Dr., Newport Beach, CA 92660, (714) 252-0990.

Circle 1272 on Inquiry Card.

Supercompact 386 Workstation

Designed for graphics and multitasking environments, the MiStation 3 comes with a 32-bit 33-MHz 386DX

CPU, 4 MB of RAM (expandable to 32 MB), a 16-KB cache memory system, two serial ports, one parallel port, an IBM PS/2-compatible mouse port, a 101-/102-key keyboard, and two 16-bit full-length expansion slots. The slimline case has room for two 1-inch-height 3 1/4-inch floppy drives and one half-height 3 1/2-inch hard drive. A seven-tiered security system features keyboard, system control, and form-factor locks.

You can upgrade the MiStation 3 from its standard VGA graphics resolution of 1024 by 768 pixels in 16 colors to 1024 by 768 pixels in 256 colors, both in noninterlaced mode.

Options for the MiStation 3 include 40-, 120-, and 200-MB hard drives, monitors, a Mitac PS/2-compatible mouse, Ethernet cards, OS/2 1.21, Windows 3.0, and Microsoft Works 2.0.

Price: About \$1940 (£1019).
Contact: Mitac (U.K.) Ltd., Unit 12, Hortonwood 32, Telford, Shropshire TF1 4EX, U.K., 44-952-670370; fax 44-952-605605.

Circle 1273 on Inquiry Card.

Open Architecture Terminal

With an industry-standard SBus expansion slot and a Unix API-compatible micro kernel, the TX800C color Open Network Terminal can download and run a variety of terminal services in addition to X Window System terminal services. The expandable display terminal, designed to maximize local client-based processing, is able to interpret X commands at a rate of 104,000 Xstones per second.

The terminal comes with a local Motif or Open Look window manager and a software license. Options include a Turbo JPEG video image decompression card.

Price: Base model, \$3495; Turbo JPEG card, \$1495.

Contact: Visual, 120 Flanners Rd., Westboro, MA 01581, (508) 836-4400; fax (508) 366-4337.

Circle 1274 on Inquiry Card.

Expandable Notebook

The AquaLite-I 25-MHz 386SXL has a 1.44-MB floppy drive, a 60-MB hard drive, a backlit supertwist 9 1/2-inch LCD with 640- by 480-pixel resolution, and 256 KB of video RAM for up to 32 gray levels. The unit's 2 MB of RAM is expandable to 8 MB. Interfaces include one parallel and two serial ports, and ports for a keyboard, a CRT, and a docking station. It also has a socket for a 387SXL math coprocessor.

Price: \$1995.
Contact: CAF Technology, Inc., 1315 Johnson Dr., City of Industry, CA 91745, (818) 369-3690; fax (818) 369-3692.

Circle 1318 on Inquiry Card.

Back Up Via the Parallel Port

Able to transfer data at up to 1 Mbps, the Trakker 250 plugs into the printer port of your notebook or desktop PC. A separate parallel connector on the back of the unit lets you operate a printer from the same port when you're not backing up data. Conforming to QIC 40 and QIC 80 industry standards, the tape backup system uses extended-length tapes and data compression to provide a data capacity of 250 MB on DC-2000 mini-cartridges. The unit supports multiple languages and is compatible with NetWare 286 and 386.

Price: \$549.

Contact: Colorado Memory Systems, Inc., 800 South Taft Ave., Loveland, CO 80537, (800) 451-0897 or (303) 669-8000; fax (303) 667-0921.

Circle 1275 on Inquiry Card.

Portable Personal Printer

Apersonal printer sized for tight spaces, the Coronajet 200j ink-jet printer has 300-dpi resolution for text and graphics. The unit includes Hewlett-Packard PCL 3+ emulation, 20 resident fonts, portrait and landscape modes, and a replaceable ink-jet cartridge. The 6¼-pound printer operates at less than 45 dB.

Price: \$499.

Contact: Smith Corona Corp., 65 Locust Ave., New Canaan, CT 06840, (203) 972-1471.

Circle 1276 on Inquiry Card.



The plug-and-play Trakker tape backup device supports the enhanced PC parallel port.

Data Storage to Go

Three lightweight portable hard drives that come in small packages can help ease your data-storage problem while traveling.

Unison's Pocket Rocket, a 4½- by 8¼- by 3¼-inch external SCSI hard drive, has an unformatted storage capacity of more than 1.3 GB, an average seek time of 10 ms, and a data transfer rate of 10 MBps. A 512-KB segmented cache buffer enhances throughput.

Price: \$2085.

Contact: Unison Information Systems, Ltd., 21 Walsh Way, Framingham, MA 01701, (508) 879-3200; fax (508) 879-0772.

Circle 1277 on Inquiry Card.



The EasyStor Portable Data Module from UniStor plugs into the parallel port of your laptop or desktop PC. Able to transfer data at



up to 15 Mbps, the unit is available in 40- to 180-MB capacities. The 1½- by 3½- by 7-inch unit includes a 3-hour battery, hardware data encryption, and user password protection. EasyStor's Easy-Step device driver software quickly configures most PCs to automatically recognize its presence.

Price: \$599 to \$1199.

Contact: UniStor Corp., 23402 South Pointe Dr., Laguna Hills, CA 92653, (800) 422-2115 or (714) 581-3442; fax (714) 581-7564.

Circle 1278 on Inquiry Card.

PalmDrive, a 1- by 3- by 5-inch external drive, transfers data at a rate of up to 5 MBps via its Stealth controller. The controller hides the drive from your PC's BIOS, so the system sees it as a device driver occupying only 2.5 KB of memory. The unit attaches to the PC via a quick-release cable that also supplies power to the drive from the PC.

Price: 40 MB, \$599; 80 MB, \$799; 120 MB, \$999.

Contact: ProTégé Corp., 3440-C West Warner Ave., Santa Ana, CA 92704, (714) 241-0891; fax (714) 241-1218.

Circle 1279 on Inquiry Card.

Fast Data Transfer

The AL-1000 high-speed SCSI adapter can transfer data at rates as high as 250 Kbps. A complete system, the adapter includes cables and advanced SCSI programming interface drivers and utilities for hard disks. Fixed and removable media in the package include optical, floptical, CD-ROM, and tape drives.

An innovative parallel-port inquiry scheme optimizes the AL-1000's performance, enabling you to use it with older computers that have unidirectional printer ports as well as with newer computers that have high-speed bidirectional and enhanced parallel ports. The system's portability enables you to connect your portable computer to such external peripherals as printers, hard drives, tape backup systems, and CD-ROMs.

Price: \$199.

Contact: Always Technology Corp., 31336 Via Colinas, Suite 101, Westlake Village, CA 91362, (818) 597-1400; fax (818) 597-1496.

Circle 1280 on Inquiry Card.

Watch TV on Your PC

Turn your PC into a full-screen TV with 50/50 Micro Electronics' PC/Television. The board includes a 119-channel tuner that handles VHF, UHF, and cable TV frequencies. You can connect the board to a coaxial cable, an external TV antenna, a VCR, a laserdisc player, a video camera, or an internal private-broadcast TV cable.

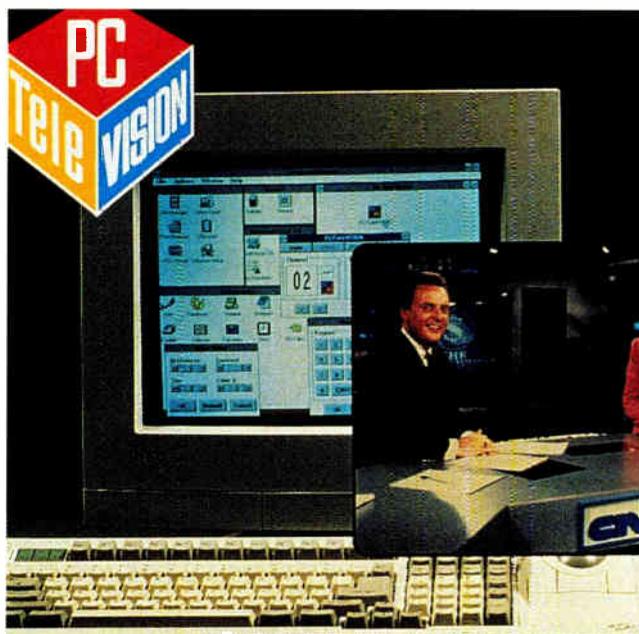
PC/Television, which fits into a standard 8-bit bus, is compatible with VGA and Super VGA graphics adapters and monitors that support VGA. You can work in a computer application and, with a keystroke, switch to watch TV, or you can listen to TV while you work and view your application on your monitor. You can select a channel, set your video display, and program channels from the keyboard or mouse. **Price:** \$395.

Contact: 50/50 Micro Electronics, Inc., 550 Lakeside Dr., Suite 8, Sunnyvale, CA 94086, (408) 730-5050; fax (408) 732-5050. **Circle 1281 on Inquiry Card.**

PS/2 Performance Boosters

The Stax SX 25 MHz and the MicroMaster 486SX 25 MHz boards upgrade PS/2 computers to 386SX and 486SX levels, respectively. The Stax SX 25 MHz increases the speed and performance of Models 50, 50 Z, and 60 and supports the 287 and 387 math coprocessors. The board supports Windows 3.1.

The MicroMaster 486SX 25 MHz, a bus master processor upgrade board, boosts the processing performance of the 286- and 386-based PS/2s. The board uses exist-



PC/Television, which lets you control your TV from your PC, operates in noninterlaced mode.

ing system memory and also supports up to 16 MB of 32-bit on-board memory.

Price: Stax SX 25 MHz, \$495; MicroMaster 486SX 25 MHz, \$1600.

Contact: Aox, Inc., 486 Totten Pond Rd., Waltham, MA 02154, (617) 890-4402. **Circle 1282 on Inquiry Card.**

High-Speed A/D Conversion

The AIN-24 A/D conversion card comes with on-board cache and DMA for applications such as high-speed data capture, transient analysis, and general logging functions. DMA lets you transfer data to your PC's RAM at a rate of 80 kHz. You can configure the AIN-24 under software to have 24 single-ended channels or 12 differential channels.

Additional features on the AIN-24 include a software-selectable gain and software-

selectable input configuration. The package includes a DOS device driver that provides access to all the board's functions through minimal programming in most high-level languages.

Price: About \$846 (£495). **Contact:** Blue Chip Technology, Hawarden Industrial Park, Manor Lane, Deeside, Clwyd CH5 3PP, U.K., 44-244-520222; fax 44-244-531043.

Circle 1283 on Inquiry Card.

Capture Video in a Window

A real-time, true-color image capture and display card, the VIGA Window can accept video from three inde-

pendent video sources (e.g., NTSC, PAL, and S-Video). With the ability to scale multiple live video windows, VIGA Window lets you open a window within a window and manipulate, edit, store, and retrieve the captured images. The board, fully Windows 3.x compatible, can provide output to a VGA or multisync monitor at resolutions of up to 1024 by 512 pixels.

Price: \$695.

Contact: Visionetics International Corp., 21311 Hawthorne Blvd., Suite 235, Torrance, CA 90503, (310) 316-7940; fax (310) 316-7457.

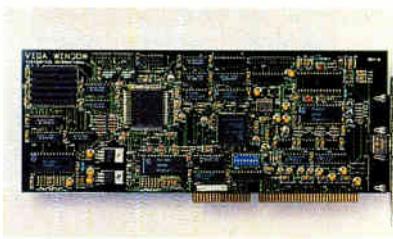
Circle 1284 on Inquiry Card.

The Local Bus Makes the Connection

A combination of a 24-bit graphics card and a 486 motherboard, FlickerFree ColorBahn and Genoa 486 TurboExpress work with the local bus to provide 16 million colors at 640- by 480-pixel resolution and 256 colors at 1024- by 768-pixel resolution. The card snaps into a local-bus slot on the 33-MHz or 50-MHz motherboard, which has a flexible cache memory of from 64 to 256 KB and up to 32 MB of DRAM.

Price: \$589 and up. **Contact:** Genoa Systems Corp., 75 East Trimble Rd., San Jose, CA 95131, (408) 432-9090; fax (408) 434-0997.

Circle 1285 on Inquiry Card.



VIGA Window provides full-motion digital video support.

Try stuffing these into a laptop.



Laptops have their place, but for mission-critical applications requiring serious expansion, workstation power, CRT-quality screens or toolbox ruggedness, get a P.A.C.[™] (Portable Add-In Computer).

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All with the kind of features that made Panasonic printers the leaders of the industry. Such as multiple paper paths, EZ™ Set control panels, and a two-year limited warranty on parts and labor†.

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The KX-P2123, a 24-pin with ATM and color option.*



The KX-P2180, a 9-pin with color option. ATM not available.*



The KX-P2624, a 24-pin with ATM. Color option not available.*

PQ9-BY

Circle 139 on Inquiry Card.

Elegant PC Security

The Firmloc access control system combines a smart electronic key and key receptacle with an internal microprocessor to prohibit unauthorized computer access. It recognizes authorized users when they insert a personal electronic key into the key receptacle, which is connected to the parallel port on the PC.

When a key is removed, the TSR software automatically locks the computer, immediately suspending the application that is running and blocking all routes into the system by blanking the screen and disabling the keyboard, the floppy drives, and the mouse. When the key is reinserted, the computer resumes operation where it left off. The software keeps an access record and records of invalid access attempts.

Price: \$249.95.

Contact: Intelligent Security Systems, Inc., P.O. Box 1133, Addison, TX 75001, (800) 237-4774 or (214) 869-3663.

Circle 1286 on Inquiry Card.



Transparent to authorized users, Firmloc has an administrator and a user security level.

Listen to Your Computer with the CAT

If you have a speaker on your PC, you can convert voice or sound messages into executable files with the CAT Sound Studio. You can transfer these files over a network, and the person receiving the files can listen to the message by typing the filename.

The CAT Sound Studio lets you edit messages and create special effects for Windows or DOS batch-file playback. You can merge voice and music with graphics and watch the sound patterns on the VU Meter and Histogram. The unit, which connects to the parallel port, includes a microphone, a parallel-port I/O audio interface, and sound-processing software.

Price: \$59.

Contact: Computer Aided Technology, Inc., 10132 Monroe Dr., Dallas, TX 75229, (214) 350-0888; fax (214) 904-0888.

Circle 1289 on Inquiry Card.

The CAT Sound Studio offers more than 300 sound clips.

Problem Solver

The Programmable Protocol Converter allows incompatible hardware devices to communicate. The PPC-2 comes with two RS-232 ports with hardware, XON/XOFF handshakes, and modem control capability. For complex programming, a four-port device, the PPC-4, allows independent debugging while normal data I/O takes place on two or three other ports. You can leave the compact device in place as a stand-alone protocol converter once you finish your program.

The PPCs contain an integer BASIC interpreter and a standard Pascal compiler. The packages include an IBM PC ANSI emulator program with file transfer capabilities and an internal menu-driven EEPROM filing system that can store up to 20 user programs.

Price: PPC-2, about \$574 (£309); PPC-4, about \$707.50 (£378.50).

Contact: KK Systems Ltd., 36 Mill Hill Dr., Shoreham by Sea, West Sussex BN43 5TL, U.K., 44-273-452357; fax 44-273-440535.

Circle 1287 on Inquiry Card.

Touch Capability for Any Monitor

Visage's TouchMate input device works with any 12- to 19-inch computer monitor weighing up to 90 pounds without requiring the attachment of an additional screen or sensor. TouchMate fits underneath your monitor and plugs into your computer's serial port. Four sensors inside the unit accurately measure the location of a touch and the pressure exerted. TouchMate supports DOS, Windows, Unix, X Window System, and VMS.

Price: \$895.

Contact: Visage, Inc., 1881 Worcester Rd., Framingham, MA 01701, (508) 620-7100; fax (508) 620-0273.

Circle 1288 on Inquiry Card.

Motorized Color Scanning

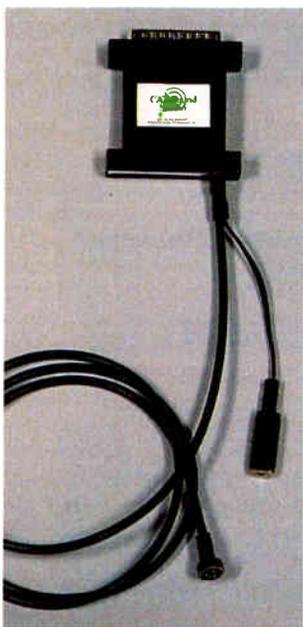
At the heart of the Primax ColorMobile SC-424A hand scanner is a stepper motor that drives the scanner over your image in a straight line, eliminating stretched or uneven images caused by irregular hand movements. The scanner offers resolutions of up to 400 dpi in 16.8 million colors. For scanning a large image, the ColorMobile SC-424A uses a merge function and a TrackPad to ensure that the two halves of the image join exactly.

The ColorMobile SC-424A includes 64 KB, 256 KB, or 1 MB of buffer memory on the interface card; the TrackPad; iPhoto Plus image-enhancement software; and Interpreter OCR software.

Price: \$495 to \$595.

Contact: Primax Electronic, Ltd., Sixth Floor, No. 159, Kang Ning St., Hsi Chih Town, Taipei Hsien, Taiwan, 886-2-648-3073; fax 886-2-648-3064.

Circle 1290 on Inquiry Card.



WATCOM SQL

PC-based Client/Server SQL Tools

Four Good Reasons to get your copy right away:

1. True Client/Server for reliability and performance

Your databases are protected from corruption by features such as referential and entity integrity, as well as true transaction processing. Client/server architecture and our 32-bit database server software help deliver increased performance for applications running on your PC LANs.

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3. Scalability

Whether you implement applications using the ACME front-end or write them in C or C++, they can be designed to run without change in environments ranging from standalone 640K single-user PCs to large networks running our

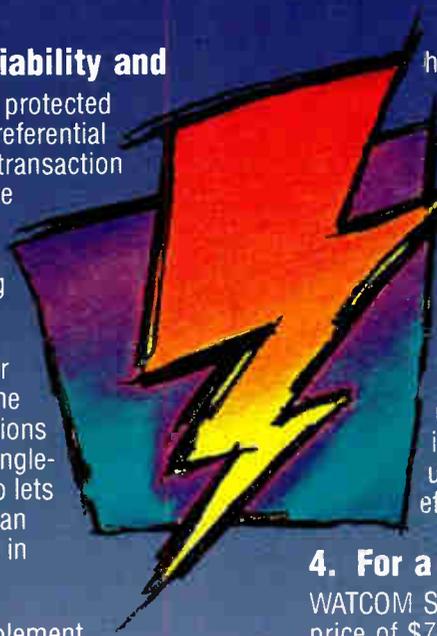
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From entry level PCs... You can use DOS PCs with just 640K memory as database server machines for small networks. For single-user standalone environments, the SQL database server together with an application can run on DOS PCs equipped with a minimum of 640K memory.

...to high end servers. The WATCOM SQL database server automatically adapts to utilize the available memory on your system for increased performance. The 32-bit version unleashes the power of 386/486 PC's to efficiently serve many clients in large networks.

4. For a limited time it's yours for just \$395

WATCOM SQL Developer's Edition has a suggested retail price of \$795 but for a limited time you can get it at the introductory price of only \$395. Even better, as a registered user of the Developer's Edition you'll be able to get a copy of the 6-user Network Server Edition for only \$99 (Suggested retail price: \$795).



Developer's Edition

Complete Client/Server Development Tools Package Including Standalone Single-user SQL Database Engine

The Developer's Edition allows you to develop and deploy single-user standalone applications, and to develop applications for use with the WATCOM SQL Network Server Edition. You get the **ACME (Application Creation Made Easy)** front-end application development system. It combines visual forms design with simple event-driven programming to allow rapid prototyping and development of client applications without C programming. The Developer's Edition also includes IBM SAA standard embedded SQL support for C/C++ application development with WATCOM, Microsoft C/C++, and Borland C/C++.

Package components include: Single-user standalone database server (both 16 and 32-bit versions) • Interactive SQL • ACME front-end application development system • Embedded SQL/C preprocessor • SQL libraries for use with WATCOM C, WATCOM C/386, Microsoft C/C++, and Borland C/C++.

System Requirements:

Hardware: IBM PC compatible with hard disk, 640K minimum memory
Software: DOS, Windows DOS box, or OS/2 DOS box

Special Introductory Offer: \$395 (Suggested retail price: \$795)

Special offers available to registered users: (details inside package)

- **Royalty-free run-time support:** \$99
- **6-user Network Server Edition:** \$99 (Suggested retail price: \$795)

Network Server Edition

High-performance Multi-user SQL Database Server for PC LANs

The Network Server Edition provides client/server support for multiple concurrent users in a local area network environment. The WATCOM SQL database server supports ANSI standard SQL and provides advanced capabilities, including bi-directional scrollable updatable cursors, referential integrity, row-level locking and symmetric multiprocessing of requests. WATCOM SQL also gives you comprehensive security capabilities, data encryption and data compression. Compatible programming interfaces let you implement applications that run without change using either the standalone single-user database or the Network Server Edition.

Package components include: Multi-user network database server (both 16 and 32-bit versions) • Interactive SQL • Network requestor and request manager.

Client System Requirements:

Hardware: IBM PC compatibles, 640K minimum memory
Software: DOS, Windows DOS box, or OS/2 DOS box

Database Server System Requirements:

Hardware: IBM PC compatible with hard disk, 640K minimum memory
Software: DOS

Network Requirements: NetBIOS or Novell Netware (IPX)

Suggested Retail Price: 6-user version: \$795
Unlimited version: \$1,595

WATCOM, 415 Phillip Street, Waterloo, Ontario, Canada N2L 3X2
Telephone: (519) 886-3700, Fax: (519) 747-4971

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The on-board SCSI option lets you add SCSI I or II devices anytime. SCSI hard drives, opticals and more are easy to add.



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Try the P24T! Start today with the 486 CPU of your choice. Select between the 486SX-25 or 33, the 486DX-33, the 486DX2-50 or the 486DX2-66. Then, in 1993, you'll be able to add the new P24T super processor (you'll note the extra row of pins around each side of your CPU upgrade socket, that's what they're for). Maximum power today *and* tomorrow.

Consider the Vertical Option. We can build your new upgradable system in our eight-bay vertical case. It comes complete with our high-capacity power supply and two cooling fans. Add only \$95.

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While the others are talking about local bus, often creating their own non-standard solutions, ZEOS gives you a VESA future. As a working member of the VESA Standards Committee, ZEOS has incorporated *two* slots conforming to the recently established VESA standard.

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Unparalleled VESA local bus performance! We've taken one of your two VESA local bus slots (which can also be used for standard 16-bit cards if you wish) and added a *screaming* local bus video card. Windows has never moved so fast! And with our bus mastering capability, a second local bus card can be added in the future as well. ZEOS gives you more performance options than anyone else. *Take a closer look!*

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With ZEOS, performance enhancements are standard. If you have a technical bent you'll love reading about them. If you're a typical user, just tell your friends your new ZEOS system has these things. They'll be impressed. Like what?





You can upgrade your system now or in the future with our optional 128K or 256K secondary cache modules.



ZEOS systems feature award-winning reliability and support. Nine times PC Magazine's Editors' Choice.

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THE CACHE OPTION IS YOURS.

Because painfully missing from many competitors offerings is the option for a secondary cache. With ZEOS you can add a secondary cache of 128K or 256K. This speeds up many memory intensive applications. Take it now or add it later if you wish. ZEOS gives you the option. And that's just for starters.

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Because your new ZEOS upgradable offers you the additional option of on-board SCSI. By simply adding a single socketed SCSI chip to the board your new ZEOS system supports both SCSI I and SCSI II type devices. You can now have SCSI hard drives (running *in addition* to your standard IDE drives) plus tape backups, optical drives and a host of other SCSI peripherals. Take it now or add it later. Only from ZEOS.

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Like the two cooling fans you'll find in every ZEOS system. While ZEOS systems run cooler than most with *one* fan we still give you *two whisper-quiet cooling fans*. The cooler your system runs the longer it will last. We also include a built-in surge suppressor in every system. These are extra features the others *can't* or *won't* offer you. From ZEOS, they're yours. No additional charge.

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Lotus 1-2-3 for Windows, Ami Pro, and Freelance Graphics. The software alone carries a suggested retail price of over \$1,000 and we're giving it to you absolutely free. Now that's ZEOS Value.

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486DX2-66	\$3095

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Power Protection for Your LAN

The LanGarde UPSes, ranging from 400 VA to 1250 VA, meet both the UL1778 UPS rating and the UL1449 rating for transient-voltage surge suppression. The MouseTrax remote system in the units provides remote monitoring and tracking of the AC power and the unit itself. A removable display-and-control front panel fits on your desk, where it's easy to see without having the unit take up desktop space.

Other features include EasyChange battery replacement; the SpikeLog Surge Monitor, which reports when a surge activates the protection circuitry; and the Net-Trax Windows software, which controls, monitors, and analyzes power by taking snapshots of events or at periodic intervals. The units also include a dynamic battery-monitoring system and an interface system that permits network power management of units such as hubs and printers.

Price: \$499.95 and up.
Contact: EFI Electronics Corp., 2415 South 2300 West, Salt Lake City, UT 84119, (800) 877-1174 or (801) 977-9009; fax (801) 977-0200.

Circle 1291 on Inquiry Card.

Take a Peek at Your Network

A troubleshooting tool for network managers, TokenPeek captures and decodes network traffic in any mixed-platform token-ring environment. The Mac-based network analyzer turns any connected Mac into a passive



You can cascade multiple LanGarde UPSes from a single serial port, creating a local UPS network.

tap that uses the token-ring interface card to capture all network traffic for real-time and post-capture analysis.

TokenPeek displays network baseline data in bar-graph form, allowing a manager to explore packet traffic to the bit level when searching for the source of problems. The tool decodes packets so that protocol layers and data appear in straightforward text. Able to generate token-ring traffic, TokenPeek is also useful for network configuration testing.

Price: \$995.
Contact: The AG Group, Inc., 2540 Camino Diablo, Suite 202, Walnut Creek, CA 94596, (510) 937-7900; fax (510) 937-2479.

Circle 1292 on Inquiry Card.

Multiple Modems

Able to operate for up to 12 hours on a set of four AA batteries, the Omron Impala 24/96 portable fax modem for Windows and DOS includes a power saver that puts the modem into sleep



mode when the unit is offline and the PC-to-fax interface is idle. The Class 2 device, which supports the Hayes extended AT command set, has V.42bis and MNP 5 data compression; it includes V.42 and MNP 2 through MNP 4 error correction. A Mac version is also available.

Price: \$399.
Contact: Omron Office Automation Products, Inc., 3945 Freedom Cir., Suite 400, Santa Clara, CA 95054, (408) 727-1444; fax (408) 970-1149.

Circle 1293 on Inquiry Card.

The Smart One 1442F internal and 1442FX external fax modems incorporate V.42bis and MNP error



correction and data compression for 57,600-bps throughput. Including time-scheduled transmission, multiple-file broadcasting, and polling capabilities, the modems can also view, rotate, and print incoming faxes. The external version is available for Windows, DOS, and the Mac.

Price: 1442F, \$399; 1442FX, \$499.

Contact: Best Data Products, Inc., 9304 Deering Ave., Chatsworth, CA 91311, (818) 773-9600.

Circle 1294 on Inquiry Card.

The UltraLite 14.4 data/fax modem from NEC Technologies supports V.32bis for data transmission speeds of up to 38,400 bps and fax send/receive speeds of 9600 bps. Compatible with the company's UltraLite SL/20, SL/20P, and SL/25C notebook computers, the modem includes cellular capability, data encryption, flash ROM, MNP level 4 or V.42-compliant error protection, and MNP 5 or V.42bis data compression.

Price: \$699.
Contact: NEC Technologies, Inc., 1414 Massachusetts Ave., Boxborough, MA 01719, (508) 264-8000.

Circle 1319 on Inquiry Card.

Pocket Parallel-Port Print Servers

Two new Pocket Print Servers attach to your printer's parallel port to speed up printing on NetWare networks. The ESI-2829A model supports 10Base-2 (thin coaxial) Ethernet, and the ESI-2848A model supports nine-pin token-ring connections. Supporting NetWare 2.15 or higher and NetWare 386, the Pocket Print Server parallel interface transfers data in large blocks at speeds of up to 50 KBps.

Price: ESI-2829A, \$495; ESI-2848A, \$995.

Contact: Extended Systems, 6123 North Meeker Ave., Boise, ID 83704, (800) 235-7576 or (406) 587-7575.

Circle 1295 on Inquiry Card.

See us at Networld [Booth 1268]. And Interop [Booth 2542].

IT OPENS UP SOME REMOTE POSSIBILITIES.

The problem with local area networks is that they're too local. People fly, ride, travel and go places. LANs don't. Or at least they didn't, until now. ⚡ With Microtest's LANMODEM, authorized users can call in from any location in the world and access their Novell networks without the typical dial-in complexity. Same for network managers performing remote support. ⚡ LANMODEM is a high-speed, network attachable modem that also acts as a communications server. So it opens up possibilities that you've never had

before—in one integrated solution. ⚡ One easy-to-install box allows entire workgroups to share high-speed modems, not only for dialing into the network, but also for dialing out to electronic information services or other LANs.

Any combination of these applications are possible simultaneously, when a second modem is attached to LANMODEM's external



serial port. ⚡ While users enjoy easier network access, LAN administrators will appreciate LANMODEM, too. Its innovative hardware/software design and group set-up capabilities make LANMODEM easy to install and manage. Plus, LANMODEM's advanced security features protect the LAN from unauthorized access. ⚡ To find out how LANMODEM can open up some remote possibilities for your network,



LANMODEM includes a V.32bis/V.42bis internal modem.



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 by WATCOM

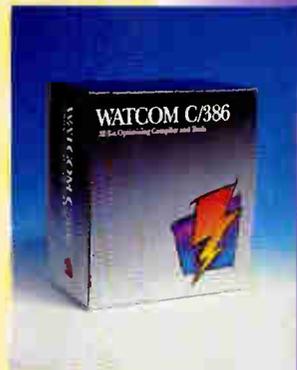
NEW PRODUCT-SPECIAL INTRODUCTORY OFFER. Complete client/server development tool allows you to develop and deploy single-user stand-alone applications, and to develop applications for use with the Network Server Edition. (sold separately). Includes: Single-user database server (both 16 and 32-bit versions); ACME application development system; Embedded SQL/C pre-processor; SQL libraries for WATCOM C, C/386, MS C/C++ and BC/C++.

LIST: \$395 **PS Price: \$379**
FastFacts 1044-035

WATCOM C/386
 by WATCOM

Develop and debug 32-bit applications for extended DOS, Windows and OS/2 2.0. Includes royalty-free 32-bit DOS extender, true 32-bit Windows GUI Application Kit, our fast, tight, and reliable 32-bit Code Optimizer, licensed Microsoft Windows SDK Components, an interactive Source-Level Debugger, an Execution Profiler and More! Now includes OS/2 2.0 Support.

LIST: \$895 **PS Price: \$599**
FastFacts 1044-029



The PKWARE Data Compression Library
 by PKWARE

The PKWARE Data Compression Library allows software developers to add data compression technology to applications. The application program controls all data I/O, allowing data to be compressed or extracted to any device or area of memory. Only 35K of memory is needed to compress data, and only 12K is needed to extract data. Compatible with MSC, BC++, TC, TP 6.0, Clipper, Basic 4.5, 7.1, ASM.

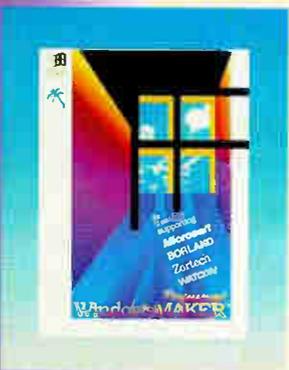
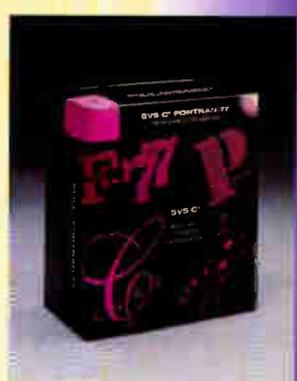
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FastFacts 3043-011

SVS C3 ANSI C, Pascal, or FORTRAN-77
 by Silicon Valley Software

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	LIST	PS Price
ANSI C	\$325	\$315
Pascal	\$325	\$315
FORTRAN	\$395	\$375

FastFacts 1958-048: (C), 1958-050: (Pascal), 1958-049: (FORTRAN)



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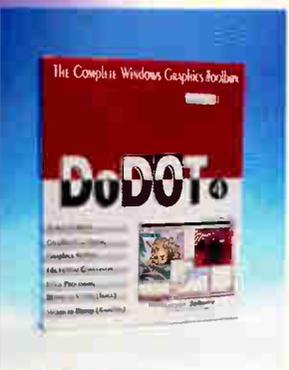
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FastFacts 2001-006

PC-lint 5.0
 by Gimpel Software

PC-lint 5.0 is the leading C diagnostic facility for finding bugs, glitches and inconsistencies that your C compiler, working on one module at a time, will miss. PC-lint, with over 400 messages and 100 options, is extraordinarily powerful and fully customizable. New features include a slow-control analysis to catch possibly uninitialized variables and programmer-controllable typedef-based strong type checking. Contains special checks for Windows debugging. Supports full K & R and ANSI C standards, and is the perfect add-on to your Microsoft C compiler.

LIST: \$139 **PS Price: \$95**
FastFacts 53-009



DoDOT 4
 by Halcyon Software

DoDOT version 4 is the complete graphics toolbox for Windows users. Graphics file conversion/viewing/printing, screen capture, bitmap-to-vector, vector-to-bitmap (Trace), color image processing and editing, scanner input, FAX output, and many more, all integrated into one easy-to-use environment. It also catalogs graphics files with preview images (Thumbnails) for quick access. Supports over 50 vector (Draw) and bitmap (Paint) file formats.

List: \$189 **PS Price: \$175**
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SMARTCOM EXEC™
 by Hayes Microcomputer

Powerful communications software that combines terminal emulations, error-control protocols, and a text editor to meet the needs of virtually any user. In addition to modem sharing support over a LAN, Smartcom Exec provides SCOPE scripting language, keyboard macros, mouse control, language support, and more to provide the ideal program for business and home use.

LIST: \$129 **PS Price: \$119**
FastFacts 1952-019



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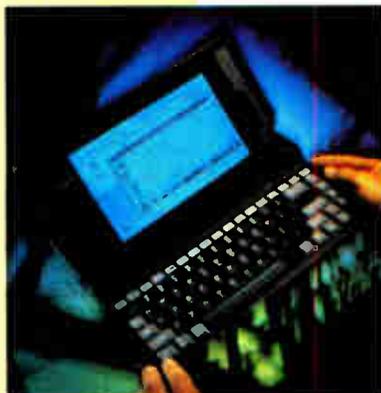
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The card below registers you for the Winning Streak Daily Drawing at COMDEX. We're giving away one fully-loaded GRiD 386SX Notebook every day of the show, November 16–20! You don't have to be present to register or win. If you're at the show, just drop the card off in our booth (#H7330 at the Las Vegas Hilton). Otherwise, send it to us by November 12, 1992.

Your Winning Streak continues at COMDEX. Try to get lucky with Big Bertha.

Big Bertha is over six feet of slot machine loaded with goodies from Computer Associates, Pro-C Ltd., 3-D Visions, and many other hot manufacturers. Not to mention a special grand prize—to be announced at COMDEX—from us. Come to our booth (#H7330 at the Las Vegas Hilton) and give Big Bertha a spin!

So get on a Winning Streak with the Programmer's Shop.

If you've won cash off your next Shop purchase, you can take it right now. To claim your Notebook or Calculator, send us the postcard below by December 31, 1992. Call now to find out what you've won, then fill out and mail the postcard to register for the Winning Streak Daily Drawing at COMDEX. Good luck!

Call today: 1-800-421-8006.

Fill out this card to claim your Notebook or Calculator and to register for the Winning Streak Daily Drawing at COMDEX. You could win a GRiD 386SX Notebook!

You must complete all information below to be eligible for the daily drawing at COMDEX. No purchase is necessary, and you don't have to be present to win, but we must receive this card by November 12, 1992 to include you in the drawings. If you're attending COMDEX, drop it off at our booth during the show. So fill it out, put a stamp on it and pop it into the mail today.

Your prize code is: **S03BB**

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I. NO PURCHASE IS NECESSARY TO PLAY. Call 1-800-421-8006 and tell us your prize code. Fill out prize card to claim prize if you have won either a notebook or calculator prize and/or to register for Winning Streak Daily Drawing at COMDEX to win notebook. II. PRIZE QUANTITIES AVAILABLE AND ESTIMATED UNIT RETAIL VALUE AND ESTIMATED ODDS OF WINNING based on 1,195,000 prize codes. (1) GRiD Systems 386SX Notebook (model #1755) estimated retail value \$5,255 (odds of 1:209,000). Odds of winning a notebook at COMDEX drawing are dependent upon number of prize cards returned. (2) Scientific/Programmer's Calculator estimated retail value \$19.95 (odds of 1:1,608). (3) \$10 discount on any single purchase from Programmer's Shop of \$299 or greater (odds of 1:10). (4) \$5 discount on any single purchase from Programmer's Shop of \$199 or greater (odds of 1:1.1). Overall odds of winning any prize are 1:1. (5) All prize claims must be received by December 31, 1992. Claims

Rules continued on other side

World Radio History



GRiD Systems 386SX Notebook (model #1755)

This 20 MHz, 80C386SX machine with rugged ABS casework comes with DOS 5.0 and PenRight! Pro SDK for effortless development of pen-centric applications.

The 386SX offers high-contrast, sidelit, Triple-Supertwist LCD with 1:1 aspect ratio; 80MB hard drive; 8MB RAM; 2400 BPS MNP-5, and FAX modem*. It supports 640X480 VGA graphics and includes ports for parallel printer, serial RS-232 (9-pin), and VGA monitor; rechargeable battery with built-in quick charge, resume battery, real-time clock, full system power management, and 110/240V AC autosensing power supply. This system, worth over \$5000, comes equipped with a Microsoft ballpoint mouse and a leather-and-cordura carrying case for easy transportation.

GRiD Systems designs, manufactures, markets and services laptop, pen, desktop and multimedia computers, pen-based software development tools, electronic mail and networking systems.

*FAX operation requires FAXTalk software (not included).

Scientific/Programmer's Calculator

This pocket-sized calculator features binary, hexadecimal, octal and decimal conversion in addition to trigonometric and statistical function keys. Comes with durable black vinyl carrying case, operation manual and batteries.



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Rules continued from other side

received after December 31, 1992 shall be null and void and ineligible for prizes. Unclaimed prizes will not be awarded. (6) To be eligible for COMDEX drawing, we must receive your prize card by November 12, 1992. During COMDEX, you may deposit your prize card at our booth (#H7330 at the Las Vegas Hilton) at any time before our final drawing at 12:30PM, November 20, 1992. We suggest you photocopy your prize card for your records. (7) GENERAL CONDITIONS Open solely to U.S. residents. Employees of The Software Developer's Company, Inc. and organizations engaged in the development, product advertisement or distribution of game materials and their immediate families or members of their households are not eligible to participate or win prizes. VOID WHERE PROHIBITED, LICENSED OR TAXED BY LAW. By participating in this game you agree to be bound by these rules and the decision of the judges shall be final. All taxes on prizes are winner's responsibility.

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	LIST	PS Price
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FastFaxits 502-408: (PRO). 502-407: (Stand.)



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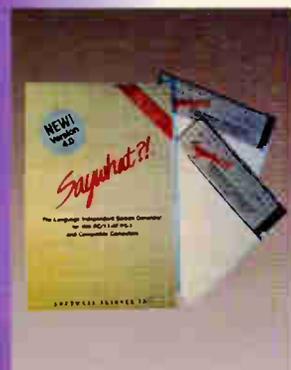
LIST: \$300 PS Price: \$259
FastFaxits 873-008



High C/C++ v3.0 by MetaWare Incorporated

MetaWare Incorporated introduces its newest product: the 32-bit High C/C++ compiler, version 3.0. High C++ is a true compiler, not a C to C++ translator. "Incremental Strengths" lets you specify the level of C++ compilation, allowing you to migrate from C to C++ one C++ block at a time. Included in the package is a C++-tailored source-level debugger, and a 32-bit Application Development Kit for Windows. MetaWare offers a full line of multi-language, multi-platform compilers for professional software developers.

LIST: \$795 PS Price: \$749
FastFaxits 89-038



SAYWHAT?! (v4.0) by Software Science Inc.

Designing screens should be simple! With Saywhat!, it is! Create slide shows. A terrific prototyping tool - design user interfaces with your user in seconds! Supports all programming languages, template based code generator, mouse, moving bar menus, screen libraries. If you use dBase files, access them while building screens. Sample screens, code and utilities, plus free technical support. Upgrade policy for owners of other screen designers. 60 day money back, no questions!

LIST: \$79 PS Price: \$75
FastFaxits 1098-001

M++ by Dyad

M++ is both a math library and an array language extension to C++. M++ incorporates the functionality of both LINPACK code for solutions to linear equations and EISPACK code for solutions to eigenvector problems. M++ includes generalized outer operations, FFT and convolution functions, array manipulation functions, indexing methods, etc., in a multidimensional array language. Also available with source code.

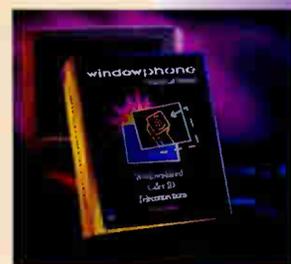
LIST: \$295 PS Price: \$279
FastFaxits 3138-001



WindowPhone™ Software Developer's Kit by AG Communication Systems

Write applications for WindowPhone™, the personal call manager with Caller ID teleconnections. Your Windows/WindowPhone program may connect millions of home-office and corporate users to customer service databases, PIMs, order entry and much more. Includes everything needed to write customer applications: WindowPhone board, PSKSPY utility and source code, DLL, API documentation, on-line help, developer user manual and demo program.

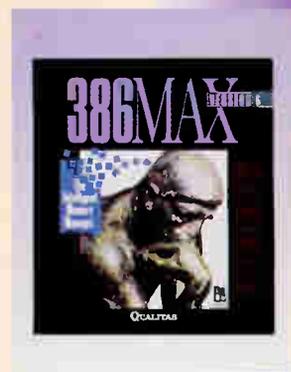
LIST: \$495 PS Price: \$439
FastFaxits 4061-002



386MAX 6.0 by QUALITAS

Winner of the 1991 BYTE Award of Merit, PC Magazine's Editors' Choice Award, PC World's Best Bet, InfoWorld's Top-Scoring Memory Manager, and one of PC/Computing's 200 Best Products, 386MAX 6's new graphical interface seamlessly integrates memory management with SmartMemory™, disk cache and a powerful system analyzer.

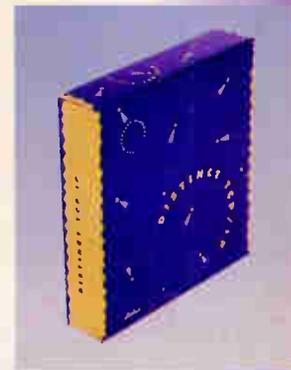
LIST: \$100 PS Price: \$61
FastFaxits 123-001



Distinct TCP/IP for Windows by Distinct Corporation

Distinct TCP/IP for Windows SDK extends the TCP/IP and RPC/NDP networking capabilities to Microsoft Windows. Includes the smallest and fastest DLLs today available for Berkeley Sockets, RPC, Telnet, and FTP. Coexists on the same board with Lan Manager, Novell and Banyan. Supports Packets, NDIS and ODI drivers. Only 5KB of DOS memory required.

(SDK) LIST: \$495 PS Price: \$439
(Applications) LIST: \$395 PS Price: \$379
FastFaxits 1951-003: (SDK), 1951-007: (App.)



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ResourceSHIELD by The Stirling Group

ResourceSHIELD integrates the process of creating, editing, translating, compiling and managing resources for graphical applications. A visual resource development tool with seven resource editors that will edit resources in binary or text resource files. Pre-designed resource templates for dialogs, menus and icons are included.

	LIST	PS Price
Windows	\$149	\$139
OS/2 2.0	\$295	\$279
Windows NT	\$295	\$279

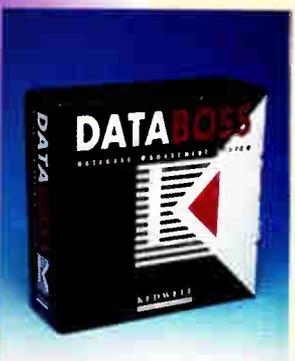
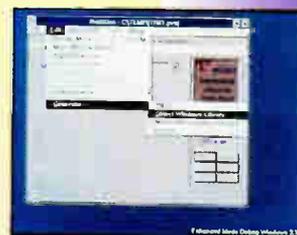
FastFacts 2929-019: (Win. & OS/2)

ProtoGen 3.0 by Protoview

NEW VERSION! The industry standard for code generation and prototyping Windows applications. Develop the user interface of your application using Visual prototyping methods. ProtoGen generates expert level, commented code for ANSI C, Microsoft MFC C++, Borland OWL C++, Turbo Pascal, and Microsoft NT Win32. All generators included! User Code is preserved from one generation to the next. It's easy and fast.

LIST: \$199 **PS Price: \$99**

FastFacts 2115-009



DataBoss 3.5 by Kedwell Software

Works with your favorite compiler to generate complete, working relational database applications in error-free C/C++ or Pascal. DataBoss cuts your development time in half, but still gives you the flexibility of traditional methods. You quickly create entry screens, menus and reports and build single-user and networked multi-user systems. Customizable source code is included, and you pay no run-time royalties. Ever.

LIST: \$695 **PS Price: \$415**

FastFacts 5277-001

Janus/Ada x86 Compiler by R. R. Software

Janus/Ada for MS Windows is a complete implementation of Ada for Windows. Windows Applications can be developed in Ada when the Toolkit is used with the Janus/Ada PDS. Hosted on 80386 and 80486 platforms, the Windows toolkit with PDS includes: royalty-free runtime libraries, Ada-sensitive editor, Ada make utility, Ada syntax checker and pretty printer, Full Chapter 13 support including C interfacing, assembler, and tutorial.

LIST: \$129 **PS Price: \$99**

FastFacts 586-002



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• Blinker	299	269	• Macro Assembler (MASM)	150	99	• ProComm Plus	129	89
• Borland C++	495	319	• MS-DOS 5.0 upgrade	100	65	• Q+E Database/VB	199	175
• Btrieve for DOS	595	399	• MS C/C++	495	309	• QuattroPro	495	349
• Carbon Copy Plus	199	118	• MS Excel	495	329	• QEMM	100	64
• Clarion Prof. Developer 2.1	845	469	• MS Test for Windows	395	275	• R&R Code Generator	199	159
• Clipper	795	499	• MS Visual Basic Prof. Toolkit	299	229	• R&R for dBASE/Compatibles	249	159
• CodeBase 4.5	395	295	• MS Windows 3.1	150	99	• Visual Basic 1.0	199	139
• dBASE IV 1.5	795	529	• MS Word	450	239	• WATCOM C 9.0/386	895	599
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• DR DOS	99	59	• MKS Toolkit	249	199	• WordPerfect	495	279
• Dr. Switch-ASE	180	146	• NetLib	299	259	• WordPerfect (Windows)	495	299
• EasyCASE Professional	649	539	• Norton Desktop for Windows	149	109	• Xtree Gold	149	109
• Filerunner	100	79	• Norton Utilities	179	115	• 286/DOS Extender SDK	495	435
• INSTALIT	149	119	• ObjectVision	150	105	• 386/DOS Extender SDK	495	435
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The World's First Multi-Mode Universal File Editor

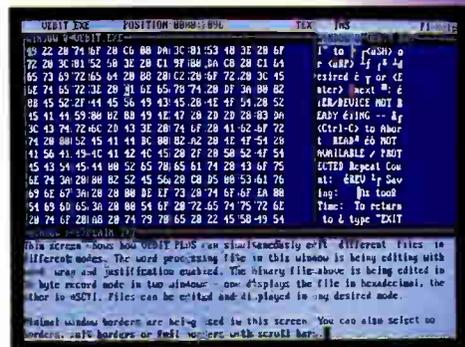
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- Emulate Wordstar, Word Perfect, Brief, vi, others



The new VEDIT PLUS is today's finest programmer's editor. Small (80K) and lightning fast, it is written entirely in assembly language. VEDIT PLUS is the only programmer's editor that can edit any text or binary file you will ever encounter.

Incredibly, VEDIT is over 20 times faster than other editors on just a 3-megabyte file. When editing multi-megabyte files, only VEDIT has the speed to get the job done.

Benchmarks in 3 Meg File	VEDIT	BRIEF	Sage
Save and continue	52 sec	3:52 min	1:47 min
Load, modify, save, exit	21 sec	49 sec	1:38 min
Block-column copy (40x200)	2 sec	30 sec	2 sec
Delete one column in file	9:58 min	1:50 hour	1:03 hour
60,000 search & replace	3:18 min	1:44 hour	1:32 hour

The extensive compiler support runs popular compilers and also your favorite linkers, debuggers and Make from within VEDIT. It even integrates tools from different vendors. When shelling to DOS, VEDIT swaps itself and TSRs out of memory, giving you a much as 620K of available memory for compiling the biggest programs. Only VEDIT gives you the advantages of a powerful editor with the convenience of an integrated environment.

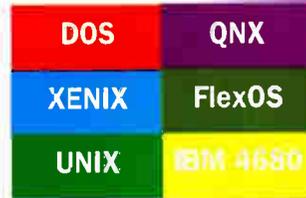
VEDIT PLUS has every advanced feature you might expect. Simultaneously edit numerous files, split the screen into windows, search/replace with regular expressions. Automatic indent, block indent, parentheses matching and block operations by character, line, file or column speed program development. Word wrap, paragraph formatting, justification, centering and many printing options are ideal for text processing.

VEDIT PLUS has the most powerful macro programming language of any editor. It eliminates repetitive editing tasks and lets you create your own editing functions. It includes testing, branching, looping, user prompts, keyboard input, string and numeric variables, complete control over windows plus access to hardware interrupts, memory and I/O ports. Source-level debugging helps you develop new macros quickly and easily.

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Until now, few PC text editors could even begin to handle huge mainframe, CD ROM, postscript, plotter output and other multi-megabyte files. The new VEDIT PLUS, with its unique virtual memory management, handles them all effortlessly.

Edit in ASCII, EBCDIC or Hexadecimal modes, or split the screen for any combination of modes. File modes support DOS text, UNIX text, binary and many fixed-length record formats.



An intuitive user interface with drop down menus, hot keys, mouse support, optional scroll bars, context-sensitive help, point and shoot file selection, 1000-level undo and unlimited keystroke macros make VEDIT PLUS easy to use, easy to learn. And it can emulate the keystrokes of almost any editor you already know.

Everything in VEDIT PLUS is configurable. The keyboard layout, the screen colors, displaying control characters, long lines, and window borders, and much more, are all configured with easy to use menus.

Confidently order your copy of VEDIT PLUS today; it comes with a 30-day money-back guarantee. VEDIT has been the choice of 100,000 programmers, writers and engineers since 1980.

VEDIT PLUS-DOS single user license: \$119; DOS network 5-user license: \$269; UNIX/XENIX, QNX: \$249; FlexOS/IBM 4680 single CPU license: \$259. Site license pricing is available.

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Call 1-800-458-3348 for a fully functional demo disk of VEDIT PLUS. Demo and shareware of VEDIT Jr. on the BBS at 1-313-994-1304

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Voice, Fax, and Data

The Ultima Home Office/PC add-in card provides voice-mail, data-modem, and send/receive fax capabilities for your desktop or portable PC. With a V.32bis modem, the card can transmit at speeds of up to 14,400 bps. The card also has MNP level 5 and V.42bis automatic error correction and data compression, enabling it to determine the speed of another modem and connect at that modem's highest speed within the range of 300 to 14,400 bps.

Maxfax, an integrated software application for fax and voice mail, operates as a DOS and Windows application. The card lets you convert ASCII, PCX, TIFF, and IMG files to fax format, and its preview mode lets you view as many as 10 fax images at once. The voice portion runs as a DOS TSR program; you go into Windows to play messages and record faxes. Line sharing enables you to connect to a standard telephone line to accept voice, fax, and data calls.

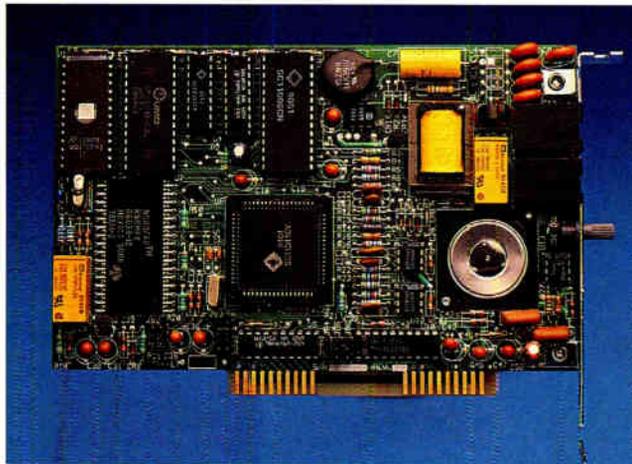
Price: \$539.

Contact: Prometheus Products, Inc., 9524 Southwest Tualatin Sherwood Rd., Tualatin, OR 97062, (800) 477-3473 or (503) 692-9600; fax (503) 691-1101.

Circle 1296 on Inquiry Card.

Cordless Modem

The Scarab 9600 Cordless Modem uses a UHF RF modulation transmission technique to connect communications devices at distances of from 50 to 200 yards. You connect the modem to your PC's serial port using the supplied three-way serial-port cable. The relocatable head



Voice mail in the Ultima Home Office/PC lets you identify mailboxes to which you can forward urgent messages.

unit and range-test facility lets you determine unexpected areas of radio window, maintain optimal reception and siting at range, and escape areas of radio shadow.

The Scarab Program can run in the background and pop up between communications tasks and interface to foreground DOS applications. The package also includes Datasoft's Datatalk4 modem software. You can also program the Scarab 9600 as a multifunction messaging and error-protected multiframe transfer system or as a serial-port sharer and multiplexer for communications equipment such as fax modems.

Price: About \$540 (£301).

Contact: New Era Microsystems Ltd., 24 Cargate Ave., Aldershot, Hampshire GU11 3EW, U.K., 44-252-345426; fax 44-252-317699.

Circle 1297 on Inquiry Card.

Remote Control in Windows

The Windows-based remote-control and communications application Remotely Possible/Dial 2.0 uses a Windows DLL to interact with the Windows 3.x GDI (Graphics Device Interface)

library. In addition to allowing full access to a remote PC running Windows, the dial-up software includes file transfer and interactive chat between two PCs that are running Windows.

With support for serial-port speeds as high as 115,200 bps, Remotely Possible/Dial 2.0 is compatible with the Codex 3261 V.Fast modem, as well as V.32 and V.32bis modems. The new version also supports Super VGA displays of up to 1024-by-768-pixel resolution with 256 colors, as well as Windows accelerator cards. A single copy supports the local and remote PCs. Site licenses are available.

Price: \$199.

Contact: Avalan Technology, Inc., 116 Hopping Brook Park, Holliston, MA 01746, (800) 441-2281 or (508) 429-6482; fax (508) 429-3179.

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Peer-to-Peer Networking

Two systems offer different approaches to building a peer-to-peer LAN. One con-

centrates on small networks; the other has larger aspirations.

The MosesAll peer-to-peer network operating system lets you network up to eight computers, which can share applications and data, print files, and run Windows from any Windows-compatible PC on the network. MosesAll comes with a 2-Mbps network card, a copy of Moses-NOS 3.0 network operating software, and 25 feet of standard telephone wire. The expandable system supports operations at up to 500 feet per node via standard unshielded twisted-pair cable.

Price: \$99 per node.

Contact: Moses Computers, 15466 Los Gatos Blvd., Suite 201, Los Gatos, CA 95032, (408) 358-1550.

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Available for up to 200 PCs, the Let's Talk Modular Networking System lets you transfer files from one computer to another, send messages to others on the network, and access any networked printer from any networked computer. You can exchange messages with other people on the network without interrupting your current application. The Chat feature lets you type in messages on one side of a double window while receiving responses on the other side.

To install Let's Talk, you plug a small interface module into the parallel port of the PC. Any printer connected to the port remains operative. Computers are linked via a daisy chain of modular telephone cord.

Price: Two-computer starter kit, \$279.95; expansion kit, \$139.95.

Contact: Data Spec, 9410 Owensmouth Ave., Chatsworth, CA 91311, (818) 772-9977.

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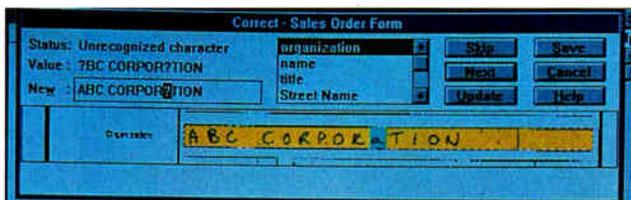
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Build Fax-Driven Programs for Windows

T PDK (Teleform Programmer's Developer Toolkit) lets you build fax-driven action into your Windows applications. The toolkit contains Cardiff Software's Teleform fax-processing program and a data interpretation library, TIE (Teleform Interpretation Engine). Teleform is Windows-based fax-processing software that lets you distribute custom-designed forms and collect filled-in forms via fax. You can also collect form-based data from sources such as scanned documents or fax servers.

Teleform processes the contents of collected image files via shaded circles or intelligent character recognition and stores the data. TIE is a DLL that interprets the collected data and performs a specific action (e.g., route, store, format, or execute data in real time) indicated by the information gathered.

TPDK runs under Windows and is written in C. According to the developer, it will work with any fax board,



TPDK flags suspicious characters to ensure that your applications collect useful data.

network, fax server, or scanner. A multiuser version lets you process multiple incoming faxes simultaneously. **Price:** TPDK, \$1495; multiuser version, price depends on configuration. **Contact:** Cardiff Software, 531 Stevens Ave., Building B, Solana Beach, CA 92075, (800) 659-8755 or (619) 259-6430; fax (619) 259-6450. **Circle 1304 on Inquiry Card.**

Generate Portable Windows Code

Cross-platform portability is one of many new features built into version 4.0 of the WMP (WindowsMaker Professional) Windows application builder and C/C++ compiler. Using interchangeable code-generation modules, you can design your application once and then generate code for ANSI C, Borland OWL C++, Windows NT,

OS/2, Turbo Pascal, and other languages and platforms.

WMP generates both framework and interface code. The system provides often-used GUI elements (e.g., menus, scroll bars, and dialog boxes) in a toolbar, so you can make your most common selections from a main window. The WMP simulation mode lets you test your Windows interfaces before generating code.

WMP ships with the ANSI C code-generation module. There are no run-time fees or royalties associated with distribution of WMP-based programs.

Price: WindowsMaker Professional 4.0, \$995; additional code-generation modules, \$495 each. **Contact:** Blue Sky Software Corp., 7486 La Jolla Blvd., Suite 3, La Jolla, CA 92037, (800) 677-4946 or (619) 459-6365; fax (619) 459-6366. **Circle 1301 on Inquiry Card.**

Windows OOP Originator Upgrades

The latest Windows release of the Smalltalk/V OOP (object-oriented programming) tool provides traditional Smalltalk/V features (e.g., source code browsers and push-button debuggers) while offering support for Windows 3.1-based features. New to version 2.0 are DDE and DLL support. The system

also includes a configurable panel of push-button programming functions, an application status window, and support for non-U.S. character sets.

According to Digitalk, Smalltalk/V Windows source code is compatible with code generated in the Smalltalk/V OS/2 environment.

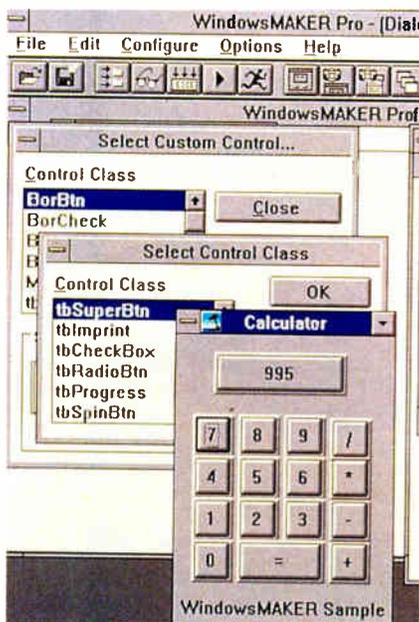
Price: \$499.95. **Contact:** Digitalk, Inc., 9841 Airport Blvd., Los Angeles, CA 90045, (310) 645-1082; fax (310) 645-1306. **Circle 1302 on Inquiry Card.**

Portable GUIs from XVT

A pair of programming tools from XVT Software let you design and build a program that will run on six different GUIs and over 26 platforms without rewriting code. To use version 3.0 of the royalty-free XVT Portability Toolkit, you write your application in C or C++ and use the XVT API calls to create and manipulate the interface. Supported GUIs include Windows, Presentation Manager, Macintosh, Motif, Open Look, and character displays.

XVT-Design 1.1 lets you graphically design and manipulate all controls and attributes available in the Portability Toolkit. XVT-Design generates ANSI C GUI code, C header files, make files, and Universal Resource Language files that are compatible with the Portability Toolkit.

Price: XVT Portability Toolkit 3.0, \$1450 to \$4400; XVT-Design 1.1, \$1200 to \$2900. **Contact:** XVT Software, Inc., 4900 Pearl East Cir., Boulder, CO 80308, (303) 443-4223; fax (303) 443-0969. **Circle 1303 on Inquiry Card.**



WindowsMaker Professional provides the visual elements of a Windows user interface as ready-made objects.

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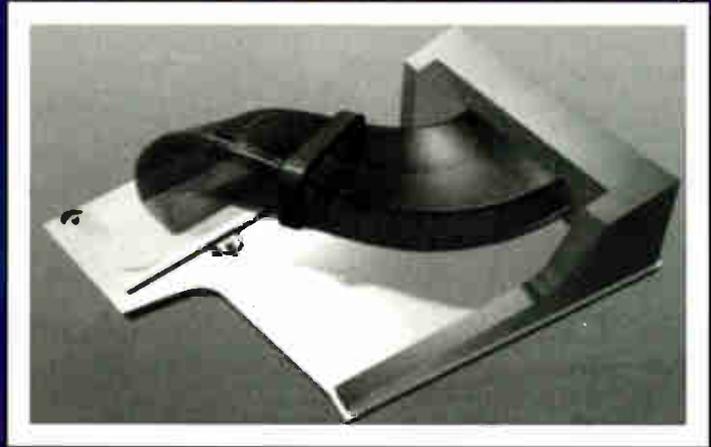
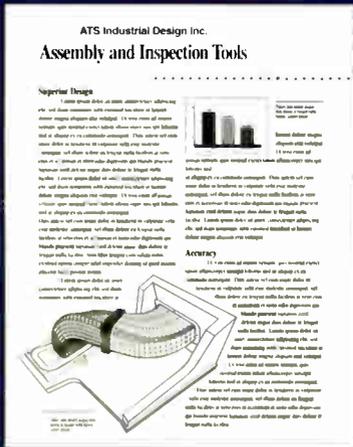
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ProTracer achieves its high quality output by utilizing a 64 nozzle printhead to deliver crisp lines and bold, high contrast blacks. Its 360 dpi resolution assures sharp lines needed for everything from the most complex engineering drawings to sophisticated text and graphics used in letters and reports.

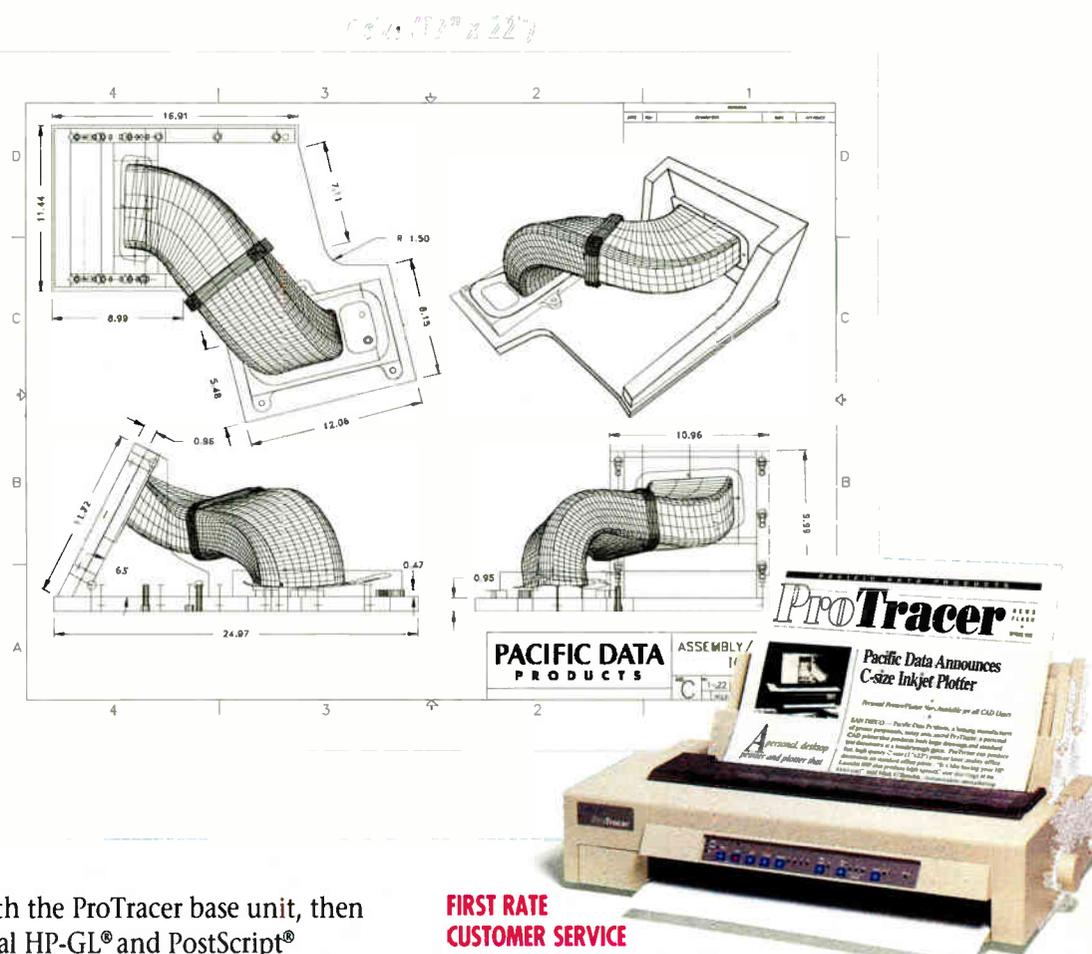
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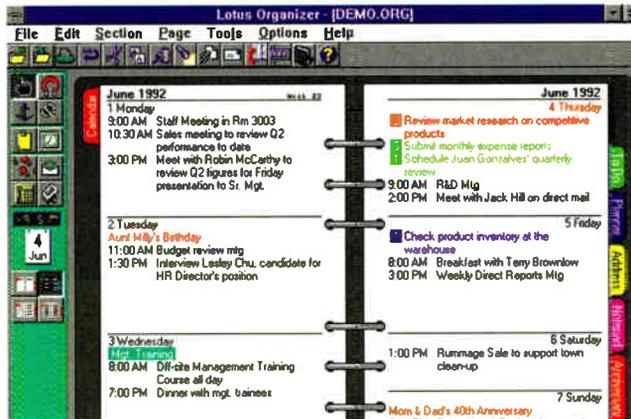
Lotus Organizes and Symphonizes

Recently acquired from U.K.-based developer Threadz, Lotus Organizer uses a notebook metaphor to pull together the six sections of the program. Different-colored vertical tabs let you access Organizer's calendar, to-do list, planner, address book, notepad, and anniversary-tracking tools. Context-sensitive icons in each tool guide you in performing such tasks as selecting views, creating new entries, and building links between entries. You can also create multiple copies of particular notebook sections. Version 1.0 does not yet support Windows 3.1's OLE, but it is DDE-enabled.

In bringing new Windows products to market, Lotus has not forgotten the DOS platform. Symphony 3.0 integrates spreadsheet, word processing, graphics, database, and communications functions and includes Bitstream display and printer fonts. WYSIWYG display and spreadsheet-publishing capabilities, scroll bars, and sizable windows are new, as are improved memory management, a spreadsheet auditor, and an enhanced file viewer. **Price:** Organizer, \$149; Symphony 3.0, \$695. **Contact:** Lotus Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142, (800) 343-5414 or (617) 577-8500. **Circle 1305 on Inquiry Card.**

Unix Accounting

Version 7.0 of Unifacts Unix accounting software includes a new Cash Book facility, free-format in-



The Lotus Organizer notebook interface even has rings down the center of the screen.

voice layouts, and a price/discount matrix in the Sales Ledger. The enhanced Stock Control module includes three list prices and a quantity price discount structure for each record. Also, you can now search for products by description, as well as by product code.

Unifacts provides a gateway to open systems by storing data elements in C-ISAM format. With this format, you can create an on-line link to other packages and tailor Unifacts to your business requirements.

Available for SCO Xenix 386 and SCO Unix, the core Unifacts package consists of six modules: Sales Ledger, Purchase Ledger, Nominal Ledger, Invoicing, Payroll, and Stock Control. You can expand it to include additional Cash Book, Factslink, Sales Order Processing, Bill of Materials, Job Costing, Management Accounts, and Fixed Asset Register modules.

Price: Six-module core package, about \$3400 (£1795); extra modules, about \$665 (£350) each.

Contact: Pegasus Software Ltd., 35-41 Montagu St., Kettering, Northamptonshire NN16 8XG, U.K., 44-536-410044; fax 44-536-81796.

Circle 1316 on Inquiry Card.

Expanded Database Support for IQ 3.0

Improved screen-creation tools and expanded database support come with version 3.0 of IQ (Intelligent Query) for DOS. The database-independent report writer and query tool from IQ Software now works with more than 60 databases and file systems (including Structured Query Language and 3GL-based systems), with support for Informix, Ingres, and Sybase files provided in the current release.

IQ helps you create reports from simple columnar to complex free-form and matrix output using its pop-up menus for selecting and retrieving data and a screen painter for report layout. IQ's WYSIWYG screen painter lets you define areas for sub-headings and page footers. You can also incorporate long text fields with features such as margins, font control, and word wrapping. IQ now lets you create matrix (or

cross-tabulation) reports for generating spreadsheet-type summaries. Also included is a label generator, which offers more than 30 styles of labels. **Price:** Single-user license, \$500; 50-user license, \$17,000.

Contact: IQ Software Corp., 3295 River Exchange Dr., Suite 550, Norcross, GA 30092, (404) 446-8880; fax (404) 448-4088.

Circle 1306 on Inquiry Card.

Peachtree Ships Major Accounting Upgrade

Version 6.0 of Peachtree Complete Accounting for DOS consists of three programs: Peachtree Basic Accounting, Complete Accounting, and a multiuser version of Complete Accounting. Basic Accounting, a start-up system for small businesses, includes tools for general ledger, accounts receivable, accounts payable, budgeting, billing, inventory management, reporting, and other tasks. Complete Accounting provides all the functionality included in the Basic program and adds a custom report writer and purchase-order, job-cost, payroll, and fixed-assets modules.

Peachtree Complete Accounting also lets you process handwritten checks, delete previously posted invoices, print your Trial Balance by range, and add new invoice formats, including a new service invoice and a customized invoice form.

Price: Basic Accounting, \$99; Complete Accounting, \$249; Multi-User Version, \$399 with unlimited user support.

Contact: Peachtree Software, 1505 Pavilion Place, Norcross, GA 30093, (800) 247-3224 or (404) 564-5800.

Circle 1307 on Inquiry Card.

Have You Ever Wanted To Leap Out The Nearest Window?

Take The Plunge With Proxy. It's Network Remote Control For Windows, From Windows.

Some things you expect in remote control software. Like lightning-fast speed. And control over both DOS and Windows on the host PC. But new Proxy gives you something you probably don't expect. Because it not only works with Windows, it works from Windows. And that makes all the difference.

You see, other remote control products run from DOS, even



Proxy supports host computers running Windows.

No need to abandon your own work when someone calls. Just click on a Proxy icon and instantly connect to the caller's machine. You now have full control of their hardware and software, complete with mouse and keyboard support, whether they're running Windows or DOS.

Reconfiguring Lots of Workstations? Leap Out The Nearest Window.

Now you can perform administrative chores like software installation, updates, and system configuration without going from room to room. Just capture a PC and perform any operation as if you were sitting in front of it. You can even reboot it remotely!



Proxy gives you complete control of any computer on the network.

Need More Processing Power? Leap Out The Nearest Window.

Imagine off-loading your most CPU-intensive tasks to separate machines you control as if they were part of your own desktop. Imagine two, three, or more applications, each running at full speed because each has its own dedicated processor. That's the power of multi-processing with Proxy.

You can make Proxy available across the network and give power-hungry users access to spare or idle PCs. You can even dedicate PCs to specific tasks, like a high-powered 486 for CAD or a modem-equipped 286 for communications.

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PROXY™



If it runs on the host, it runs in a Proxy window. Even graphical DOS programs.



You can connect to multiple PCs over a network, with each appearing in its own window.

those that support a host running Windows. So they allow just one connection at a time, and demand total attention from your computer. But Proxy is a Windows application that lets you make multiple connections simultaneously. You can display and control a different host PC in each window you open, while you continue to run local applications.

Users Calling For Help? Leap Out The Nearest Window.

If your job is to help users on the network, Proxy will make it easier.



Run time-consuming jobs on dedicated processors, and control them all from Proxy.

**FUNK
SOFTWARE**

System Requirements: Proxy "Master" runs in Windows and can control multiple "Hosts" running DOS or Windows over an IPX network (e.g. NetWare).

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ware like disk array, self-correcting ECC memory and redundant power supplies. And both are backed by AST's comprehensive service and support, including optional 24-hour a day, 7-day a week on-site service for the Manhattan SMP.



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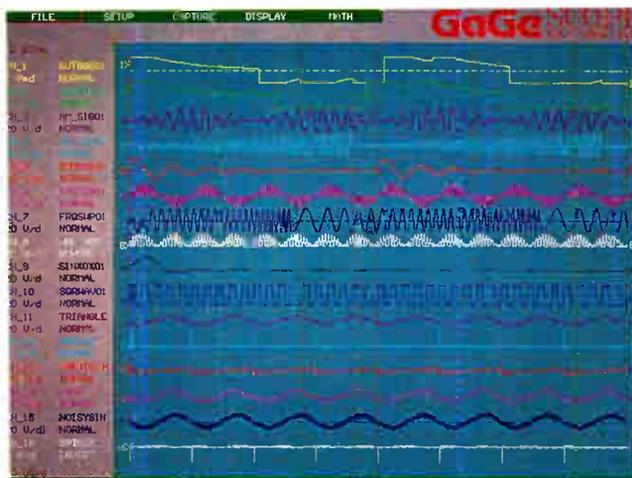
Turn Your PC into an Oscilloscope

Used with a Gage Computer Scope data acquisition card, GageScope 2.0 turns your DOS-based PC into a 16-channel oscilloscope. GageScope provides real-time sampling rates of up to 100 MHz and memory depths of up to 8 MB. GageScope can display data with a time base ranging from 10 ns to 1 megasecond. You can perform absolute and differential measurements on-screen and zoom in to highlight areas of the signal. The software lets you load and store infinite numbers of signals and setups, the developer says, and you can perform data analysis via mathematical functions such as windowed FFT (fast Fourier transform).

Price: GageScope 2.0, \$100; FFT module, \$100.
Contact: Gage Applied Sciences, Inc., 5465 Vanden Abeele, Montreal, Quebec, Canada H4S 1S1, (514) 337-6893; fax (514) 337-8411.
Circle 1309 on Inquiry Card.

Graphing Options for DOS

More than 60 styles of 2-D, 3-D, and Statistical Process and Quality Control graphs are included in the version 2.0 upgrade of PlotIt for DOS. PlotIt graphs data directly from dBase, Excel, Lotus 1-2-3, or ASCII files and now supports thousands



GageScope can display over 65,000 data points in 1 second on a 33-MHz 386 system.

of third-party fonts. Also new are an automatic axis-value-setting function, the ability to compose multiple graphs in the same file, and support for rotated x- and y-axis labels. An On-Line Worksheet lets you perform data transformation and analysis via spreadsheet operations and graph the results. Also available for Windows, PlotIt has a 20-shade palette.

Price: \$495.
Contact: Scientific Programming Enterprises, P.O. Box 669, Haslett, MI 48840, (517) 339-9859.
Circle 1308 on Inquiry Card.

Solve Chemical-Reaction Problems

Now you can solve chemical-reaction problems,

including reaction equations, heat balances, equilibrium compositions, formula weights, phase stability diagrams, and Eh-pH diagrams, on your PC with HSC Software for Windows. The package performs calculations using an integrated thermochemical database of more than 5600 compounds.

Equilibrium calculations help you observe the effects of process variables (e.g., temperature and amounts of raw materials) on product composition. HSC Software calculates equilibrium compositions using the Gibbs Free Energy Minimization method. A Cell Equilibrium calculation option is also available for calculating charge and composition of phases in electrochemical cells (e.g., batteries).

A program for calculating formula weights accepts any form of chemical formula using conventional organic or inorganic expressions (without superscripts and subscripts). HSC displays the formula weight and elemental composition as both weight and atomic percentages.

Phase stability diagrams offer a quick way to locate the stability regions of different phases at varying partial pressures of elements such as oxygen, sulfur, chlorine, and nitrogen oxide. For understanding problems of corrosion, dissolution, leaching, and selective precipitation, HSC can graphically display Eh-pH diagrams. You can draw simple diagrams with only one element and water, as well as more complicated diagrams with several elements.

Price: Single-user license, \$1250

Contact: Outokumpu Research Oy, P.O. Box 60, SF-28101 Pori, Finland, 358-39-826-111; fax 358-39-827-310.

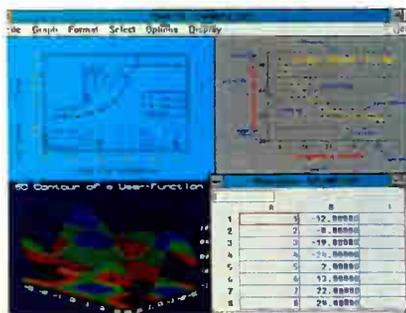
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A Substance-Based Equation Solver

With EES (Engineering Equation Solver), you can design equations using a wide variety of thermophysical property functions. Thermodynamic and transport-property functions for substances such as water, common refrigerants, nitrogen, methane, propane, helium, and other substances are included in version 3.0, which runs on Mac- or PC-based systems. EES lets you set up your equations in a word processor-like window. You can use the software to develop parametric tables by solving the same equation repeatedly with varying input data.

Price: \$400.
Contact: F-Chart Software, 4406 Fox Bluff Rd., Middleton, WI 53562, phone and fax (608) 836-8536.

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PlotIt for DOS lets you build multiple 3-D pie graphs, pareto charts, bubble graphs, fence plots, and many other graphs in the same document.



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Professional Image Processing

The latest version of V, an image-enhancement and analysis package for PCs, turns your system into a scientific imaging workstation. The program includes expanded memory support, multiple image types, contrast processing, dual histograms, color support, and algebraic operations. V2 also offers logical operations, extended mathematics, FFTs (fast Fourier transforms), and other functions.

V2 lets you process and display a variety of data types, from single-bit binary to 64-bit floating-point complex images. Contrast-processing facilities include linear stretching, intensity range remapping, and interactive binary thresholding. You can plot, compare, equalize, and match histograms of images and save histograms in a spreadsheet-compatible format. Geometric operations let you resize images and support noninteger scale factors and unequal horizontal and vertical scaling.

Price: \$1995.

Contact: Digital Optics Ltd., P.O. Box 35-715, Browns Bay, Auckland 10, New Zealand, 64-9-478-5779; fax 64-9-479-4750.

Circle 1315 on Inquiry Card.

Draw and More

At the heart of IntelliDraw lies a program that simplifies drawing by taking care of such tedious work as updating cloned items or aligning objects. Available for Macs and PCs, IntelliDraw combines elements of drawing, CAD, word processing, desktop publishing, and presentation programs in a single application.



V2 lets you process and display a variety of data types. Your images can be anything from single-bit binary to 64-bit floating-point.

IntelliDraw offers specialized tools such as the Connection, which lets you create live links among items. Other "intelligent" tools include the Symmetricon, which draws perfectly mirrored objects, and a framing tool that automatically aligns and spaces the objects it contains. Pop-up palettes give you access to freehand drawing, object blending, image locking, object matching, and other drawing tools.

Price: \$299.

Contact: Aldus Corp., 411 First Ave. S, Suite 200, Seattle, WA 98104, (800) 333-2538 or (206) 628-3320.

Circle 1311 on Inquiry Card.

PC-Write Advanced 4.0

Although it's a DOS application, PC-Write Advanced Level 4.0 sports a

visual interface with pull-down menus, dialog menus, and context-sensitive help. The DOS word processor offers extensive customization options, improved column functionality, advanced mail merge, and multiple windows under DOS.

PC-Write offers drag-and-drop text movement, cut-and-paste operations, columns with multicolumn headlines, and page preview. A new button bar lets you keep frequently used commands close at hand and adapts to specific tasks such as memo or report writing. The program lets you move among 10 open documents at a time. It can import and export WordPerfect, DCA-RFT, and ASCII files.

Price: \$89.

Contact: Quicksoft, 219 First Ave. N, Suite 224, Seattle, WA 98109, (800) 888-8088 or (206) 282-0452; fax (206) 286-8802.

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SPREAD THE WORD

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ColorFax lets you send and receive fax images in up to eight colors with full fax-processing functionality. ColorFax includes an auto-dialer, editable send and receive queues for outgoing and incoming faxes, cover-sheet generation, and background transmission. You can zoom, rotate, and invert incoming fax files, and you can also edit incoming ASCII-based faxes.

The software supports any Intel Communication Application Specification-compliant fax board and also provides image conversion among file formats such as TIFF, GIF, PCX, and Targa.

Price: \$179.

Contact: Black Ice Software, Inc., Amherst Station, Rte. 122, Amherst, NH 03031, (603) 673-1019; fax (603) 672-4112.

Circle 1313 on Inquiry Card.

First Speech Access Package for Windows

Window Bridge lets blind users read Windows programs, such as word processors, databases, spreadsheets, telecommunications packages, and electronic mailers, via voice synthesizers.

When you move a mouse or an arrow key, the software instructs the synthesizer to verbalize an object, such as bit-mapped text, icons, dialog boxes, and buttons. You can attach voice labels to icons and have them spoken automatically.

Price: \$795.

Contact: Syntha-Voice Computers, Inc., 125 Gailmont Dr., Hamilton, Ontario, Canada L8K 4B8, (800) 263-4540 or (416) 578-0565; fax: (416) 578-0625.

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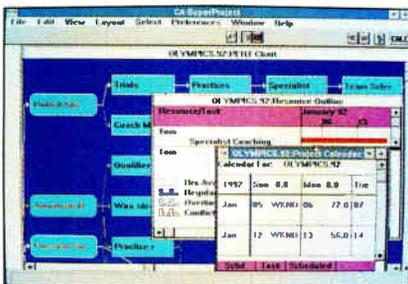
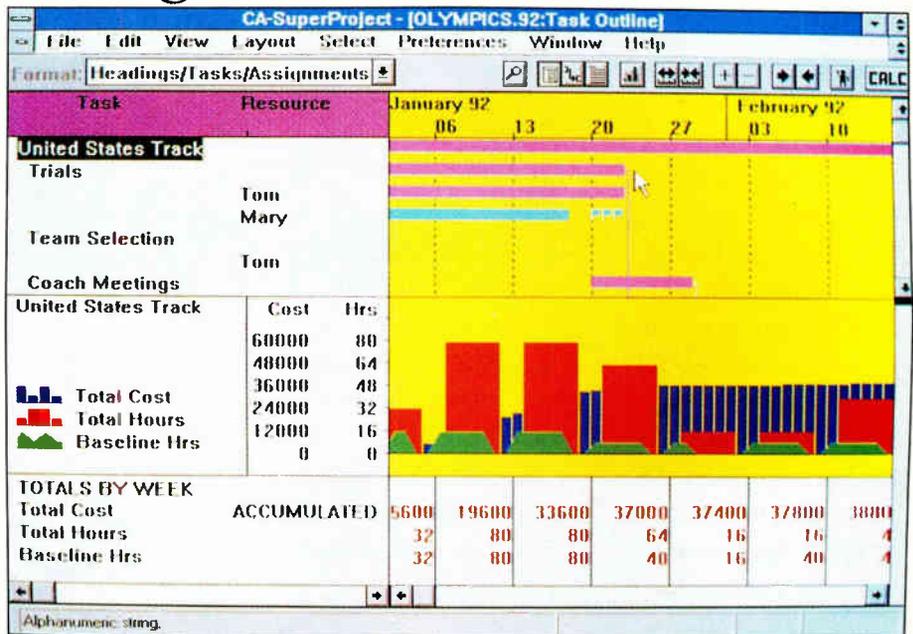


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ing days—leaving Microsoft Project, Timeline 4.0, Project Workbench and Project Scheduler in the dust.



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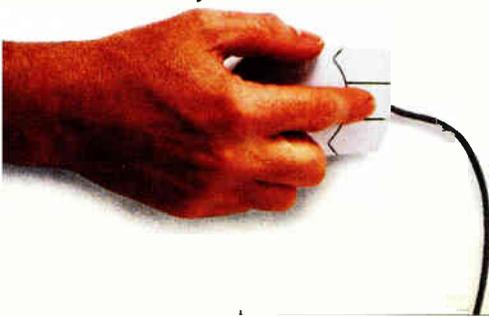
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project, but the finish dates varied by as much as five months. CA-SuperProject For Windows finished first in 214 work-

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"ALR PACKS POWER INTO NOTEBOOKS"

Info World June 22, 1992



If you think computing on the road means sacrificing the type of power you've become accustomed to, then you need to take a look at the new Ranger M486 from ALR. With a choice of high-powered i486 CPUs, the Ranger M486 is a match for any desktop PC. And, unlike other notebooks, the Ranger M486 is upgradeable. You can advance all the way up to 25-MHz i486DX™ computing by simply plugging in a new CPU module!

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circuitry, the Ranger M486 can keep going long after traditional notebooks have shut down. And its super



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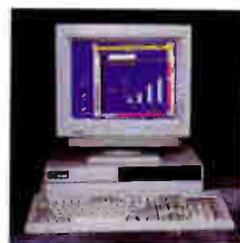
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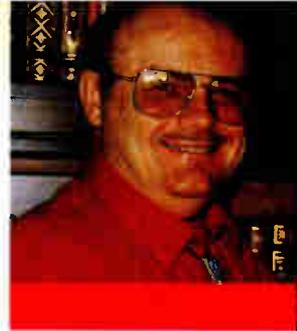
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World Radio History



JERRY
POURNELLE

ON THE ROAD AGAIN

We're headed home from the Western Regional Science Fiction Convention in Phoenix. Robert's driving, the freeway is smooth, and while the light's plain horrible—the sun is directly on the screen—the Zenith Mastersport 386SL seems very much up to the task. When the backlighting goes off, the screen is invisible; but as long as it's on, I have no problems.

One presentation at Westercon was made by Dr. Bill Gaubatz, the McDonnell Douglas manager of the Delta Clipper DC-X program. DC-X begins the new breed of spaceship that General Graham and I sold to Vice President Quayle and his National Space Council a couple of years ago.

The full program develops into a spaceship that flies into orbit and returns without dropping parts downrange. Unlike the shuttle, it's single stage to orbit, everything reusable. Also unlike the shuttle, SSX (Space Ship Experimental) series ships take off and land vertically on a tail of fire, the way the lunar landers did during the Apollo series. When the ship lands, you refuel it and send it up again like an airplane. Next April we'll fly DC-X, a scale model of the orbiter, as a proof of principle and demonstration of SSTO technology and operations. This will be the first rocket ship whose design was driven by operations rather than performance.

University of California at San Diego's Dr. Vernor Vinge asked Dr. Gaubatz why this ship was possible now and wasn't 20 years ago when the shuttle was designed.

"Microcomputers. You need on-board guidance."

X for Salvation

The SSX program revives the X-ship concept of the 1960s, when government financed technology development programs while industry built and operated the actual products. The X-1 broke the sound barrier, and the X-15 flew to space. Others found what you could do with jet engines and odd wing shapes. X ships led to technology, not a government operation; they weren't prototypes. We'd build a few X ships, fly them to the edge of the performance envelope and beyond, probably crash them, and use what we'd learned to build them even better. The result was extremely rapid advances in technology.

In 1970 the U.S. had a favorable balance of trade: we exported more than we imported. Our major export was high technology—chiefly airplanes, but other high-tech stuff, too. Much of that grew directly out of the X programs.

Alas, Robert McNamara killed the X programs in the

name of arms control. They were just too effective in creating new and unpredictable technologies, and unpredictable technology was precisely what the arms controllers did not want. The result was that technology development slowed; and today the major export of the U.S. is agricultural products, not high technology.

Whatever the wisdom of that in McNamara's time, today the real threats to the U.S. are economic, not an uncontrollable arms race. If we're not going to be just another "developing" nation exporting food and raw materials to more advanced nations, we'll need all the high technology we can get. I'm no fan of big government operations like the Incredible Shrinking Space Station; but that's not what the X programs were about.

Indeed, we might well expand the X concept beyond airplanes and spacecraft to other technologies. Build working models, license the technology to American companies at a dollar a year, and use what's learned to move ahead while private industry makes products. I think it's high time to revive the X programs.

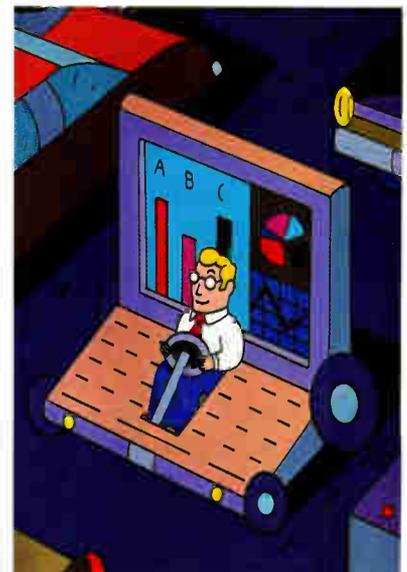
BSE's Flashdrive

We're driving across the desert. The Mastersport's batteries lasted all the way to Phoenix, but I just got the "Low Battery" signal, so I set up my full lash-up: a Zirco 110-volt power supply powering up the Mastersport's regular external power system. I figure I ran the computer off batteries for about 4 hours.

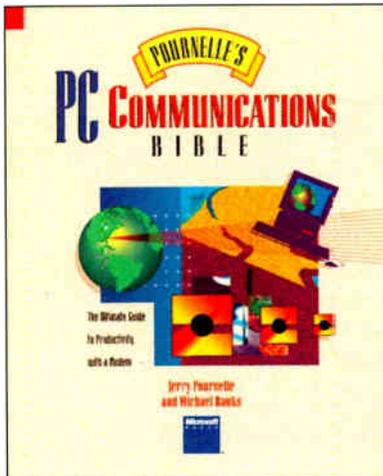
I also have a new gadget, a 130-MB Flashdrive from BSE. It hangs off the parallel port, and it works just fine. I can remember when a 10-MB hard drive was the size of a small washing machine. Now I've got 130 MB in a little box about the size of a Walkman, and that tiny package includes rechargeable batteries.

I installed the Flashdrive last night in about 30 seconds. You just connect it to the parallel port, switch over to

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the floppy drive, and type INSTALL. The Flashdrive takes care of the rest, and it gives you a 130-MB drive D or whatever is your next unused drive letter. It's considerably slower than the internal laptop drive, but for most purposes you don't notice that, particularly with a portable.

The Flashdrive has an internal battery. The software will power down the drive at an interval you set during installation; the default is 30 seconds. Access after power-down takes about 3 seconds, which is actually less time than the Mastersport's internal drive takes to power up (about 5 seconds), so saving a short file to the Flashdrive takes no more time than to the laptop drive. Longer files can be a pain, but I usually don't have many long files I need to transfer.

The power management works: I've had the Flashdrive running for a couple of hours now, and so far it shows no sign of power loss. There's also an external power supply.

The Flashdrive is really "just another drive": I tried putting the pop-up thesaurus on it, and that works fine. You can store programs or run them on the Flashdrive; your machine probably won't notice the difference.

Just before we left, I installed the Flashdrive software on the Cheetah 486. I transferred a lot of stuff from the Cheetah to the Flashdrive, discovering in the process that the Flashdrive works just fine under Norton Commander in both DOS and Windows 3.1. The software is cleverly done: when you reset or power up, if there is a Flashdrive on the parallel port, it will install itself; otherwise, it doesn't burden your system with it. This means that when I get back from the trip, I'll connect the Flashdrive to the Cheetah and copy over any work I got done. That's even faster than LapLink.

We have a 30-MB Flashdrive for Toshiba-san, the T1000 that Roberta used to carry before she fell in love with the Texas Instruments TravelMate 3000 WinSX; it has worked for years, so we're pretty confident about this new one. I'm still not completely happy until I've saved my work onto a floppy disk that I've removed from the machine, but that's old habits; the fact is that the Mastersport's hard drive is reliable, and so is BSE's Flashdrive, so saving on both ought to be enough. Meanwhile, I've got my whole computing environment on that disk.

The Laptop Dilemma

The Mastersport is enough computer for just about anything I would want to do. Like any laptop, it has its limitations as a tablet, although given the Flashdrive,

capacity is not one of them; for that matter, it's got a large enough internal drive. It's a bit heavy to carry around as a notebook.

A few years ago that was no problem. Any machine good enough to write with wasn't really portable enough to carry to meetings and use there. Of course, what's "good enough to write with" has changed a lot. I can recall doing columns from Europe on an NEC PC-8201 that displayed eight rows of 60 columns—and that only because of Traveling Software's Ultimate ROM.

I got a lot of work done with that NEC machine; but then my primary machine was Old Zeke, a CP/M system that displayed only 16 rows of 64 columns each. The PC-8201 had no screen backlighting and only 32 KB of memory.

Nowadays, we expect a lot more of our portable machines. To get the greater performance, however, we had to put up with increasingly larger and heavier "laptops," until we got to the Zenith Supersport 386SX, a wonderful portable with great features, but weighing so much you couldn't really work with it on your lap. I carried that Supersport all over the world, but once I had lugged it into a hotel room, I was never tempted to carry it to meetings.

Things change. The Mastersport 386SL doesn't have quite as large a screen as the old Supersport did, but it's brighter, and I don't have any trouble seeing what I'm doing. The keyboard doesn't feel quite as good, but it's good enough. And the whole unit weighs only about a quarter what the Supersport weighed. I could stuff this machine into a briefcase and carry it to meetings.

There are drawbacks. Zenith, TI, and NCR laptops have fairly noisy keys, and while that's not a problem in a café, it sure would be in a meeting or a press conference. I'm told that one remedy for that is to get one of those plastic keyboard skin thingummies, and I suppose I ought to try that sometime, but I confess I'm not eager to.

Those machines are also fairly heavy and bulky: add a notebook computer to your briefcase, and it's the weight of several books. Put anything else in there, and once again there's that familiar list to starboard as the shoulder strap drags you over. Then, too, unless you habitually carry a briefcase or backpack, there's the decision, do you want to carry a briefcase or backpack at all?

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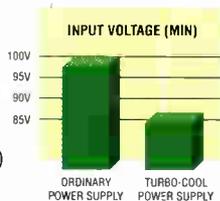
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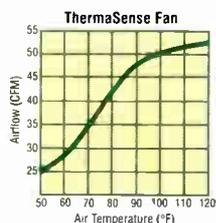
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World Radio History

Safari NSX/20 notebook to be different, and it is. They've gone about as far as you can go in making a true notebook computer out of a laptop. This handsome unit is lightweight and reasonably durable. The small door that covers the parallel port has had to be secured with duct tape, but that seems pretty standard for little covers on laptops; I can secure this one invisibly from the inside.

I've no real complaints about its construction. They've dropped the odd little handle from the earlier model, and it's as well: I thought I liked that handle, but in fact I never used it. The keyboard is about as small as a keyboard can get. The keys are somewhat stiff, but they will wear in. The Home and End keys are not as conveniently placed as on the Mastersport's keyboard, but I've found I can get used to just about any keyboard.

Naturally they've had to make compromises. The worst has to do with the trade-off between having a mouse-like device and having arrow keys. The Safari solves the mouse problem by replacing the normal arrow keys with three keys that together act as a mouse.

The center key acts as a small joystick,

The NSX/20 is about as far as you can go in making a true notebook out of a laptop.

while those on each side of it act as mouse buttons. It's a bit awkward to use, and I find that clicking and dragging really requires two hands, but it does work; and it avoids having to attach the Microsoft Ballpoint Mouse or Logitech's TrackMan Portable mouse device. Those work very well—I like them—but they make the notebook considerably more unwieldy to carry about.

The mouse keys are very much a compromise, because it means that to get or-

dinary arrow-key functions, you must press and hold the blue function key while using the mouse keys as arrow keys. This means using two hands for activities that usually take only one.

In particular, most of my DOS applications want arrow keys, and some don't even know mice exist; not that it matters, because DOS applications like Norton Commander that will use a mouse can't find the Safari's mouse keys. I'm told Safari Systems may fix that in an update; it shouldn't be hard to do. Meanwhile, the mouse-key software will get out of the way if you load in software for a trackball or a real mouse.

The Safari runs Windows very well, and the mouse keys are adequate for that. They are not ideal. If you set the mouse speeds high enough to get the cursor quickly across the screen, the adjustment is a bit delicate for fine-tuned work; if you set it for accuracy, it's annoyingly slow for other work. Also, I do find it a nuisance to need two hands to click and drag. Still, you *can* use it, and it's often a lot more convenient than attaching a TrackMan Portable or Ballpoint. I'm glad that this option is available. There's also a setup

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toggle so the mouse keys can become arrow keys.

The new Safari is considerably changed from the older AT&T model. Some things didn't change enough: the DOS font is better (I'm told because of my suggestion), but I still don't find it as attractive as the Mastersport's. However, I don't hate it. There are also bug fixes. The original Safari had a horribly inconvenient implementation of the blue function key. Now it works as you expect it to. The most important difference is that they've achieved low weight and a thin profile by eliminating the floppy drive.

There are two substitutes. One is an external 3½-inch floppy drive that can be attached with its own port and cable. It gets power from the Safari. Two Safari users could swap programs and data in flight by passing the drive back and forth. The other way to save your work is PCMCIA.

PCMCIA

The Safari has a small front slot for a PCMCIA connection. I didn't at first realize it, but that's probably the machine's most valuable feature. PCMCIA is going to have a big impact on the computer rev-

olution. Ed Coté of NCR thinks it will have as much effect as the AT did on the PC world. He may be right.

The immediate effect of the PCMCIA slot is that you can save your work to a 1-MB card about the shape of a baseball card but perhaps three times as thick. If one of these is in the slot at power-up, it becomes either the A or B drive (depending on whether you've got the external floppy drive attached), and it works just like an extremely fast 1-MB drive. It's odd to have the B drive faster than the C drive. Once you have saved, you can remove the memory card and put it in your pocket or replace it with another; and it appears to be as reliable a way to back up your work as anything else.

I guess I believe that, but my work isn't really safe until it's on a floppy disk. On the other hand, there was a time when I didn't trust 3½-inch floppy disks. If you carry the Safari and a memory card, and keep the external floppy drive and a power supply in your checked luggage, you can save any work done on the airplane—it's unlikely that you can do more than a megabyte of work—on the memory card and transfer the whole mess to a floppy

disk when you get to your hotel and set up your system with wall power.

Years ago I promulgated Pournelle's Laws of Computing. The first, "one user, at least one CPU," has proved accurate. The second, "silicon is cheaper than iron," said that electronics rather than precision-tooled metal would be the mass-storage devices of the future. So far that hasn't been true; but the PCMCIA is moving that way. PCMCIA memory costs about \$50 a megabyte (just like SIMMs), but that price is falling in the usual way.

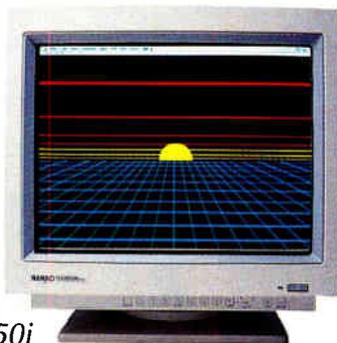
However: it's important to realize that while the PCMCIA can be used as a non-volatile RAM disk, it is not just a memory card. That slot is a full I/O device, a bus extension if you will. You could hang a modem with all its software out there. You could also use it for data distribution: imagine a salesperson getting a full catalog-update database on a tiny write-protected card. You can put software on these cards and run it from them. Connect to your network through them. There are hundreds of potential uses for PCMCIA, and I expect to see a lot of them at this fall's Comdex. Stay tuned. The PCMCIA revolution is just beginning.

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The Ultimate Notebook

I like the Safari, and the PCMCIA slot is a neat feature; but when sitting in my hotel room, I prefer the Mastersport, and Roberta is extremely fond of the TI WinSX and its clone, Gateway's Nomad 420SXL. She carries them alternately. We find that the screens are somewhat better than those on other notebooks, and the keyboards on the WinSX and the Nomad seem to be the best keyboards of the lot, and they're certainly quieter.

I've just swapped over to the Safari, and having to use two hands to get arrow keys is a bit annoying; on the other hand, the machine is plenty good enough. I could easily finish the column with it and start in on fiction. I'm writing in Q&A Write, which is a DOS program I run under Windows, and there's no reason why I can't attach a real mouse and toggle the Safari's mouse keys to arrows. Moreover, the Safari is superb at communications, as you'd expect from an AT&T machine.

Meanwhile, there's a conference going on; and while I'm not at all tempted to carry the Mastersport to any meetings or panels, the Safari is lighter enough that I carried it to the Science Fiction Writers of America business meeting to take notes. Getting rid of the floppy drive did make the Safari lighter and thinner and just plain handier, and not having to attach a trackball makes it a lot simpler to carry.

All told, if you need to run Windows on a notebook computer that you'll actually carry around with you, I've found nothing that beats the new Safari. Recommended.

The Alternative

The alternative to carrying a laptop is to use a palmtop. My son Phillip is an officer in the Navy. He runs his division on the U.S.S. Tripoli with a Poqet palmtop; and he loves it. I've previously told the story of my colleague in Moscow who wrote his TV news commentaries on an Atari Portfolio. He could two-finger-type on that about as fast as I can touch-type on a full-size keyboard.

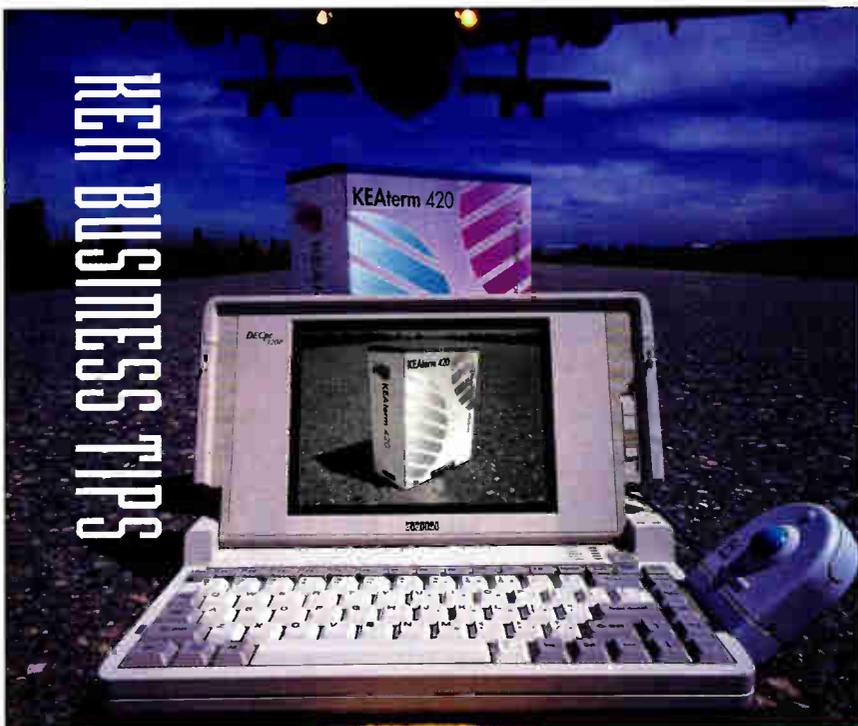
I have or soon will get: the new Poqet, an Atari Portfolio, the HP 95LX, and FranklinQuest's Academy. The latter is not in the same class as the others, being more similar to the Boss or the Wizard, but with this difference: the Academy is capable of connecting up to FranklinQuest's Ascend, which is the Windows implementation of the Franklin Time Management system. I've become addicted to Ascend, which has changed my life for the better.

The big problem with palmtops is entering data. Most palmtop users are two-finger typists. I suppose I could unlearn my touch-typing and try two-finger banging if I'd thereby get real portability; however, the Academy uses a one-hand chord-entry system. The Academy's start-up documentation says you can learn the chord system in about two hours, and given practice can get up to about 45 words per minute one-handed. We'll see. I've seen Wayne Yacco using his Academy, maybe not at 45 wpm, but at a steady clip, so I know it's possible. The Academy has some neat little removable memory and software modules—alas, not PCMCIA compatible—greatly increasing the flexibility.

Anyway, over the next few weeks I'll be trying out various alternatives to carrying a notebook. Meanwhile, if you really have to carry a Windows notebook, look at the NCR Safari NSX/20.

The Apple Scene

A few months ago we went to a party at the home of Joe Coulombe, the founder of the



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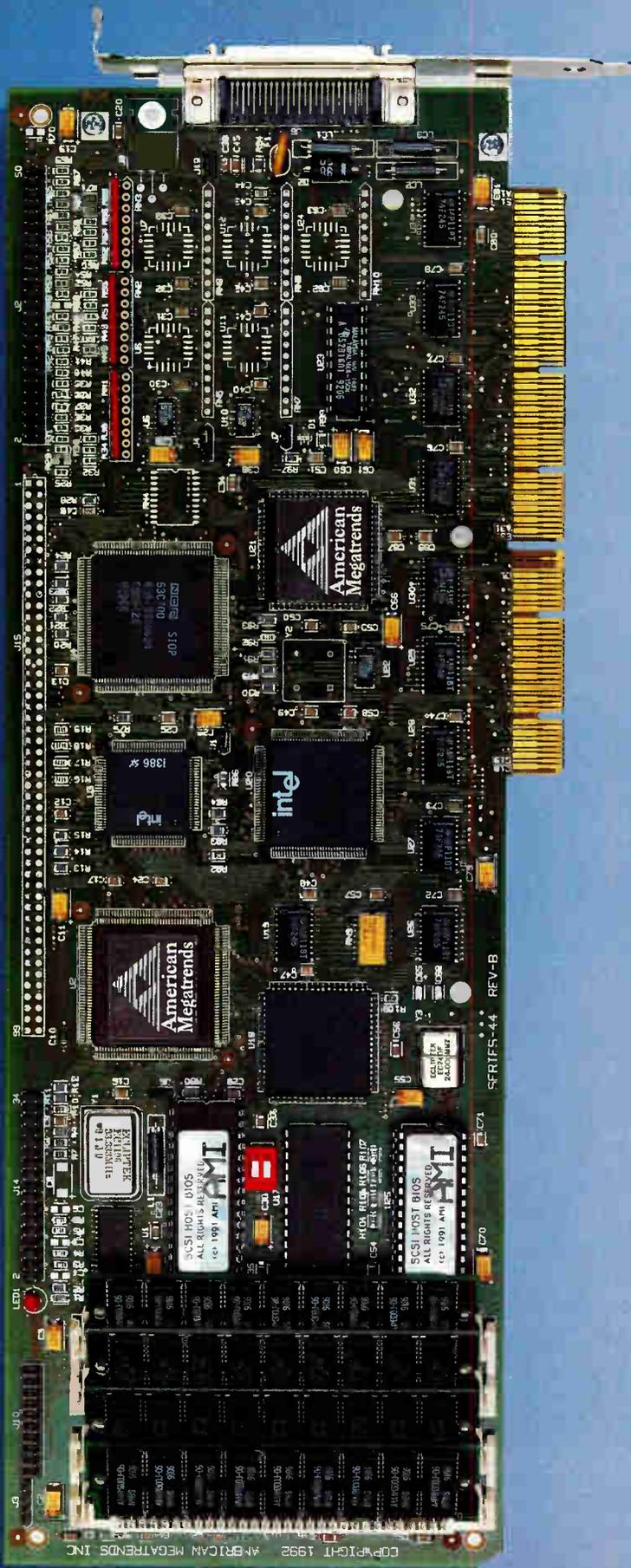
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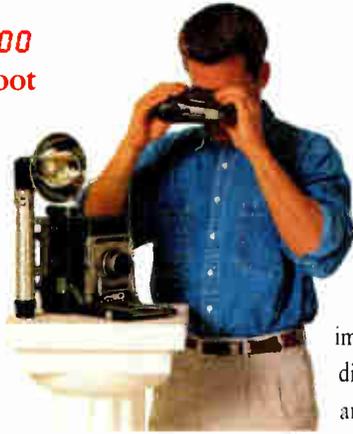
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Circle 80 on Inquiry Card.
World Radio History

USER'S COLUMN

Trader Joe's chain, where I get my coffee, cheeses, and blue corn tortilla chips. He had just got a new PowerBook, and he loved it.

They had another party last week, and he still loves it. Trader Joe's stores use Macs because, as Joe says, "It's a lot easier to get some useful work out of begin-

The lack of a good portable was one of the limitations of the Mac. This is no longer true.

ners with a Mac. They learn to do things in a day."

I don't have a PowerBook, but everyone I know who does is happy with it. The lack of a good portable was one of the limitations of the Mac. No longer.

Roberta's Story

System 7.0 works well, although Roberta finds that it takes getting used to. One correspondent reports that he has 130 copies of the clock open on his Mac Quadra. It takes the system 3 seconds to update them all, but meanwhile he was logged onto BIX with all that going on. Impressive. Windows won't do that, although I'm told OS/2 will.

Roberta uses a Mac more than I do. She does the LA Opera League newsletter using a Mac Quadra and PageMaker; and she's been adapting her reading program to run on Mac systems. It will probably end up in HyperCard, but her first attempt was to use SoftPC, a program that emulates a PC on the Mac. Here's her story:

"I was attempting to install SoftPC first on the Quadra. There are two sets of disks, with the third disk for each set being the data disk. All went well on the installation procedure until the data disk. About three-quarters of the way through, up pops the message: unexpected error -36 on line number 642.

"Suspecting things might go better if I used the standard set of disks, I try again with the second set. Same result.

"Take things downstairs to the Mac SE and try the two sets on it. Same result. I

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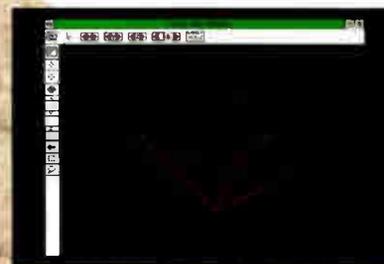
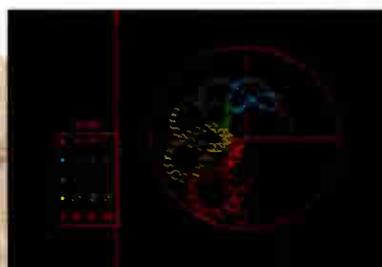
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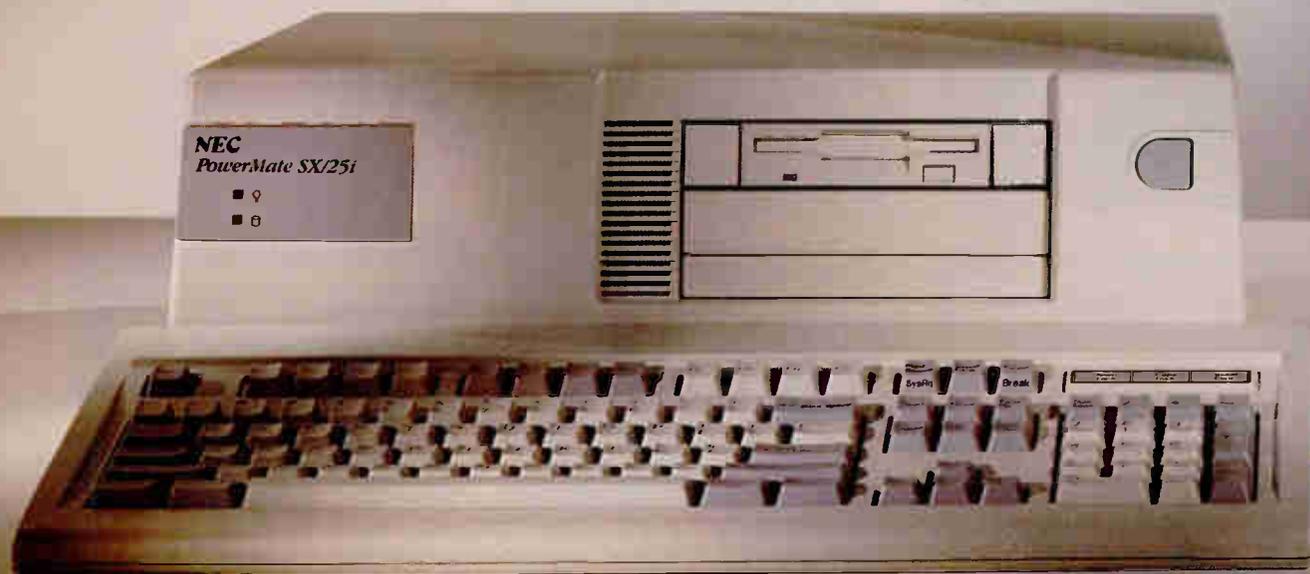
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USER'S COLUMN

call SoftPC. The woman in technical support says that is an Apple error call. 'Just a minute. I'll see what my Apple manual says about this error.' Ruffling heard, and then a giggle. 'Well,' she says, 'I don't think this is going to help much. It says I/O error bummer.' She suggests I call the sales folks and ask for another disk. Electronic answering in sales. I leave a message that perhaps we need another disk and to call where and when. Assuming, of course, that they would like us to write something other than 'bummer.'

"Desiring to track things down a bit more, I call Apple because we bought our SE directly from Apple. They inform me that I must contact the dealer we bought the machine from. Learning that we bought the used machine from Apple directly, the spokesfemme says I must establish a relationship with a local Apple dealer. This is a little difficult because of the following circumstances. Our yellow pages indicates only five Apple dealers in Los Angeles. Two have gone out of business. Two have stopped selling to individuals. The fifth is about 100 miles north of us, and the machine must be brought in and a fee paid. All this to discover what the error message means? (I mean other than 'I/O bummer.')

"What is wrong with this picture?"

It's a good question. Macs are easy to learn and use as long as there are no problems. Learning what to do about errors leaves a bit to be desired. One partial remedy, suggested by BYTE's Tom Thompson, is to use the System Error DA (desk accessory), which is available on BIX in the Macintosh listings area as SYSERR31.SIT. It explains all those error codes and gives you a handle on what the real problem is.

Another remedy is to get yourself a copy of Larry Pina's book *The Dead Mac Scrolls* (ISBN 1-56609-016-4). Other excellent books are *The Mac Bible* (ISBN 0-940235-11-0) and *The Mac Bible: "What Do I Do Now?" Book* (ISBN 1-56609-014-8); all are published by Peachpit Press. If you have a Mac, you really need these books.

Drawing and CAD

I recently installed Corel's Blockbuster, which was a package containing CorelDraw on CD-ROM, Corel SCSI, and a CD-ROM drive. I understand Corel Systems has discontinued that package, which is a shame, because it was the most painless way to install a CD-ROM drive I have ever seen.

However, Corel still sells the SCSI software, so you can use almost any CD-ROM drive. BYTE testing editor Stan Wszola

has used the Corel software to test removable-media SCSI devices and says that it has worked well with every device he tested.

Many of the modern CD-ROM drives are pretty good. There are also a lot of very slow drives for sale inexpensively; those will do for text retrieval, but they won't do for graphics-intensive programs like CorelDraw.

CorelDraw is wonderful. I have one reader who isn't strong on computers, and another who is; both are writing their Ph.D. dissertations, and both use CorelDraw to paste in illustrations and graphics. They're in biological sciences and need some fancy stuff, including doctored-up scanned images.

Another reader uses the low-end Windows Draw from Micrografx for the same purpose. He needs only monochrome line drawings, and he's extremely happy with Windows Draw. It's cheap, and it installs easily and gets things done fast without bother. If you don't need fancy color art, this may be the program you need. Otherwise, if you want the fancy stuff, the CD-ROM version of CorelDraw will do just about anything you ever wanted; and there's not a company in the world that understands system integration as well as the Corel people do. Corel SCSI works. Highly recommended.

The Seybold Digital World Conference

I have to go to a lot of computer shows. Most are boring: I go for the exhibits and to talk to people, but I seldom go to the actual conference sessions. The exception is the Seybold Digital World Conference: it doesn't have much in the way of exhibits, but it doesn't matter, because you go to it for the conference itself. Because it's held in Beverly Hills and I live close by, I don't stay in the convention hotel; this is probably a mistake, because I tend to get out of the house late and miss some of the conference sessions.

Those sessions are all worth attending. The notion of the conference is that the digital TV, digital audio, animation, and computer people are all working away without talking to each other, but their work can't really be independent. It's best if they get together every now and again. This is the place they do it, from John Sculley of Apple to the CEO of Intel, and the domestic heads of NEC, Mitsubishi, and Philips.

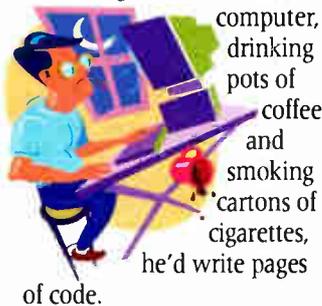
Some of the sessions were better than others. A few sessions tend to be hype for upcoming products: of course, those can be interesting. I did get somewhat weary of the seminar of critics trashing American

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He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.

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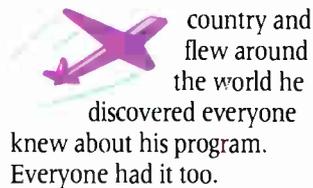
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Determined to make those long years pay off, he called on every distributor, VAR and dealer in the world. He drove from Beantown to San Diego. Flew from Dublin to Borneo. Everyone loved the program.

So he sold a few. Only a few.

Back in Boston he waited. After a long year

with only 13 orders he set out to see what happened. As he drove across the



The Global Marketplace

From Paris to Prague, his program was everywhere in Europe. When he got off the plane in Hong Kong he found his program stacked to the ceiling in every computer store. Amazed in disbelief, he bought a hundred cartons of cigarettes and a hundred pounds of Indonesian coffee and flew back to Boston.

Beaten, battered and bruised he went back to the drawing board. This time he would really change the face of the software industry. He would develop a device that would prevent unauthorized distribution of software programs.

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He developed a hardware key. His peers applauded his efforts. Finally, a solid solution for revenue protection.

But he didn't know what to call it. He thought of naming it after an exotic place he visited in his travels. Madagascar was a bit too long, though.

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popular culture. Far better was another session by entertainers and artists who are just discovering these new tools and are excited about what they can do with them. There was another on protection of intellectual property, a matter of great interest to me; and a number of projections about new consumer products incorporating digital technology.

That technology leaps ahead. I think we are already at a point at which photographs can be so expertly doctored that you can't

tell it was done: meaning that courts are going to have to think hard about what is and is not admissible photographic evidence. It's much the same with recorded speech; it will not be long before I can synthesize anyone's voice and have it say anything I like.

We live in interesting times.

Science Adventure

Science Adventure: Discoveries That Changed Our World is marketed as a trib-

ute to Isaac Asimov. His white mutton-chops dominate the cover.

This is the third in the series of interactive books by Knowledge Adventure. They characterize it as "multimedia without a CD-ROM," and it comes on six floppy disks and needs 8 MB of disk space. Installing that on the hard disk takes time, but the graphics on the screen at start-up are interesting. Roberta thinks that installation programs for educational software should provide you with something to think about while waiting for the whirring and swapping to stop. The graphics look great on her VGA Zenith Flat Technology Monitor.

The subjects covered are math, physics, chemistry, life, technology, earth and ecology, and space. Obviously they didn't get everything on each of these subjects on six disks, but they have done a good job of selecting their material and doing dynamic links.

As with their other products, there is a small globe, a text window, a navigation window, a time line, and a large picture window. One of the navigation buttons is for sound, but you don't really need it. Roberta ran this with the Disney Sound Source and says, "Hearing the sound of dropping water did not increase my understanding, but hearing Edison's first message on the phonograph might be worth it."

She continues, "I browsed for a couple of hours without boredom. The depth is not as great as one would find on a CD-ROM, but I think there is enough to create more curiosity in a student or even the parent. For instance, they describe logarithms but not cosines.

"The required game is included, but I hope the company will give it a little more thought. Neither the on-line help nor the 24-page documentation was sufficient for me to know when I was on the correct path. Typing speed becomes critical, which is a mistake, I think. If one pauses more than a couple of seconds while navigating, the program thinks you are beginning your answer again. This will frustrate a serious contestant who has the will to win."

Recommended.

DeMystifiers and Other Tools

If you develop Windows programs, you may need these tools. DeMystifiers gets inside Windows programs to tell you what is going on. I'll probably have more to say about this program when I do a full report on my own efforts to develop Windows programs using Visual Basic and Windowcraft.

DeMystifiers consists of five smaller programs to monitor internal Windows

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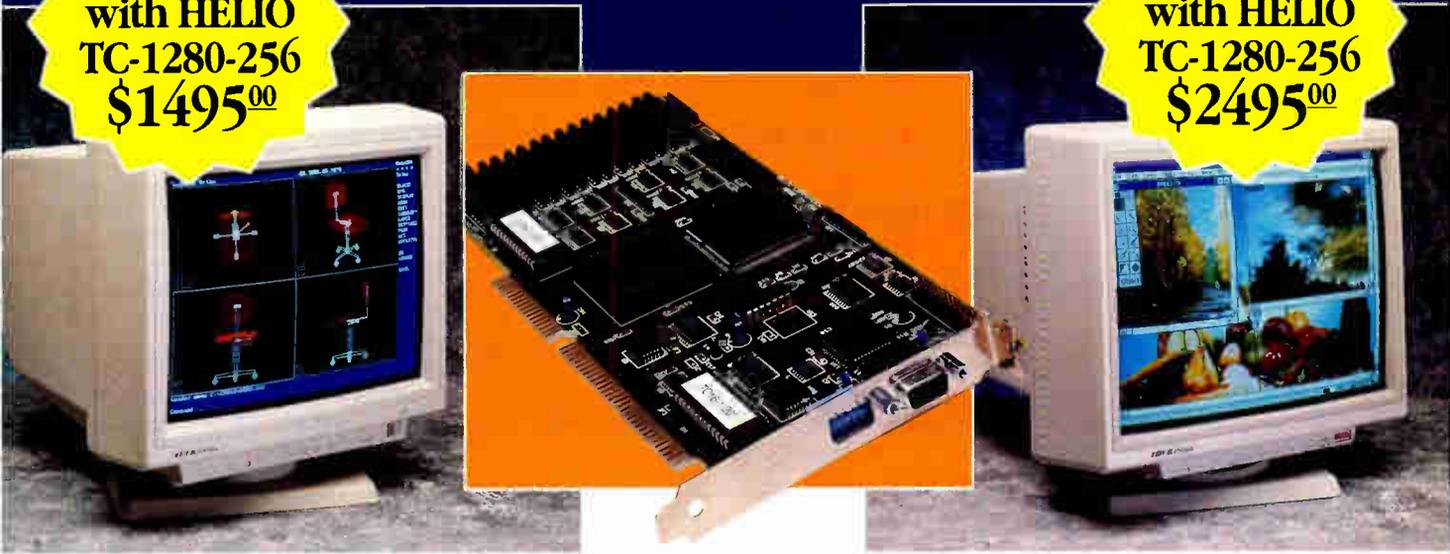
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USER'S COLUMN

messages, investigate the capabilities of devices and device drivers, and look at selected parts of your I/O routines. Think of it as a high-level debugger. Understand, I haven't done much with the program, so this is mostly to let you know it exists. More another time.

OS/2

I haven't got far yet working with OS/2. I can report that it's really nifty as a means for multitasking and running DOS programs, provided you have an advanced system with at least 8 MB of memory. It's much easier to set up DOS programs so they multitask together in OS/2 than in Windows.

OS/2 is not so hot on Windows applications, since it makes them run in standard mode and doesn't understand version 3.1. It's a better DOS than DOS, but not necessarily a better Windows than Windows. The installation program sucks toxic waste. More next month.

Winding Down

My book *Pournelle's PC Communications Bible* is out from Microsoft Press. It bills itself as "The Ultimate Guide to Productivity with a Modem." I call it "my book," but in fact Mike Banks did more of the work than I did.

The book isn't intended for experts, but if you're an expert, you may want to keep one around to hand people so you won't have to answer all their questions. It's pretty complete.

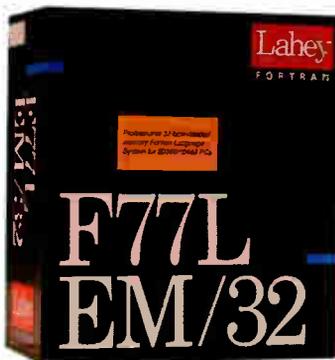
The real computer book of the month is Martin Heller's *Advanced Windows Programming* (Wiley, ISBN 0-471-54711-5). The subject of this book is quite over my head; but Martin Heller has always been good at explaining complex concepts in simple language, and this is no exception. If you do advanced Windows programming, you need this; if you don't but you are thinking of trying it, you definitely need it.

The book of the month is by Marvin Harris, *Cows, Pigs, Wars, and Witches: The Riddles of Culture* (Vintage, ISBN 0-394-48338-3). Ever wonder if there's a practical reason for cow worship in India? There is.

The game of the month is *Might and Magic 3* from New World Computing (P.O. Box 4302, Hollywood, CA 90078). Understand, this isn't so much a game as a career: you'd better like investigating dungeons and strange places, because you will *not* finish this quickly. I'm only partway through. My son Alex got so intrigued with the game that he went out and *bought* a copy.

Next month I continue with my look at

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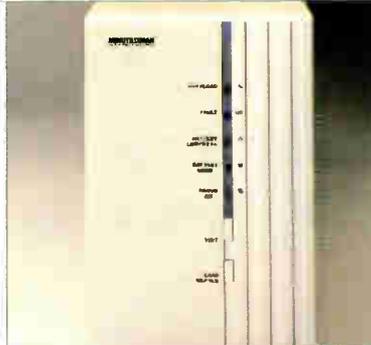
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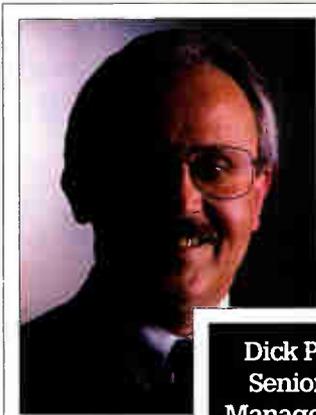
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**Dick Patefield,
Senior Project
Manager for Store
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JCPenney**

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.

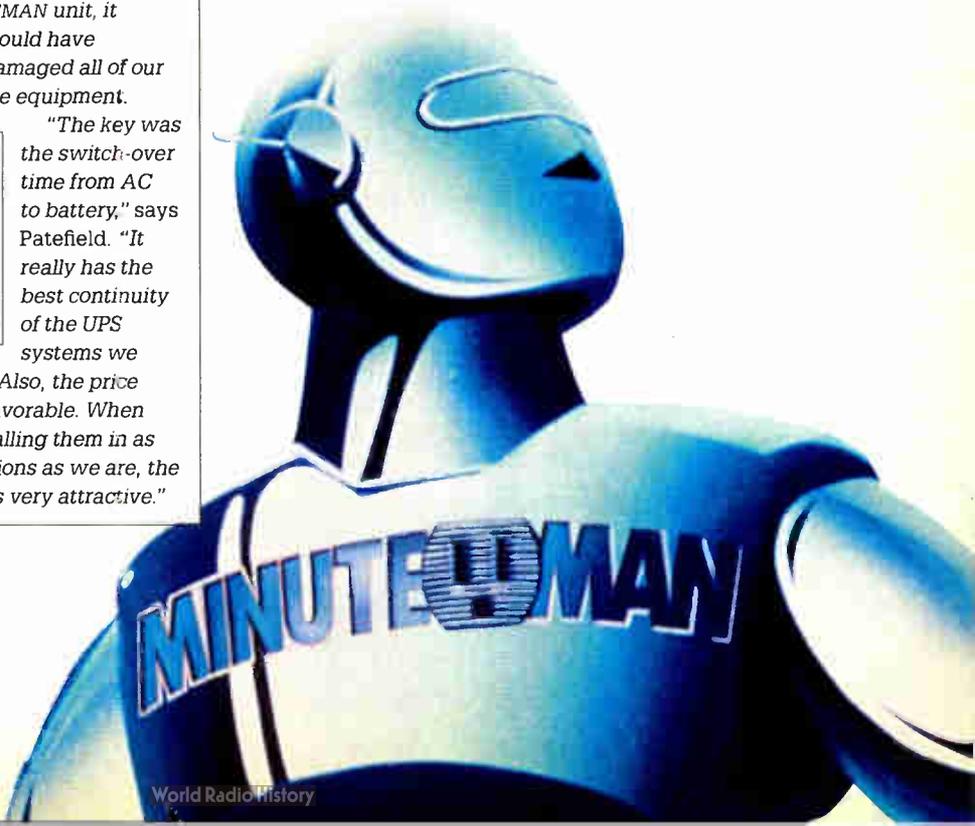
"There was a violent surge in one of our stores," says Patefield. "If we didn't have the MINUTEMAN unit, it probably would have seriously damaged all of our point-of-sale equipment.

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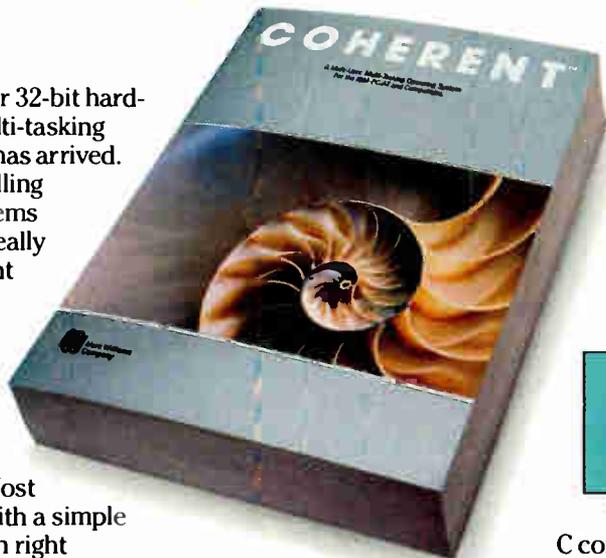
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No. of Disks	6	25
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TREVOR MARSHALL

For many applications, your personal computer is only as fast as your slowest component. That zippy CPU plays a constant game of “hurry up and wait” while your video card and hard drive controller, sitting in an 8- or 16-bit slot, pass along data at a fraction of its speed. A local bus can create a fast lane for peripherals by connecting them directly to the CPU. But because no local bus standard has existed, add-in card vendors have been unwilling to build products for the many proprietary local bus designs.

That’s changing. Three local bus standards—VESA’s (Video Equipment Standards Association) VL-Bus, Intel’s PCI (Peripheral Component Interconnect), and Apple’s QuickRing—promise to place performance of speed-critical peripherals such as video and storage on a par with that of today’s fastest CPUs.

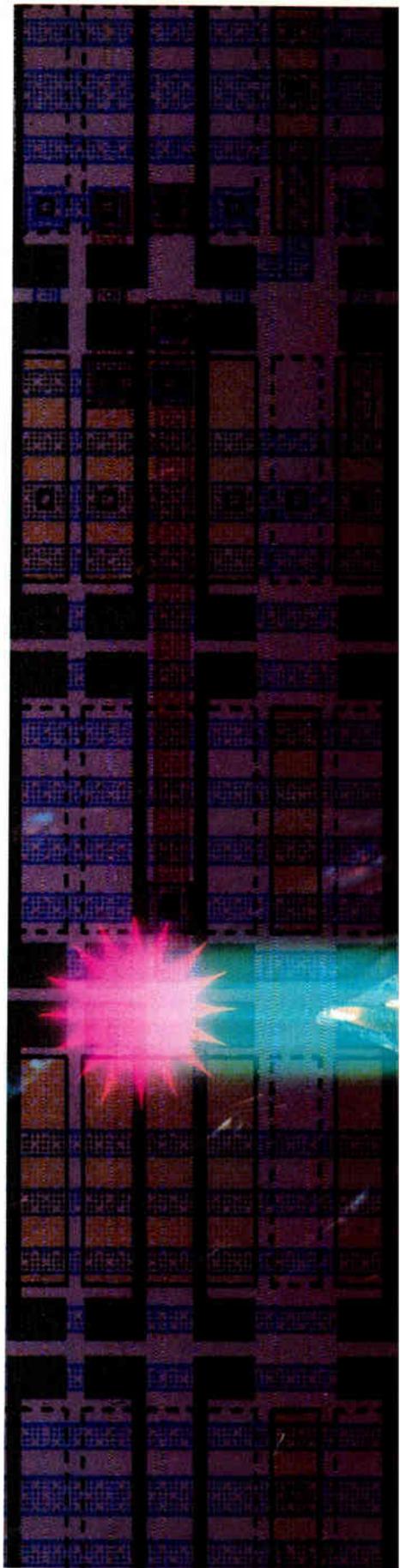
Tests performed in the BYTE Lab indicate that relatively low-cost VL-Bus video and hard drive controllers rival or beat today’s best, more expensive offerings (see the text box “Putting VL-Bus to the Test” on page 124). The test results are even more dramatic when VL-Bus peripherals are combined with Intel’s clock-doubled 486DX2 CPU: We saw a 50 percent increase in hard drive performance when we went from a 33-MHz 486DX CPU to a 66-MHz 486DX2.

For Intel-based PCs, VL-Bus is here now. An impressive lineup of system and add-in board makers have already announced their support for VL-Bus. By the time you read this, vendors such as CompuDyne Products and Gateway 2000 will be selling VL-Bus PCs. Intel’s PCI has also lined up solid support, including IBM and AST Research; despite reports of prototype systems, however, you may not be able to buy a PCI-based PC for about another 10 months. VL-Bus is the solution of choice—some say the short-term solution—among low-end vendors, while high-end, name-brand system vendors see PCI, a board-level local bus implementation, as the better-developed, long-term solution.

VESA expects VL-Bus and PCI to work together harmoniously. Intel is less optimistic, saying that VL-Bus risks overloading the CPU. Questions remain regarding the long-term viability of both standards, but given the need for a local bus standard now, at least one is certain to survive.

Meanwhile, Apple’s QuickRing is a model of what the personal computer bus architecture of the future could look like. Borrowing concepts developed for supercomputers, QuickRing is three times faster than either VL-Bus or PCI. And it just might eventually find its way to your Intel-based PC.

continued





World Photography

Putting VL-Bus to the Test

STANFORD DIEHL

With all the promises being made, we were eager to put a preproduction VL-Bus motherboard through BYTE's benchmark suite to test its mettle. After all, the whole purpose of VL-Bus is enhanced performance. If the bus specification does not result in significantly speedier peripherals, no amount of hype will make it fly.

The testing detailed here is a preliminary look at VL-Bus. The components are engineering samples, so we can't make definitive assumptions. But strong performance is a promising indicator and should portend even better things to come.

Since VL-Bus vendors are in the early stages of developing for the new bus, the first products out of the gate will probably not represent the fastest implementations of the technology. It will take some time for vendors to iron out the kinks and develop adapter cards that take full advantage of the specification.

Our preproduction system is built from a Micronics VL-Bus motherboard and a 33-MHz 486 chip. Two key components take up the available VL-Bus slots: a Tseng Labs video adapter (a demonstration unit—Tseng Labs does not sell end-user products) and an UltraStor UL34F bus-mastering SCSI hard drive controller. For reference, we included the Compaq Deskpro 386/33L (our standard baseline machine) and the Compaq 486/33M, a high-performance 33-MHz 486

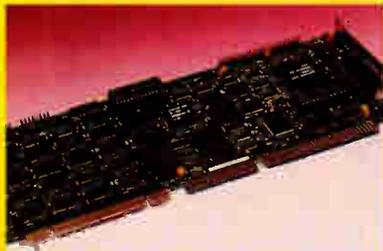


Photo A: The Micronics VL-Bus motherboard shows a typical layout for the local bus slots. The VL-Bus extensions appear adjacent to the upper two ISA slots.



Photo B: The uncached UltraStor VL-Bus hard drive controller showed impressive performance, especially when coupled with the 66-MHz 486DX2 CPU.

system with coprocessed video (see the benchmark graph).

We also obtained another piece of preproduction technology: an Intel 486DX2 66-MHz clock-doubler chip. This component added another twist to our testing, allowing us to explore how high-speed clock doubling works in conjunction with VL-Bus. All these pieces together make for an interesting set of benchmark results.

Our results suggest that there is very little performance difference between coprocessed video and VL-Bus video; in fact, the Compaq video board ran marginally faster. But VL-Bus video should cost a good bit less than a coprocessed solution. From these preliminary results, it appears that VL-Bus video will have an edge over coprocessed video when it comes to the price/performance ratio.

The UltraStor drive controller board displayed exceptional performance for a controller without a large hardware cache. We had no ISA-based version of the board to compare the VL-Bus performance to, but it is clear that the bus played a significant role.

When You're Hot, You're Hot

When we plugged the 66-MHz 486DX2 into the Micronics motherboard, our system really sizzled—in more ways than one. The chip quickly heated up to the point where it was impossible to touch without burning flesh. Again, the chip was a preproduction version, but it did make us take stock of the situation. That poor little chip was taking a whole lot of stress, burning along at 66 MHz and directly driving two peripherals at the same time. Intel's final version of the chip should handle the faster clock rate without overheating.

If vendors can run the 486DX2 reliably with VL-Bus, the payoff will be large. The clock-doubling chips limit the speed increase to CPU operations, and system performance is still crippled by a slow bus; in fact, the bus becomes even more of a bottleneck when the CPU is racing along at 66 MHz. The BYTE benchmark numbers clearly indicate that peripheral devices can take advantage of increased CPU clock speeds when connected directly to the CPU through VL-Bus.

Our drive controller ran 50 percent faster with the clock-doubling chip installed. The increase in video performance was not as dramatic, but it was still significant. Despite Intel's lack of enthusiasm, VL-Bus may actually help boost the capabilities of Intel's clock-doubling technology—that is, if the heating problems are successfully addressed.

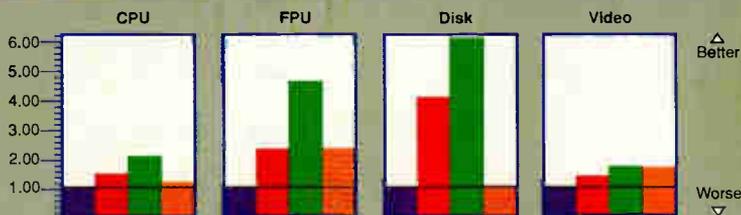
In the end, our benchmarks bear out the promise of VL-Bus. For mainstream applications, these performance gains may compare favorably to coprocessed video and hardware disk caches and cost less. VL-Bus looks like a winner.

Stanford Diehl is a BYTE technical editor and former testing editor for the BYTE Lab. You can contact him on BIX as "sdielh."

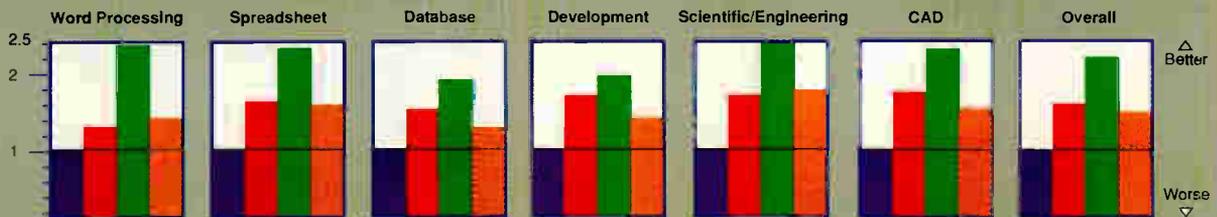
BYTE BENCHMARK RESULTS

Compaq Deskpro 386/33
 Micronics without doubler
 Micronics with doubler
 Compaq 486/33M

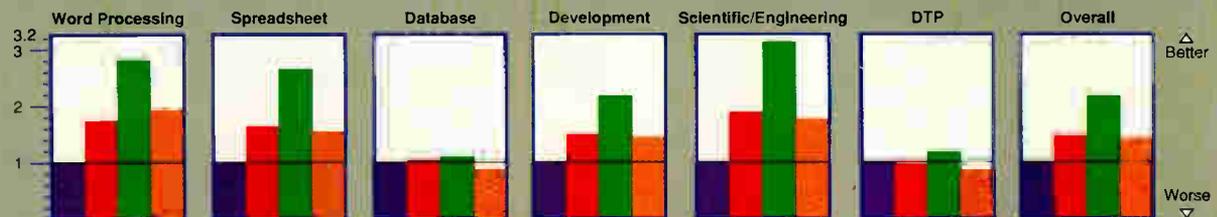
DOS LOW-LEVEL



DOS APPLICATIONS



WINDOWS APPLICATIONS



All results are indexed, and higher numbers indicate better performance. For each Index, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 = 1. The overall index is the average index of each individual test.

The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component.

BYTE's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.0. We test six application categories for each environment, running test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 3.1+ and Microsoft Excel 3.0a; Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV; Development: Borland Turbo Pascal for Windows and Microsoft C 5.0; Scientific/Engineering: MathSoft Mathcad for Windows 3.0, The MathWorks MatLab 3.5k, and Computing Resource Center Biturbo Stata 2.1; CAD: Autodesk AutoCAD release 11; and Desktop Publishing: Aldus PageMaker 4.0.

Preliminary benchmark results bear out the promise of VL-Bus. VL-Bus video held its own against the coprocessed solution of the Compaq, while UltraStor's VL-Bus drive controller displayed outstanding performance.

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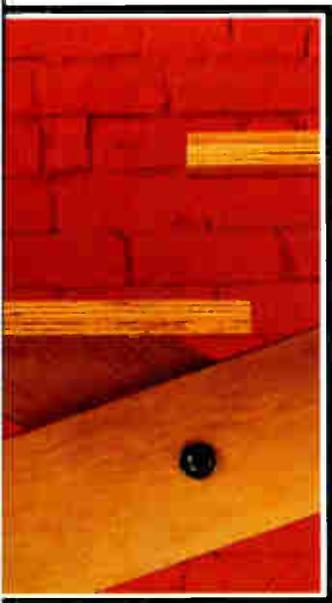
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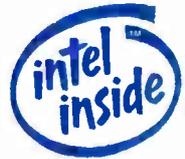
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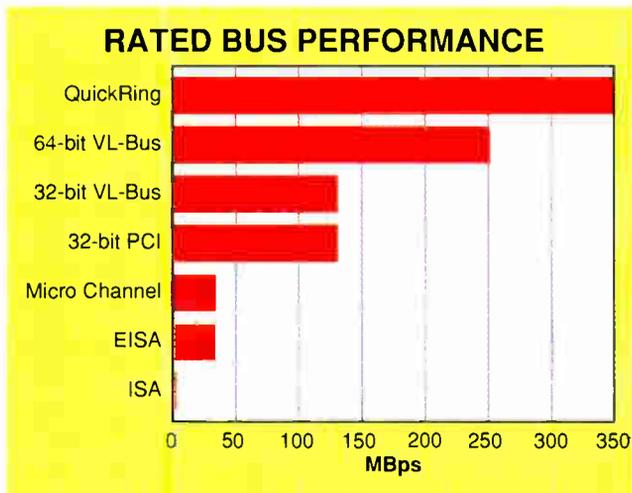


Figure 1: The new local bus standards show a significant increase in their rated speeds versus established bus architectures. Few applications today require more than 100 MBps. However, as the complexity of applications increases, greater bus speed will be needed. Both VESA and Intel are confident that they can boost the performance of VL-Bus and PCI, respectively, to meet future demands.

VESA's VL-Bus

The ISA, EISA, and Micro Channel buses have failed to deliver low-cost, high-speed operation to Intel-based PCs (see "System Bus or System Bottleneck?," March BYTE). As the individual components of a system become more powerful, the role of the system architecture—that framework that integrates components into a system—becomes more important. But the limits of a system architecture centered on a single, slow I/O bus have become increasingly apparent (see figure 1). The performance promised by succeeding generations of ever-faster CPUs became harder to achieve, while applications and peripherals were continuously demanding more performance. "The PC architecture of 1981 no

longer makes sense in 1992," says Michael Slater, editor and publisher of *Microprocessor Report*, an industry newsletter on microprocessor hardware based in Sebastopol, California.

VESA, a consortium of more than 120 companies, produced the VL-Bus specification as an immediate solution to the peripheral bus bottleneck. It works at speeds comparable to those of the Intel 386SX, 386DX, 486, or the upcoming P5 CPUs. It can be used with other processors, however. For instance, VESA claims that one company has designed a VL-Bus interface for the Mips R4000 RISC processor, allowing it to use relatively low-cost VGA and other video boards designed for the Intel-based PCs.

VESA has defined how each local bus signal will be generated, making it possible for a manufacturer to build one chip to the VL-Bus specification and have it work in all VL-Bus-compatible computers. VESA plans to certify compatibility between VL-Bus motherboards and peripherals (see the table below).

VL-Bus not only provides a standard interface for local bus chips situated on the motherboard, but also defines a slot concept that enables expansion boards to use both the high-speed VL-Bus and also the slower ISA, EISA, or Micro Channel buses concurrently (see figure 2). In fact, it is possible to build a card that plugs into the VL-Bus slots and uses signals from the slower I/O bus. For example, although VL-Bus handles all the high-speed signals, the interrupts and DMA channel handshakes that you need for a drive controller have not been provided. Thus, you can design a board that plugs into both the ISA and VL-Bus connectors, making all the needed signals available.

VL-Bus is not limited to video or drive controller boards. Any plug-in board that needs higher speed than the I/O bus can provide can use the VL-Bus slots to access the CPU directly. Both VESA and vendors warn, however, that VL-Bus is not necessarily a miracle cure for poor performance. For example, a coprocessed ISA video accelerator board could outperform a standard VL-Bus VGA card. Consequently, it would not be cost-effective to upgrade an existing system simply to improve video performance. "Local bus helps overall performance, but it's not the ultimate," says Henry Quan, president of graphics card vendor ATI Technologies, based in Scarborough, Ontario, Canada.

Surprisingly, this performance enhancement has been achieved with only a modest increase in system cost. Dan Kikinis, president of Oakleigh Systems, the Santa Clara, California, R&D subsidiary of U.K. system manufacturer Elonex, says that because VL-Bus (or PCI, for that matter) requires virtually no glue chips, an add-in card that costs \$1000 to implement for EISA will cost only \$500 for VL-Bus. "VL-Bus and PCI will be the death of EISA," Kikinis says, adding that EISA's demise will take several years. VL-Bus also uses the standard low-cost connector that was developed for the 16-bit Micro Channel bus. "VL-Bus is as fast as you can get, and as simple as you can get," says VESA executive director Thomas Ryan.

Dean Hays, technical marketing manager at chip-set maker Chips & Technologies (Santa Clara, CA), says that the original intention of the VL-Bus specification was to make it possible to design boards with existing chip sets and a little glue logic. Once the VL-Bus specification was stable, Hays said, C&T would be able to incorporate all the extra VL-Bus logic right into the main chip set itself.

continued

COMPANIES THAT HAVE ANNOUNCED VL-BUS PRODUCTS

Systems/motherboards

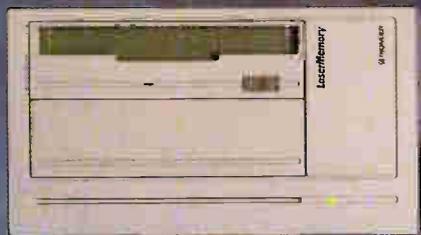
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- Alpha Research Corp.
- CMS Enhancements, Inc.
- CompuAdd Corp.
- Compudyne Products, Inc.
- DFI, Inc.
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- Digital Air Systems
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- Everex Systems, Inc.
- Genoa Systems Corp.
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- Northgate Computer Systems, Inc.
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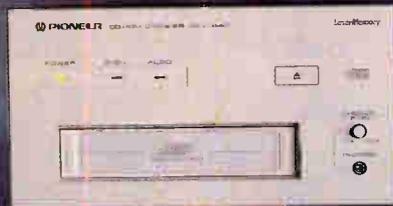
- Actix Systems, Inc.
- Advanced Integration Research, Inc.
- ATI Technologies, Inc.
- Diamond Computer Systems, Inc.
- Genoa Systems Corp.
- Matrox Electronic Systems, Ltd.
- Nexgen
- RasterOps Corp.
- Sigma Designs, Inc.
- STB Systems, Inc.

Hard drive adapters/controllers

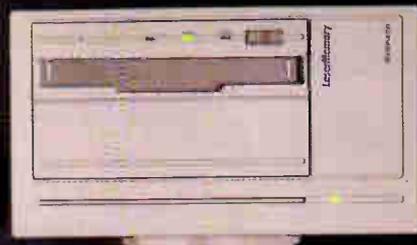
- Alpha Research Corp.
- Data Technology Corp.
- Nexgen
- Point Corp.
- UltraStor Corp.



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The Pioneer DE-S7001 dual-purpose external optical disk drive I've written about before. Log your wordprocessor to that, save early and often, and you'll have it all... In a word, WORM drives look like

the ultimate in backup storage. *Byte* (12/91)

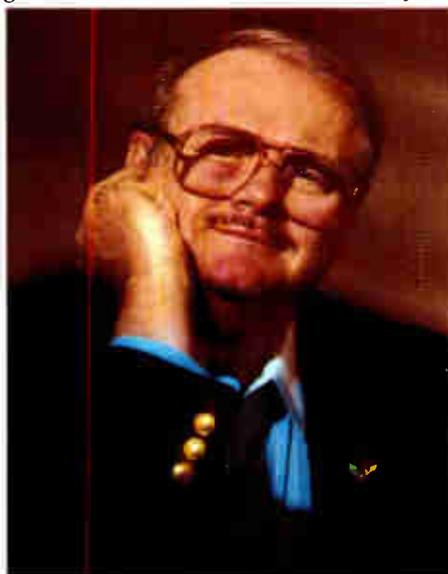
Suppose you erase a file? Overwrite one you wanted to keep? And suppose your house burned down? You don't have any off-site backup at all... I could remedy that by installing the DE-S7001 on the network server and archiving on that... *Byte* (11/91)

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It's quite intuitive [the Pioneer CD-ROM Minichanger]: no instructions are required... Recommended. *Byte* (1/91)

This technology is coming of age. *Byte* (1/91)

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VL-BUS PHYSICAL LAYOUT

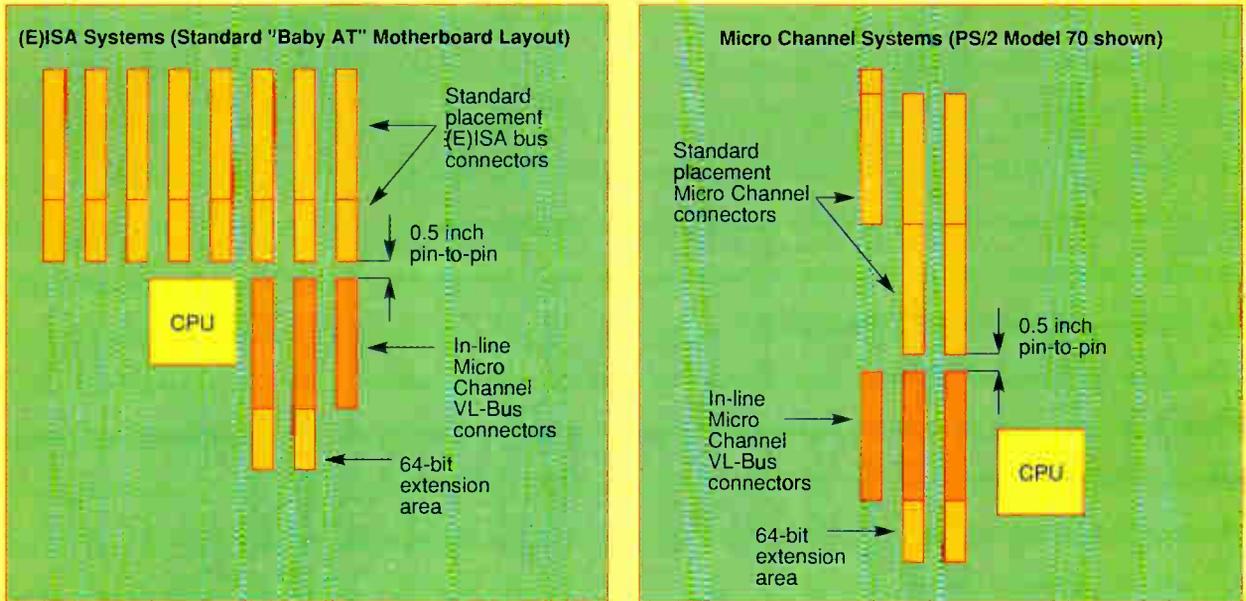


Figure 2: VL-Bus is a local bus intended to complement the capabilities of the current I/O bus. Consequently, the VL-Bus connectors are mounted in line with the existing I/O sockets. The (new) VL-Bus connectors carry all 32 data lines from the CPU, the 32 address lines, and the CPU's control signals. Additional lines provide the multimaster arbitration, the burst-transfer control signals, and the 16-bit steering logic. VL-Bus's data width can be extended to 64 bits to accommodate the next generation of CPUs.

Still, designing and building VL-Bus-capable cards is a challenge. Each of the VL-Bus boards has to be designed very carefully, with extremely short traces between the edge connector and the circuitry, and with extensive on-card buffering to relieve the load going to the CPU. These traces must be no longer than 2 inches and must have no more than one chip input connected to them. Quan says that VL-Bus simplifies his job, because ATI does not have to produce a discrete design for every proprietary local bus implementation. However, he adds, "If you're asking if it's easier to build a peripheral that runs at 33 MHz rather than 8 MHz, the answer is 'definitely not.'" At that speed, engineers have to pay closer attention to chip tolerances and specifications.

Designers are limited to a maximum of three VL-Bus slots on the motherboard. The CPU's pins can be directly driving the address, data, and some control signals simultaneously. Under these conditions, the CPU is just not capable of driving more than three external loads unless it is operating at a very low clock frequency. Thus, even though it is possible to have three VL-Bus-compatible slots in a PC, it may only be possible to have one or two slots at frequencies higher than 33 MHz. The slots may be directly connected to the CPU, or they may be buffered (buffering reduces the load on the CPU, since the signals are then driven by the buffers and not by the CPU pins). The frequency of the CPU (and hence VL-Bus) may be less than 33 MHz, or it may be greater than 50 MHz.

VL-Bus allows for up to three local bus masters. A VL-Bus master can take control of the system bus and move data to and from main memory, or to any board in the main I/O bus. For example, a VL-Bus master might be an intelligent storage controller or, conceivably, a second CPU. If there is a clash (e.g., if a VGA card is present in the VL-Bus slot and another is plugged

into the ISA bus), then the VL-Bus device will operate correctly and the ISA plug-in will be disabled.

A Fuzzy Specification

Each VL-Bus system will be different, because the detailed motherboard implementation has been left to the PC designer. The benefit of such an unusually loose bus specification is to encourage the creativity of both add-in card and motherboard designers to achieve the maximum speeds possible in a PC. The specification lays a necessary framework to protect the computer buyer from the hazards of poor compatibility.

What each manufacturer has to ensure, however, is that no matter how many slots are installed, each of them must operate correctly when a VL-Bus-compatible card is plugged into it. Scott Vouri, a founder of graphics display developer Binar Graphics in San Rafael, California, believes that compatibility to the VL-Bus specification will boost competition among add-in board makers and, as a consequence, lower prices to the consumer. "The small guys can now participate in the marketplace," Vouri says.

It is even possible for the new low-power 3.3-volt logic devices to connect to VL-Bus, provided their inputs can withstand the peak 5.5 V that may come from the CPU. With a 3.3-V design, it's possible to lower the power dissipated at any given CPU frequency, allowing for faster clock speeds without an unacceptable rise in operating temperature.

The loose specification does leave room for incompatibilities to creep in, at least in early products. Richard Chen, product marketing director for Genoa Systems (San Jose, CA), a maker of motherboards and graphics cards, estimates that it will take about six months before manufacturers understand the specification

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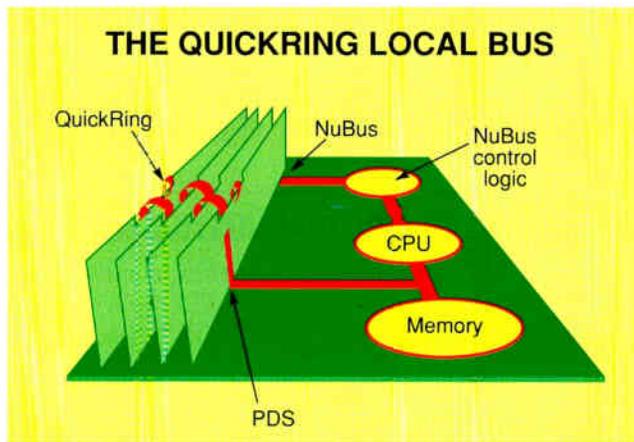


Figure 3: QuickRing is a local bus that connects the Mac's PDS to any board in the NuBus. The QuickRing architecture is identical to that of the VL-Bus, since the high-speed PDS interconnect taps directly into the CPU's signal lines and bypasses the slower NuBus control logic. Like the VL-Bus peripheral, a QuickRing card can have access to both the NuBus and the higher-speed QuickRing local bus.

well enough to ensure compatibility. Genoa's solution is to sell a VL-Bus motherboard and graphics card as a set to system vendors. "[Vendors] don't want to get a headache figuring out which board to use," Chen says.

Not surprisingly, since they are both based on the 80x86 control signals, PCI and VL-Bus are very similar. Ron McCabe, VESA Local Bus Committee chairperson, says that VESA will publish an application note on how to make a PCI device work as a VL-Bus slave as soon as the PCI bus is public. At this writing, however, Intel won't say when the details of PCI will be released. Intel agrees that the two standards could work together, but sees no reason why anyone would want them to.

The Bus Doesn't Stop Here

VESA has defined a 64-bit-wide data bus version of VL-Bus, rated—theoretically—at 250 MBps, in anticipation of the next generation of Intel microprocessors (which are widely rumored to have a 64-bit data bus). A different Micro Channel connector (the same connector that brings Micro Channel to 32-bit operation) provides the 32 new bits of data bus.

But even this performance boost does not compensate for what many see as the fundamental flaw of VL-Bus: It still relies on an obsolete, 11-year-old PC system design. VL-Bus is important because it solves the bus bandwidth problem for the short term. With PCI, Intel has taken a longer view.

Intel's PCI

Intel's PCI architecture accepts the fact that the standard PC design is running out of gas. This interconnection standard clearly intends all high-speed peripherals to be mounted on the motherboard. "PCI is an intermediate foundation for next-generation PCs," says Slater.

According to Mike Bailey, PCI market-

ing manager, Intel does not encourage people to put cards right on the CPU bus. While it is true that the output signals of the 80x86 are not designed to drive the heavy loads usually associated with a bus and card structure, the VL-Bus specification has been carefully crafted to ensure that no damage is possible. At this point, the debate becomes political.

The PCI standard defines an interconnect topology that does not allow for user upgrades or for participation by innovative (but poorly funded) peripheral manufacturers. Although anybody can design a board that plugs into a VL-Bus connector, to participate in PCI you need to have the resources to design an application-specific IC to drive the interconnects, and this involves an investment of over \$100,000. Therefore, it is in the best interests of add-in board vendors and low-end clone makers to support VL-Bus. Larger, name-brand system vendors who rely on technical innovation and component integration naturally favor PCI.

Genoa's Chen expects a lot of system vendors to use VL-Bus "as long as they have common sense." He says that VL-Bus adds value to a system and lets vendors maintain their profit margins. He says that for an additional \$10 to \$20 on the cost of the motherboard, VL-Bus provides enough of a performance boost to allow vendors to maintain profit margins while keeping their products competitive.

Elonex plans to use PCI in its high-end line of PCs and VL-Bus in its low end, according to Kikinis, with VL-Bus systems appearing first—perhaps within a couple of months. He sees PCI-based machines as about 10 months away from shipping, although some vendors might show prototype PCI systems at Comdex this November.

In an effort to gain acceptance of the PCI standard, Intel has invited system and peripheral board vendors to join a PCI special-interest group. The SIG's mission is to establish a PCI slot standard, which would alleviate the fears of board vendors who see PCI as a threat to their future, as well as those of system vendors who don't have the resources to fully integrate PCI on the motherboard.

The SIG "gets Intel out of a political tight spot," says Slater, because it places the burden of setting standards on a group of vendors. However, he believes that not coming out with a PCI connector standard immediately is "a huge mistake," because it gives VL-Bus the opportunity to establish itself.

The Speed Issue

PCI's maximum operating frequency is 33 MHz. Since PCI is a synchronous bus (i.e., each operation on the bus is performed in synchronization with the CPU clock), it is unclear how PCI peripherals will migrate to 50 MHz. According to David Carson, a PCI architect designer, Intel plans to deal with the speed differences with fractional phase-lock loops (circuits used to synchronize different clock frequencies).

Although phase-locked loops may be able to synthesize the 33-MHz PCI bus from a 50-MHz CPU clock oscillator, they will not be able to overcome the wait states (and the subsequent performance degradation) that will take place while the slower 33-MHz PCI peripheral is getting the data for the faster 50-MHz CPU; how this will affect performance, however, is not clear. A 66-MHz 486DX2 chip will run satisfactorily,

Key Points

VL-Bus

- Here now
- Inexpensive to implement
- Limited scalability
- Loose specification (allows for vendor innovation)

PCI

- Less stress on CPU than with VL-Bus
- More future-looking design
- Better tested; more robust

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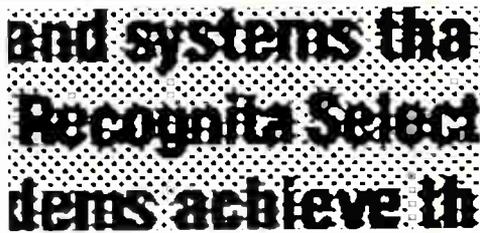
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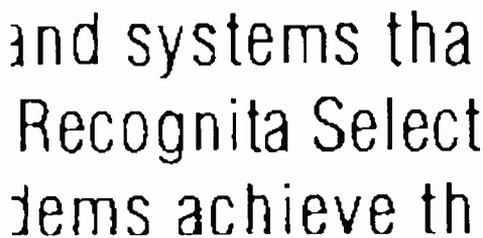
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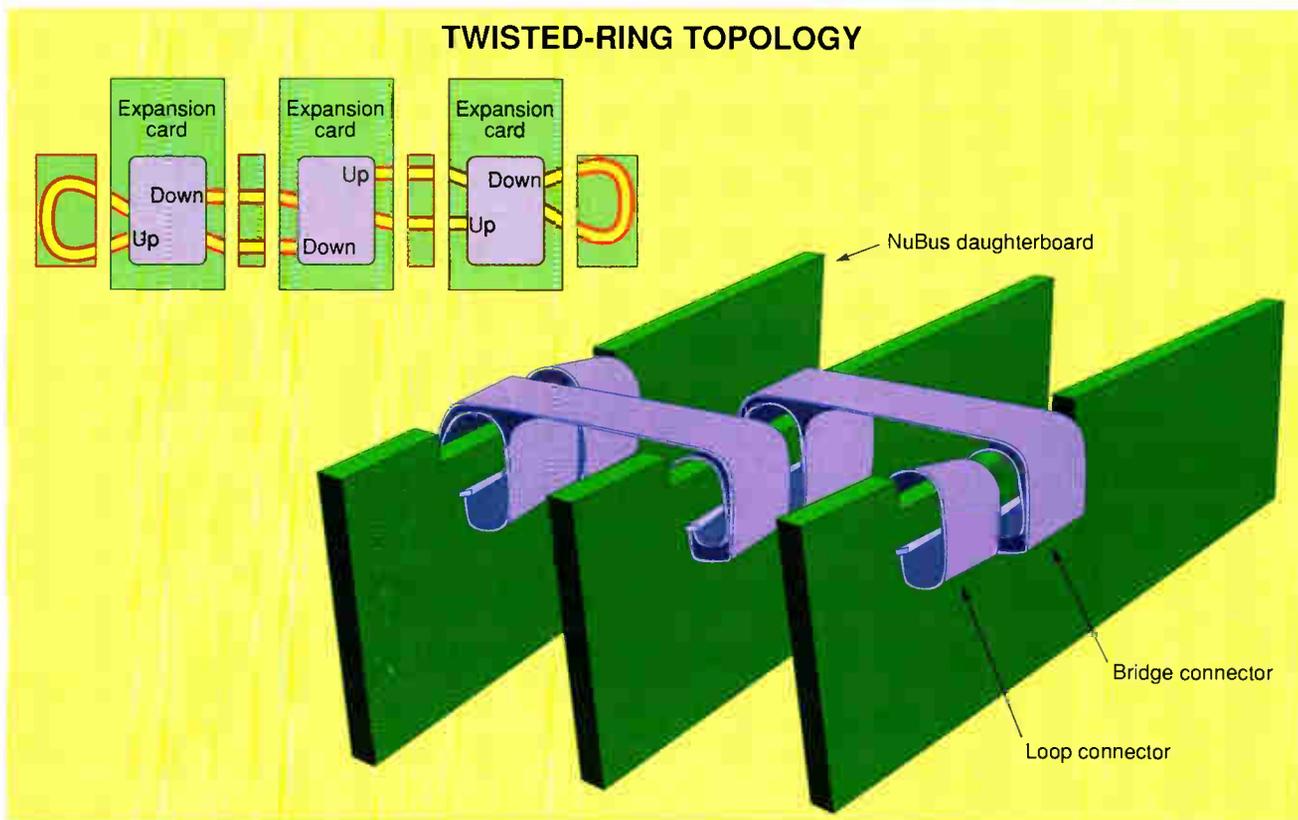


Figure 4: The twisted-ring interconnect topology ensures that data has to travel through only two connectors and one card before encountering a receiver. The QuickRing circuitry takes only 4 square inches of board space, including the 140-pin National Semiconductor interface chip.

because its external bus is run at exactly half the chip's 66-MHz clock frequency; but how will a 100-MHz 486DX2 CPU interface with PCI peripherals?

This anomaly is unusual, as PCI is otherwise a robust local bus specification. Intel spent over 2000 hours in computer simulations of the PCI bus using the SPICE (Simulator Program for Integrated Circuit Emulation). Carson insists that, as a result, the best design was chosen. "By the time we were finished, I was sure that the PCI specification was solid," he said, adding that PCI will support the peripheral interface speeds for both today's microprocessors and those coming along during the next few years.

In a manner somewhat reminiscent of EISA and Micro Channel, PCI chips have unique identification numbers. The system BIOS will interrogate the PCI peripherals at power-on to see what PCI devices are present and then execute code that will be able to use the unique features of each device.

PCI has one set of 32 pins for carrying both the address and data lines to the peripheral devices; VL-Bus, on the other hand, has 64—32 for data and 32 for addresses. Since the cost of a chip increases as its pin count rises, larger vendors who typically place video and drive controllers on the motherboard are likely to favor PCI over VL-Bus.

Apple's Revolutionary QuickRing

Local bus developments have not been limited to PCs using Intel-compatible CPUs. Apple has for some time provided a Processor Direct Slot in its Mac II range of computers. The PDS enables a plug-in card to directly access the pins of the 680x0 and

pass data to and from the CPU at very high speed.

The main problem with the PDS, and one of the reasons that so few cards support it, is that it is machine dependent. Every Mac seems to have a different PDS connector—one for the pin-out of the 68020 CPU, one for the 68030, and the newest one for the 68040. To address this situation and to produce a very high-speed local bus, Apple has developed QuickRing, a local bus designed to couple the PDS to each expansion card in the (NuBus) I/O bus (see figure 3).

But QuickRing has so many technical innovations and such a high processing speed (up to 350 MBps, or three times the speed of either VL-Bus or PCI) that it is conceivable that it (or something like it) will someday find a home in Intel-based PCs as well. Currently, QuickRing is the only way to pass data between cards at these high speeds. If some of the cards were in Macs and some were in Intel-based PCs, the QuickRing would become like a high-speed LAN, linking the two computers and allowing a developer to use the best features of each environment.

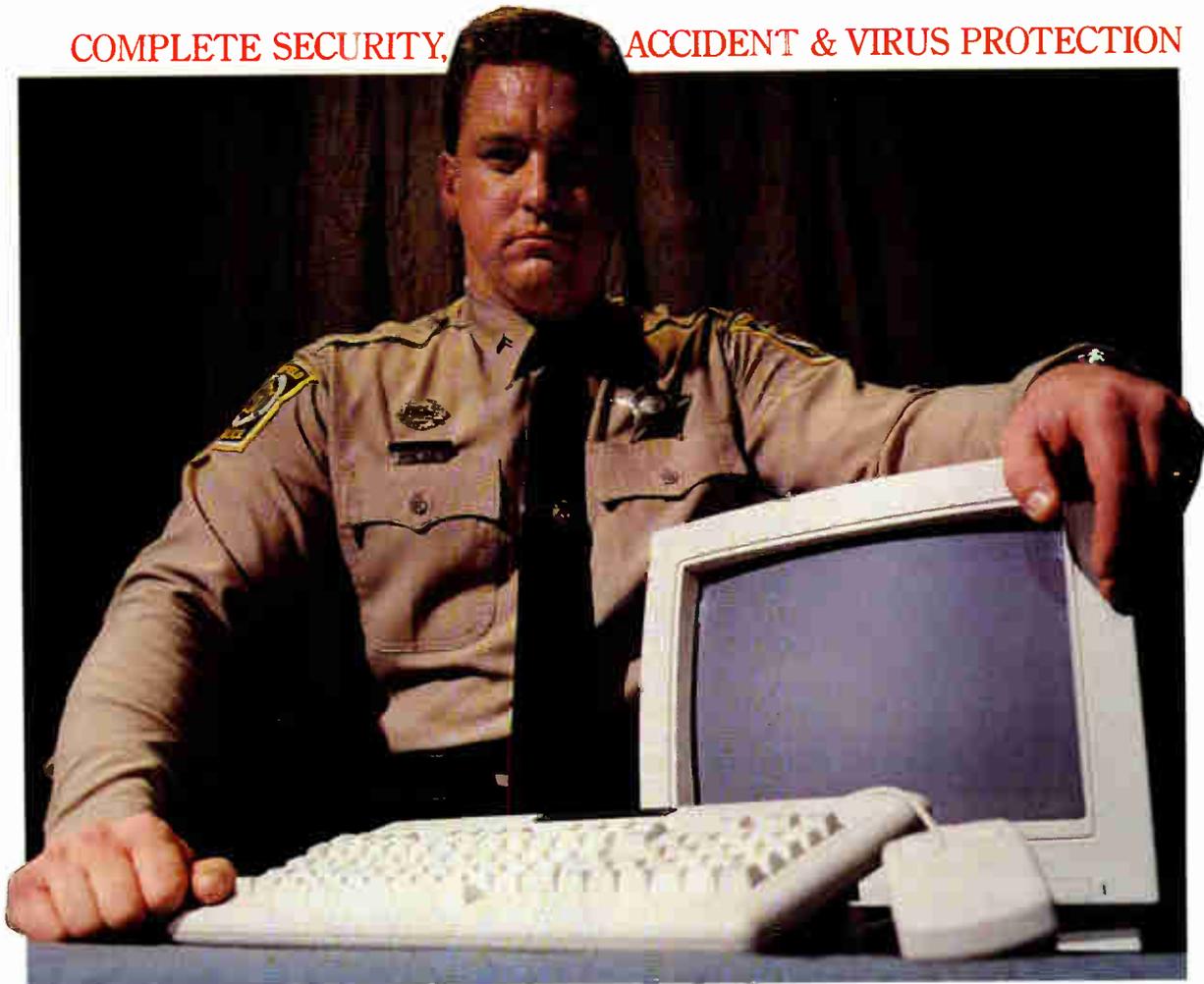
Jim Potter, director of engineering at Yarc Systems (a supplier of RISC graphics coprocessors), expects QuickRing to revolutionize desktop publishing. "I can see a system," he says, "where the PostScript RIP is running on a 486 PC while the actual page composition and editing are performed on a Macintosh." QuickRing will allow the high-speed transfer of graphics and images between the two machines.

QuickRing's Supercomputer Heritage

QuickRing's twisted-ring topology (see figure 4) is one of two innovations that stand out most clearly. The other is the use of

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The ISA, EISA, Micro Channel, VL-Bus, and PCI architectures all work with TTL-compatible logic signals. These signals swing from a logic low of around 0 V to a logic high greater than 2.4 V. Any bus using these signals has to be quite high-impedance in order to cut down the power consumed to a level that standard logic devices can handle. For example, if the 50-ohm QuickRing interconnects were to be run at these logic levels, the peak power consumed by each data line would be 0.5 watts. The 32 lines of the data bus would then dissipate at around 16 W, and the 32 address lines at another 16 W. Clearly, this would call for some form of liquid cooling of the CPU and for every other chip connected to the bus.

But National Semiconductor (Santa Clara, CA) has applied the chip technology it developed for the U.S. Navy's FutureBus to solve this problem for Apple. A very low voltage is used on each of the signal lines—much less than 1 V peak-to-peak. Special sensitive (and yet high-speed) input amplifiers sense these voltages and convert them to the TTL level that the chip uses to interface to logic on the add-in board. Only the signals transmitted over the bus are low-voltage, and it is not possible to connect the bus signals to any chips other than the special QuickRing drivers.

Beta Phase (Menlo Park, CA), which designs interconnects for supercomputers and the aerospace and defense industries, taught Apple how to interconnect cards using these high-speed circuits. Hal Kent, a designer at Beta Phase, says that QuickRing is the first personal computer bus capable of using these high-speed cables and connectors, also used in Cray supercomputers, efficiently.

The cables are made from layers of copper and flexible polyimide plastic. The signal traces are etched out of the copper in much the same way that a printed circuit board is manufactured. These cables can carry data at the full 180-MBps rate with minimal degradation in the signal quality. And they do it inexpensively: According to Apple, QuickRing will add \$20 to the cost of building a system, plus another \$5 for the connector. Controller chips and connectors are expected to be available early next year.

The Bandwidth Issue

Although QuickRing will transfer up to 350 MBps, no single CPU or peripheral could use all that bandwidth at once. But Apple's twisted-ring topology allows several data streams to simultaneously "flow" between boards. Thus, a drive controller could be pulling an image off a disk and sending it to the video memory at the same time that another part of the video memory was sending its data to a video compression chip. Each peripheral on the QuickRing appears as a *node*. To send a data stream from the CPU to the video controller, the CPU opens up a *channel* with a *token*. It then sends data tokens (or bytes) over the QuickRing whenever it has data to send.

This is why comparing data transfer rates of different local buses is so difficult. If the data is, for example, coming out of a buffer in main memory and going straight into the video card, then the data transfer rate could be quite high, but still not equal to the 130-MBps peak bus rate of VL-Bus and PCI.

This is what happens when the CPU sets up what is referred to as a *burst transfer* from a VL-Bus device. Once the transfer has been initiated, the first data word does not get back from the memory until two clock cycles later. At 33 MHz, this first transfer has taken 60 nanoseconds to complete, which equates to a data transfer rate of a mere 67 MBps. On successive transfers, however, the data words are read on successive clocks at the full

132-MBps data transfer rate.

On the other hand, if the CPU is calculating the pixels to be displayed (as with a GUI) and sending them one by one to the video card, then the data would not be of a burst nature, but would come in little chunks every now and then. In this case, the VL-Bus speed would be less than 67 MBps. PCI behaves in the same way (as do EISA and Micro Channel).

With QuickRing, the situation is more complex. The overhead in setting up a single transfer is extremely high, since you have to open channels and manipulate tokens, so QuickRing will certainly not transfer single pixels at the full 180-MBps one-way data rate. However, once the first transfer has been initiated, successive data can be transmitted at speeds much closer to the ring's theoretical limit.

More Speed to Come

Graphics and multimedia have an insatiable appetite for bus bandwidth. Now that display manufacturers can provide fast 640- by 480-pixel VGA displays, user demand has grown for even bigger and better displays. The bus bandwidth required for a 1024- by 768-pixel image is 2.5 times greater than for a VGA screen.

Local buses such as PCI and VL-Bus offer higher speed than EISA, Micro Channel, or ISA, but it will be hard to extend either of these local bus approaches to speeds higher than currently planned. Both VESA and Intel, however, are confident that their respective bus architectures can evolve to meet future needs. This raises the question, "Is more speed on the peripheral bus really needed?"

"If we can get faster buses, we can produce faster displays," says ATI's Quan. Slater, on the other hand, believes that both VL-Bus and PCI will be viable for the foreseeable future. "Even running NTSC video, either bus will have substantial bandwidth left over," he says.

For the short term, and perhaps longer, both VL-Bus and PCI should serve the needs of most users of Intel-based PCs. They represent a very cost-efficient way of meeting the performance demands of today's graphics-oriented applications and high-speed hardware. However, Quan, among others, cautions against automatically accepting any local bus as the ideal solution. "A lot of people are looking at local bus as being the messiah for graphics," he says. Quan suggests weighing all the options, including ISA, against your needs before making a decision. A coprocessed ISA video board or cached hard drive controller might prove more cost-effective than buying a VL-Bus system to save money on the add-in cards.

QuickRing, with its use of supercomputer technologies, offers a glimpse at how the highest-speed computer cards will interconnect in the future, using transmission-line cables carrying very low voltage signals. Apple is clearly taking no chances; whatever the demands of tomorrow's applications, QuickRing should be able to handle them. It still remains to be seen whether the marketplace as a whole will embrace advanced technologies such as QuickRing or just continue to load the CPU down with more and more local bus peripherals. ■

Editor's note: Also contributing to this story were Andy Reinhardt, BYTE's West Coast bureau chief; Patrick Waurzyniak, Tom Halfhill, and Ed Perratore, BYTE news editors; Andy Redfern, BYTE's London bureau chief; and Michael Nadeau, a BYTE senior editor.

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	Memory/Chips/Upgrades	16	Communications/Networking	28	Operating Systems	39	Recruitment	50
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	Monitors & Terminals				Security			

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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
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71	97	123	149	175	201	227
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410	436	462	488	514	540	566
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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

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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

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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
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1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
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235	260	285	310	335	360	385
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246	271	296	321	346	371	396
247	272	297	322	347	372	397
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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
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256	281	306	331	356	381	406
257	282	307	332	357	382	407
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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
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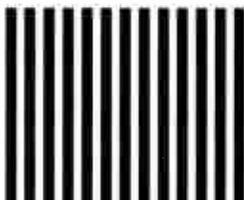
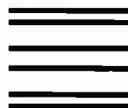
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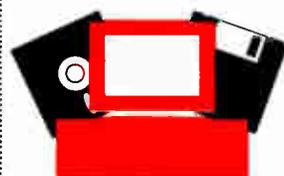
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Silicon Brains

Innovative computer devices are being inspired by the results of research on the brains of nature's creatures

T. J. SEJNOWSKI AND P. S. CHURCHLAND

Imagine a computing device that would revolutionize the stoop-labor sector of agriculture or perform many of the necessary but tedious tasks in other industries. Such agribots would need computational insides that are small, inexpensive, and enormously powerful.

Existing digital computers lack the efficiency, autonomy, flexibility, and adaptability required by the fictional agribots. However, the brains of birds, fish, mammals, and even insects prove that powerful, fast, flexible, and self-reliant computers can solve these problems (see the text box "Bee Smart" on page 142). Breakthroughs in neuroscience, combined with new computational devices such as analog VLSI chips, have made it possible to begin to reverse-engineer nature.

In addition to the sheer intellectual value of understanding ourselves, understanding how brains work could produce important economic benefits. If you know evolution's computational tricks and architectural ingenuities regarding speed, power, and flexibility, you can apply them to a variety of areas: image processing, speech recognition, free-form handwriting recognition, and holographic applications.

Current-generation neural networks capture some of the brain's general features (e.g., the parallel architecture). But neural networks represent only the beginning of brain-style computer technology.

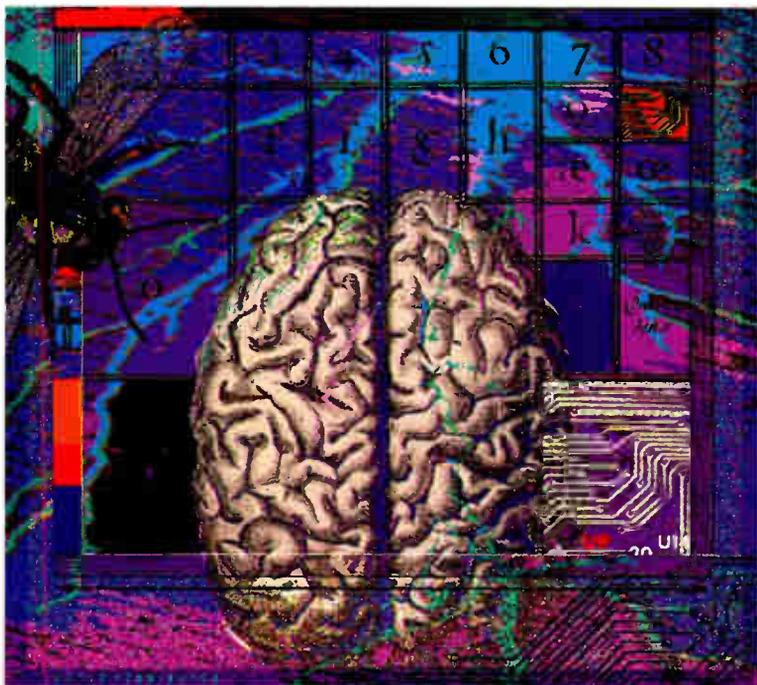
Computing in Parallel

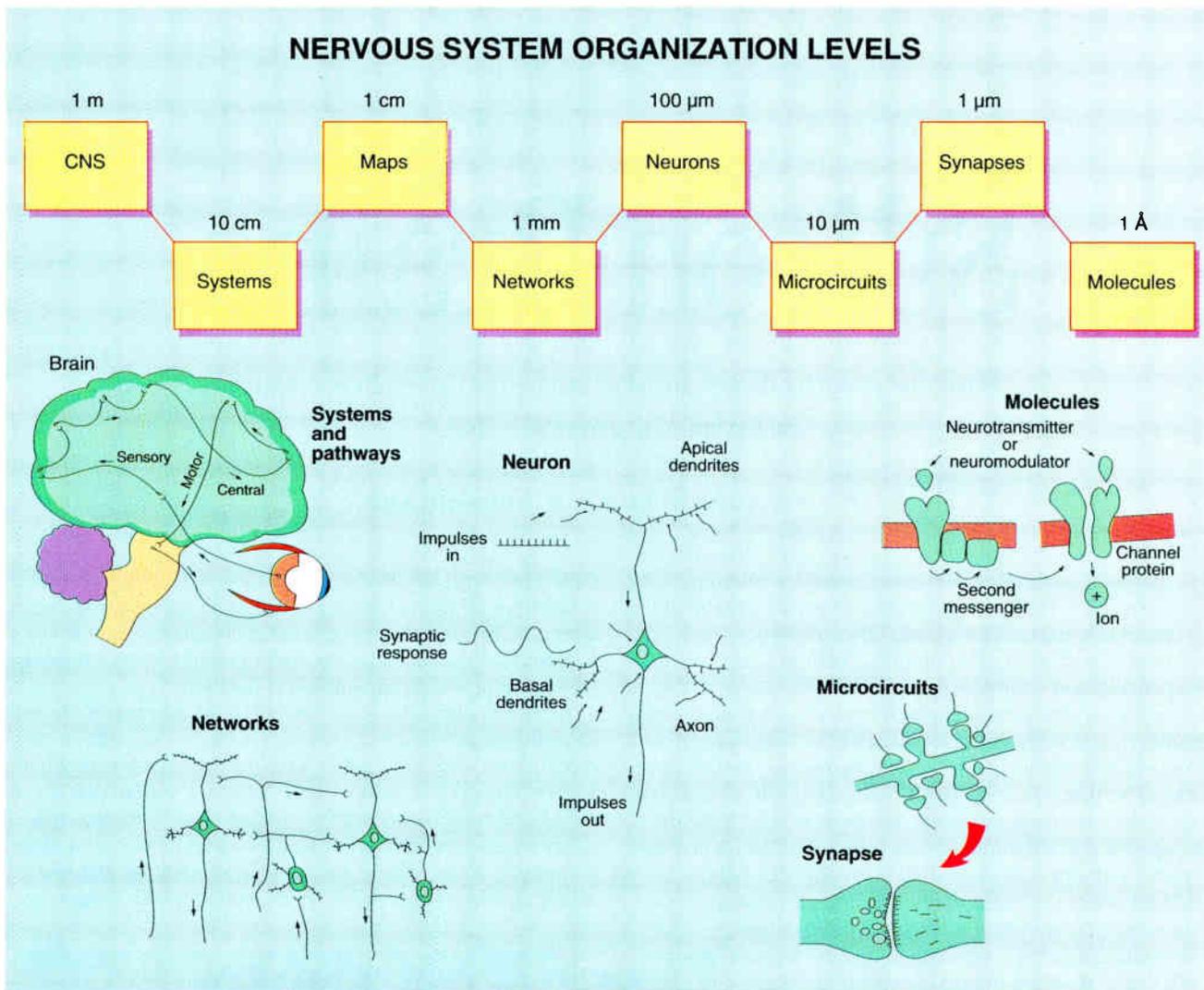
While digital technology is still very much in its heyday, there is tremendous potential in analog VLSI for addressing real-world problems. For example, current algorithms running on a digital machine can correctly read written numerals on credit-card sales forms about 60 percent of the time. The problem of machine-reading postal ZIP codes on letters is compounded by the problem of locating the digit, which is unsolved.

The crux of the difficulty is that digital ma-

chines are typically programmed to solve the segmentation problem (e.g., what character does a squiggle belong to?) and after that, to solve the recognition problem (e.g., is it a 0 or a 6?). Should the machine missolve or fail to solve the segmentation problem, recognition is doomed.

Brains, it appears, do not serialize the segmentation and recognition problems in lockstep fashion. As often as not, recognition cues are used to solve the segmentation problem. In general, people believe that the brain's approach more closely resembles cooperative computation or constraint satisfaction than theorem proving. Of course, it takes a lot more computing to be able to solve the segmentation and recognition problems in parallel. With analog VLSI technology,





The components of nervous systems include the brain and spinal cord, systems (e.g., the visual system), maps (e.g., the retina or the skin), networks (perhaps of many thousands of interconnected neurons), the individual neuron, microcircuits, synapses, and ion channels.

people are learning how to build machines that really compute in parallel.

Reverse Engineering the Brain

Computational neuroscience is the study of how the brain represents the world and how it computes. Being able to model the brain's neural circuits by computer is essential in finding out how neurons (i.e., the cellular components of nervous systems) interact with each other to produce complex effects (see the figure). Such effects include segregating a figure from its background, recognizing a banana from different angles, and following items moving in 3-D space.

Neuroscience contributes three main ingredients to this effort: anatomical parameters (e.g., the precise tree structure of various neuron types and the exact mode of

connectivity between neurons in a particular real network), physiological parameters (e.g., the response characteristics of neurons, time constants, and synaptic strengths), and clues to the function of the human biological neural network and its computational mode of operation in executing that function.

Many techniques that neuroscientists use to study the brain involve intervention—lesioning or electrical stimulation. Analyzing a working model can provide neurobiologists with information about unsuspected mechanisms and interaction; they can then test the results under actual conditions.

This type of collaboration between computer modeling and neuroscience is already producing ideas for new and innovative computing procedures. It has resulted in architectural designs for interacting in real time, storing associative memory more efficiently, coordinating

Applications Benefiting from Brain Research

- Image processing
- Optical character recognition
- Speech recognition
- Handwriting recognition
- Holography

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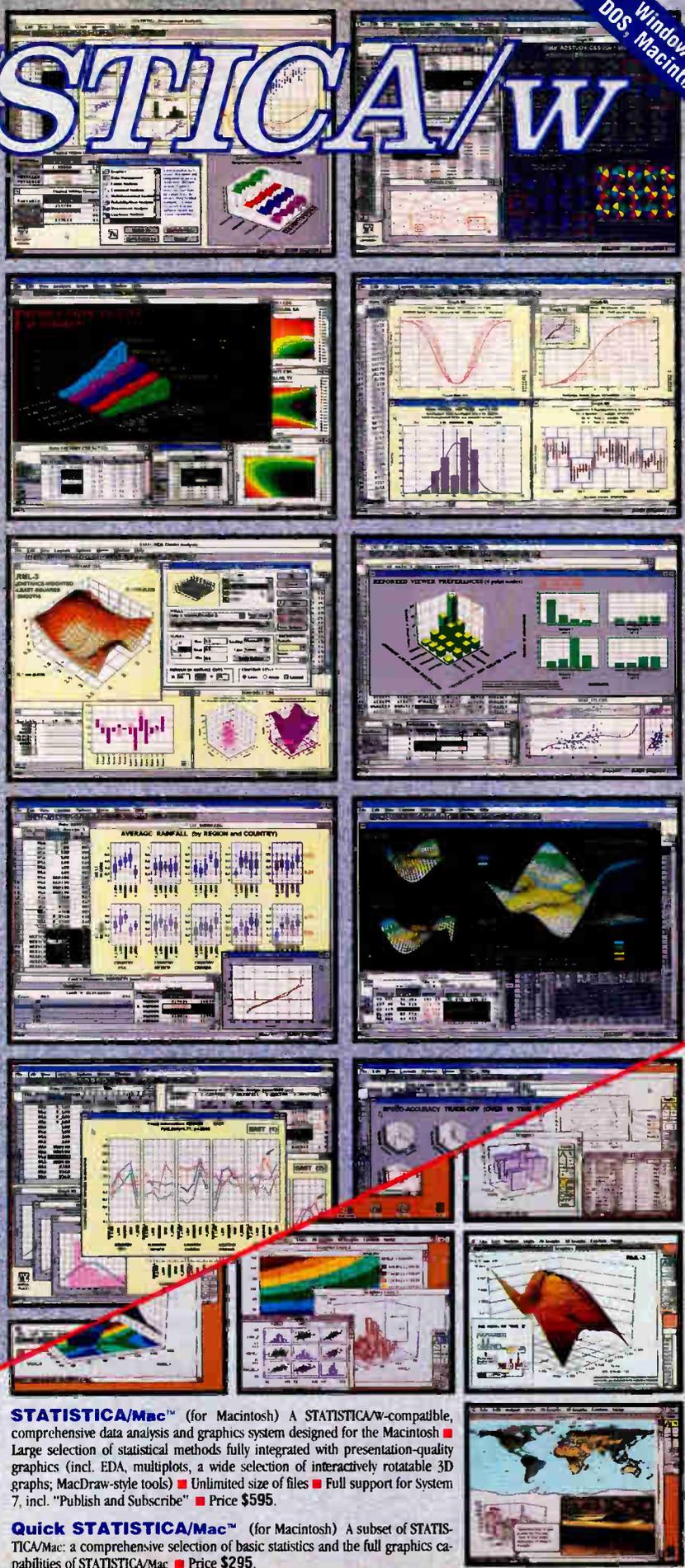
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Glossary

axon Part of a neuron that conducts impulses away from the cell body.

Brownian motion The random movement of particles caused by the collision of the molecules in the fluid around those particles.

cortical structure Structures found in the cortex, a region of the brain.

cytoplasm The fluid outside the nucleus but within the membrane of a cell.

dendrite Part of a neuron that conducts electrical signals toward the cell body.

ion channel Proteins in the cell membrane that may reconfigure to let specific ions (e.g., Ca^{2+}) enter the cell in response to chemical or electrical signals.

lesion An abnormal change in an organ's structure due to injury, disease, or an experimental procedure.

maps Regions of the brain where the topography of neurons corresponds to the topography of the sensory surface (e.g., the retina or the skin).

mitochondria Structures found in the cytoplasm that produce energy through cellular respiration.

neurons The functional units of the brain (i.e., the cellular components of the nervous system). An individual neuron can be either excited or inhibited by inputs from other neurons.

photon A packet, or *quanta*, of electromagnetic energy (e.g., light).

photoreceptor A receptor for visible light stimuli.

pyramidal neuron A type of neuron found in cortical structures.

synapse The point of contact between adjacent neurons where nerve impulses are transmitted from one neuron to the other.

mixed modality, multiplexing, and understanding attention selectivity.

Simulate or Synthesize?

Digital machines are not yet powerful enough to faithfully simulate the nervous system's processes and do it in real time. One or the other is sacrificed. The problem is that the simulation strategy consists of compartmentalizing the phenomena and solving vast numbers of differential equations; thus, compared to the real thing, it is pitifully slow.

In a neuron, ions pass back and forth across a membrane, signals are integrated, and output spikes are produced—all in a matter of a few milliseconds. However, to simulate just 1 ms in a neuron's life, computers must solve thousands of coupled nonlinear differential equations.

To compound the problem, these equations use a wide variety of time scales. In the simulation, the time steps can be only as long as the shortest significant interval. Consequently, even a powerful workstation will take minutes to simulate 1 ms of real time of the electrical and chemical events occurring in a single neuron. You can circumvent this problem by constructing dedicated hardware for synthetic neurons and nervous systems. One strategy is to construct neuron-like chips.

To construct chips that compute as well as neurons do, you must first understand how neurons perform. The production of a spike in a neuron's axon is an all-or-nothing affair. Even axonal spiking is analog in some respects (e.g., when spikes occur, how frequently spikes happen, and how long it takes to repolarize them). The main analog integration of

synaptic inputs occurs in dendrites.

Real circuits have many imperfections. Invariably, they do not meet the ideal, the components are not homogeneous, membranes leak, components malfunction or drop dead, and cross-coupling occurs. But you can't shun chip construction entirely in favor of performing simulations. The best long-term direction people should take seems to be to find out how real circuits obtain precision, speed, and power from imperfect and imprecise components. Somehow, neurons operate in real time and cope magnificently, probably by exploiting imperfections to their advantage. The coping capacity of real-world neurons is itself computationally interesting.

Neurons are organic. They use fatty molecules to make resistive membranes. Complex proteins make ion channels that let current flow across the membrane, and cytoplasm acts as the medium for transmitting current. Mitochondria are the neuron's miniature powerpacks; circulating oxygen is their energy source. But what can you use to construct synthetic neurons?

Synthetic Neurons

Analog VLSI technology turns out to be well suited to constructing synthetic neurons for two reasons. One is theoretical, and the other is practical.

The device physics of doped silicon operating in subthreshold regions is comparable to the biophysics of ion channels in the neuron membrane. Therefore, you can implement the differential equations directly with analog circuits in CMOS VLSI. And the same techniques used to create digital VLSI chips can be adapted to make analog VLSI chips. Carver Mead of Caltech and Synaptics and Federico Faggin of Synaptics, industry pioneers

You can't shun chip construction entirely in favor of performing simulations.

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Bee Smart

Start by contrasting what a small honeybee can do with tasks that today's most powerful computers can't do, and add the fact that a honeybee's brain has only about 1 million neurons versus the human brain's 100 billion neurons. Then consider the following information:

Energy efficiency. A honeybee's brain dissipates less than 10 microwatts (10^{-6}). It is superior by about seven orders of magnitude to the most efficient of today's manufactured computers.

Speed. A honeybee's brain, roughly and conservatively, performs at about 10 TFLOPS (10,000 GFLOPS). The most powerful of today's computers approach speeds of only 10 GFLOPS (i.e., 1 billion operations per second).

Behavioral abilities. Honeybees harvest nectar from flowers and bring it back to the hive. They maximize foraging benefits and minimize foraging costs—for example, by recognizing high nectar sites and remembering which flowers they have already visited.

Honeybees can see, smell, fly, walk, and maintain balance. They can navi-

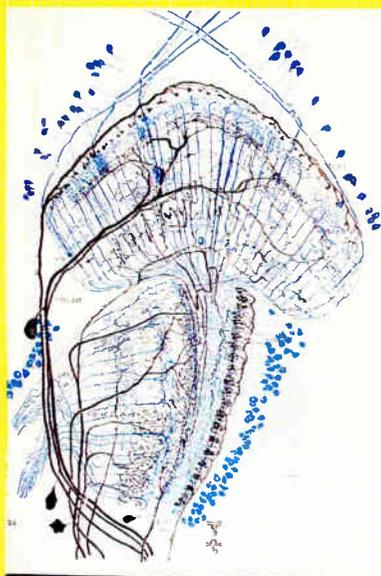


Photo A: Anatomy of a fly's visual system. Like that of other insects, a fly's visual system is highly organized. The structure of the fly's system shows how the neurons (black) are organized into layers of visual processing. (Drawing by N. J. Strausfeld, *Atlas of an Insect Brain*, New York: Springer-Verlag, 1976)

gate long distances and predict changes in nectar location. They communicate the location of nectar sources to worker bees in the hive; they recognize intruders and attack; they remove garbage and dead bees from the hive; and, when the hive becomes crowded, a subpopulation will swarm in search of a new home.

Autonomy and self-reliance. Honeybees manage these activities entirely on their own without any help from superior beings. By contrast, a supercomputer needs the constant tender care of a cadre of maintainers and programmers.

Size. A honeybee's brain takes up only about a few cubic millimeters of space. It is a marvel of miniaturization. You cannot reach all the way around a supercomputer.

From this comparison, it seems we have a ways to go in allowing computers to perform some of the simpler things in life. Nature and its creatures are models for ways in which to improve our computing devices. (See photo A for an inside view of the insect visual system.)

who played leading roles in digital chip technology, are now spearheading the development of analog chip technology for neural systems.

With analog VLSI, a chip can follow the brain's lead—for example, concurrently solving segmentation and recognition problems. As reported this year in *Nature*, Misha Mahwold and Rodney Douglas, both of Oxford and Caltech, achieved the first step in building silicon neurons (see the text box "Silicon Neurons" on page 144).

Using analog VLSI, Mahwold and Douglas created a chip that mimics selected properties of pyramidal neurons, a type of neuron found in cortical structures. Their silicon neuron consists of only one compartment (the cell body) and four types of ion channels in the membrane. By contrast, a real pyramidal neuron might have thousands of dendritic segments, as well as an axon, tens of thousands of synapses, and scores of various ion channels.

As a pilot project, however, the Mahwold/Douglas silicon neuron was successful on several counts. First, it ran in real time. This meant that Mahwold and Douglas could conduct experiments by tweaking parameters in real time, such as the density of a given type of channel. Second, the neuron's output

behavior for varying amounts of current (displayed on an oscilloscope) closely resembled that of a real pyramidal cell under various physiological conditions. Third, the neuron consumes little power.

The successful debut of a single synthetic neuron has made possible several other potential developments: By adding more compartments (corresponding to dendrites) and a wider range of ion channels, you could improve the synthetic neuron's computational capabilities. Another possible development is that of building many neurons on a single chip. You could then explore synthetic neural circuits to learn more about the computational possibilities inherent in various parameters.

Ideally, you should be able to tweak thousands of parameters in real time; thus, interfaces need to be flexible and user friendly. Using synthetic circuits would mean that you could explore neurons in virtual reality rather than having to watch points appear on a graph on your screen.

A further refinement would be to make the chip able to learn from experience. Then, instead of having to hand-set neuronal connections, you could use a training regime. Mead and his group are currently developing trainable chips that can modify connectivity based on learning certain rules similar to those

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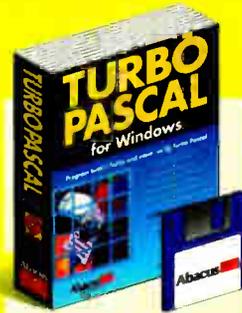
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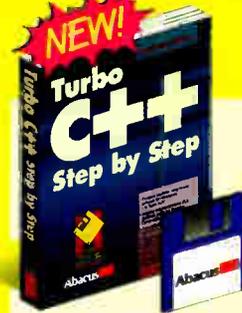


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Silicon Neurons

RODNEY DOUGLAS AND MISHA MAHWOLD

Neurons in the living body have electrical and chemical mechanisms that let them act together to represent and respond to behaviorally significant physical events. Over time, neurons have learned to manipulate how their membrane conducts various ions to produce electrical events that form a basis for computation.

Neuronal systems compute in fundamentally different ways than electronic computers do. Neurons are massively interconnected. The neurons shown in the reconstructed neocortical pyramidal cell (see photo A) receive input to their dendrites (green) from thousands of input cells and transmit to thousands of output cells via the synapses (white) made by their axons (red).

Neurons operate in the millisecond range rather than in the nanosecond range. The human brain generates 10^{16} operations per second (compared to the supercomputer's 10^9 operations per second). But the power consumption of the brain is only 10^{-25} joules per operation (compared to an electronic processor's roughly 10^{-7} joules per operation).

The perception of an object is an unsolved computational problem. The vast majority of neural computations as complex as perception are less than 100 operations deep. This fact reflects the essentially distributed nature of neural computation, in which algorithms express themselves as connectivity and processors are indistinguishable from memory. Certainly, it seems that people can learn about computing from the field of biology.

Neuroscientists are learning about

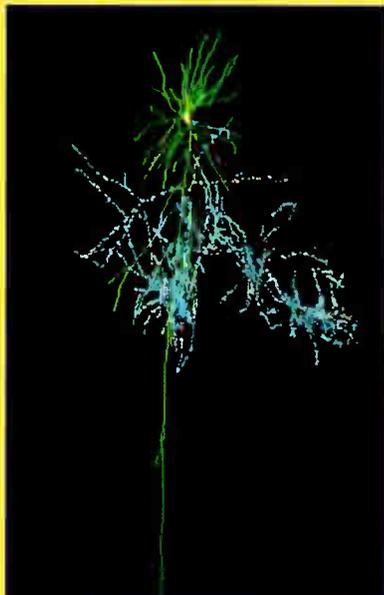


Photo A: A reconstructed neocortical pyramidal cell from a cat. The cell's neurons receive input to their dendrites (green) from thousands of input cells and transmit to thousands of output cells via the synapses (white) made by its axons (red). (Photo courtesy of Rodney Douglas and Kevan Martin at MRC Cambridge)

neural computation through reverse engineering. They combine experimental neuroscience with neuromorphic systems made from analog CMOS VLSI technology. Fortunately, the physical properties of analog CMOS are similar to those governing the electrical behavior of neurons and neural systems; therefore, analog CMOS is a

convenient medium for building neuromorphic systems, just as the properties of Lego make it appropriate for constructing structures and machines.

For example, we fabricated a generic silicon neuron that emulates the fluxes of the ionic currents that occur in real neurons. Consequently, the silicon neuron has the same computational properties (at the neuronal level) that real cells do. The neuron can emulate the behavior (i.e., personality) of any particular neuron in the nervous system simply by setting several parameters.

One exciting feature of the silicon neuron is that it behaves in real time regardless of its complexity or the number of neurons in the network. We are currently working to build many neurons, initially about 100 to 200 neurons, on a single chip.

In the not-too-distant future, we anticipate building networks of thousands of silicon neurons on multiple chips, with personalities and connectivity that can be modified in real time. Using these silicon neural networks, we will be able to emulate intelligent circuits in the brain (e.g., those of the visual system) and provide a test bed to investigate realistic learning mechanisms.

Rodney Douglas and Misha Mahwold are members of the Medical Research Council Anatomical Neuropharmacology Unit at Oxford and the Computation and Neural Systems Program at Caltech. You can reach them on BIX c/o "editors" or on the Internet at rjd@vax.oxford.ac.uk and mam@vax.oxford.ac.uk, respectively.

believed to underlie plasticity in nervous systems. Here, *plasticity* refers to a property of a neuron's body that undergoes a permanent change in shape, size, or composition under certain conditions.

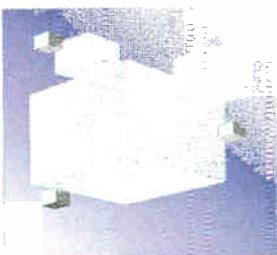
Ultimately, you will want to create chips with subpopulations of neurons specialized for different tasks, in the manner that distinct brain regions—including visual cortex, auditory cortex, motor cortex, and so forth—are specialized. Learning from the ways that nature engineers specialization and integration functions

should provide valuable information.

Following nature's lead may require that people model patterns of neuronal connectivity, both long-range (on the order of centimeters) and short-range (millimeters). Nervous systems are remarkably fault-tolerant: A circuit and its ability to function can survive the death of individual neurons within the circuit. Artificial systems might be able to achieve comparable fault tolerance if they are made to imitate the brain's connectivity, modifiability, and processing style.

continued

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ANALOG VLSI VS. DIGITAL VLSI

Analog VLSI is strikingly superior to digital technology in terms of cost, power, and computation density. (Estimates by Federico Faggin.)

	Cost (MCS*/\$)		Power (MCS/watt)		Computation density (MCS/ft. ³)	
	1991	2000	1991	2000	1991	2000
Conventional digital	0.002	0.1	0.1	10	0.2	10
Special-purpose digital	0.1	4	10	10,000	10	1000
Dedicated digital	5	200	500	50,000	40	3000
Dedicated analog	500	20,000	50,000	5,000,000	4000	4,000,000
Human brain	10 ^{9**}		10 ¹⁰		10 ¹¹	

* MCS = A million connection updates per second.

** This calculation assumes that the cost of a human brain is \$10,000,000.

Neural Circuits in Silicon

Peripheral sensory organs (e.g., the eye) are highly specialized parts of the body that translate external physical signals into electrical activity. The retina is a powerful preprocessor that transforms information about photons into a form suitable for neural representation and computation.

The retina is a powerful preprocessor that transforms information about photons into a form suitable for neural representation and computation.

In a number of animals, sensory transducers and preprocessors are about as sensitive as they can get. For example, in primates, photoreceptors in the retina will respond to just a few photons; the human ear can pick up sound close to that of Brownian motion. Powerful analog preprocessors shape the information into a neural-friendly form—but can they be reverse-engineered?

Mead has built a family of silicon retinas. Each silicon retina is a VLSI chip that is a square centimeter in area, weighs about a gram, and consumes about a milliwatt of power. Between arrays of phototransistors etched in silicon, dedicated circuits execute smoothing, contrast enhancement, and motion processing. The chip operates in its subthreshold, analog mode.

Compared with a typical CCD (charge-coupled device) camera and standard digital image processor, the Mead chip is a paragon of efficiency in performance, power consumption, and compactness. A special-purpose digital equivalent would be about the size of a standard washing machine. Unlike cameras that must time sample, typically at 60 frames per second, the analog retina works continuously without needing to sample until the in-

formation leaves the chip already preprocessed.

Operations performed with Mead's chip capture some of the functions that real retinas perform; however, real retinas contain many more circuits than Mead's synthetic one. While it makes sense to build chips to maximize efficiency in the three critical elements (i.e., power, cost, and density), you must still push analog VLSI techniques a long way to approximate neural efficiency. The incentive to go forward with this technology will depend on whether the payoff looks promising in the long term (see the table).

Neuro-Revolutions

We are on the brink of two neuro-revolutions: one in the science of the brain and the other in the technology of brain-style computing. Knowledge grows exponentially: The more you have, the more you get—and the faster you get it. So it is in neuroscience. Almost every day, surprising discoveries about the organization and mechanisms of nervous systems are being reported.

The VLSI revolution has provided computer science with unprecedented tools to transform what we know about the brain into silicon. Silicon retinas are in production, silicon cochlea are nearing production, and oculobots (i.e., robotic eyes) are on the drawing board. Although it is nearly impossible to predict future technological breakthroughs, ever-more sophisticated neuro-engineering is in the offing. ■

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Byte Magazine: May 1992

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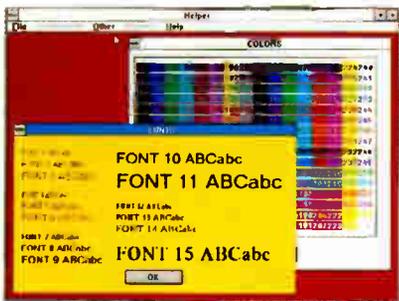


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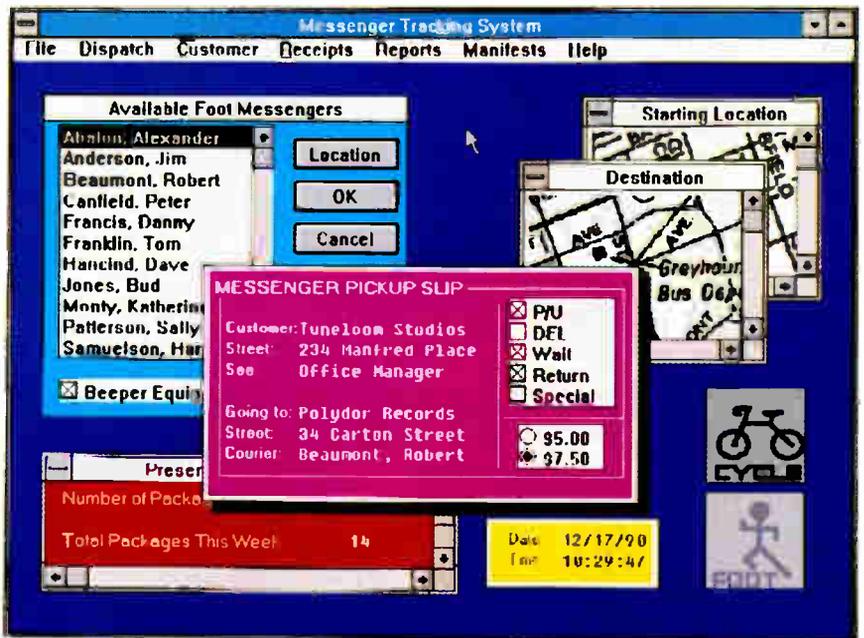
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World Radio History

Plugging Into the Internet

The range of options for Internet access is almost as broad as the range of Internet resources

DANIEL P. DERN

Sometimes you strike a nerve. Soon after my article "Applying the Internet" appeared (see February BYTE), I received numerous questions from BYTE readers about the Internet. The majority of these questions were identical: "How do I get access to the Internet?"

The good news is that almost anyone with a PC and modem can get Internet access in one form or another, often for as little as \$10 to \$20 per month. In fact, depending on the services you want, your current BBS and E-mail accounts may offer sufficient connectivity. At the high end, organizations such as Fortune 1000 corporations, schools, libraries, and other institutions are plugging into the Internet at speeds of from 56 Kbps to 1.554 Mbps (T1) and higher, at a cost of from several hundred to several thousand dollars per month.

Getting access to the Internet involves deciding what you want to do and how much you're willing to spend, selecting the appropriate service provider, and getting the appropriate hardware and software. Making these decisions and getting access may be as simple as making two phone calls, or it may involve several hours or days of research. The best choice will differ from person to person and from place to place. (For information on accessing the Internet in Europe, see the text box "Locating Internet Access in Europe" on page 151.)

The Internet is arguably the world's largest computer network, connecting thousands of sites and millions of users all around the world. Plugging into the Internet gives you real-time access to a myriad of on-line databases, library catalogs and collections, and software and document archives, as well as store-and-forward services such as Usenet News and E-mail for thousands of SIG (special-interest group) topics.

Types of Connections

Your connection to the Internet has several dimensions. The first is whether it will be a terminal-

style connection to an account on a host computer on the Internet or an IP network connection between your computer and the Internet. In the latter case, your own computer is "on the Internet," which means you can have multiple sessions and transfer files directly to and from your hard disk.

A terminal connection means you are using a terminal emulation package (or a real terminal) to connect to an account on a computer that is on the Internet. You open Internet connections between the host computer and remote systems. (Further steps are required to perform specific functions, such as downloading files from the host computer to your PC.) A terminal connection can support only one session at a time—namely, the terminal emulation session.

continued



By contrast, a network connection is capable of supporting several sessions of remote log-ins, file transfers, and other activities concurrently.

Another dimension to your Internet connection is whether you need a permanent or an on-demand connection. Many systems and LANs are connected to the Internet full-time. Others establish connections to the Internet only when needed; for example, some public-access Internet hosts will dial up a network connection only when a user request requires it.

A final factor you have to determine is whether you need access to real-time applications. Being part of the Internet means you can run real-time applications, such as file transfer and remote log-in. Many computers, networks, and services provide gateways to the Internet by supporting E-mail exchange, Usenet (the global multitopic BBS structure of newsgroups that intertwines strongly with the Internet proper), and news, without supporting the real-time Internet applications. This may be just the level of Internet access you need.

Terminal Access

Getting on the Internet through a terminal connection has become quick, easy, and affordable, thanks to the advent of public-access Internet hosts—multiuser Unix systems connected to the Internet. If you already have a modem and a communications program, you're 95 percent of the way there.

Like CompuServe, Prodigy, and thousands of BBSes across the world, public-access Internet hosts offer accounts to anyone (see the text box "Internet Access Information" on page 156). You access the Internet hosts with the same computer, modem, and communications software that you use to dial up BBSes, CompuServe, and so on. Public-access Internet hosts, such as NetCom (San Francisco) and The World (Brookline, MA), provide you with dial-up access to their systems. You can use the full range of Internet services and resources (subject to access and usage restrictions, and you may need specific accounts for certain services). The biggest difference between a terminal connection and an IP-based one is that when accessing the Internet through a terminal, you are limited to one session at a time.

From your account on a public-access Internet host, you can make use of those Internet facilities that require real-time IP connectivity, such as FTP (file transfer protocol), remote log-in (Telnet), IRC (Internet Relay Chat), WAIS (Wide-Area Information Server), access to text data sets, library catalog access, and multiuser interactive games, such as MUD (Multiuser Dungeon). You will probably require at least a little knowledge of Unix; however, a number of these systems provide on-line help tutorials—you simply type `help` at the system prompt.

An account on a public-access Internet host costs anywhere from \$1 to \$4 per hour. Some systems have a minimum monthly charge; for example, The World charges \$20 for the first 20 hours and then \$1 for each hour after that. There may be additional charges for storing over a certain quota of files and other miscellaneous fees, but it's still a bargain. You'll also have to pay extra if dialing up the system is a toll call. Many systems have arrangements to provide slightly cheaper long-distance dial-up services.

Most of the Internet public-access Unix hosts have state-of-the-art high-speed modems and protocol suites. A 9600-bps modem is standard; you can also expect

14,400 bps with V.32bis and up to 19,200 bps with compression. (The Internet host will also provide for slower speeds—2400, 1200, or even 300 bps—if you have older equipment or noisy telephone lines.)

Network Connections

By running TCP/IP directly on your computer or LAN and establishing a network-layer connection with the Internet, your computer can interact directly as a peer with other computers and services on the Internet. TCP/IP software is included in nearly every version of Unix and every Unix-type system (e.g., SunOS, Apple A/UX, Next, IBM AIX, and DEC Ultrix).

TCP/IP software is also available in commercial or free public domain versions for nearly every popular type of computer environment. For example, DEC, IBM, Novell, and other vendors offer TCP/IP along with their proprietary network protocols for most of their computing environments. More important, TCP/IP is available for most desktop computing systems, including MS-DOS, Windows, Mac OS, and Amiga. That's right: Even your Mac PowerBook or portable Windows notebook can connect as a peer computer on the Internet.

By running TCP/IP, you can execute Telnet, FTP, IRC, and other IP applications directly from your own computer, rather than having to dial up as a terminal. Because your connection is a full IP network connection, you can have multiple sessions concurrently (e.g., two Telnet, two FTP, and one IRC, each in its own window—assuming, of course, your CPU can handle this load).

Many of the Internet service providers offer dial-up IP connections from which you can log on and transfer files across the Internet at will. Organizations offering dial-up IP connections are called *public dial-up providers*.

If you are using an IP dial-up connection, rather than directly plugging into a LAN, your computer must also support (in addition to TCP/IP) an underlying protocol for communicating over a serial line (i.e., a telephone line). Most products you buy will include either PPP (Point-to-Point Protocol) code or its predecessor, SLIP (Serial-Line IP).

If you decide to dial in as a protocol-speaking host, you will need a location where you can receive and store your incoming mail (i.e., a network address on a system that will hold messages in its queue for you). When you dial in, you use one of the TCP/IP Post Office Protocols to connect to the mail server so that you can retrieve your messages in batch format. Once you download the messages, you can read them off-line on your system. Many commercial and public domain mail readers, which can upload outgoing E-mail you've created, are also available. Most of the service providers that offer dial-up network service also offer mail queuing; if not, you'll need to find a site that will act as your mail drop. Similar arrangements, protocols, and programs are available for browsing, downloading, and posting to Usenet.

If your organization wants full-time, full-capability Internet connectivity—meaning using leased-lines to connect its LANs or backbone to the Internet—you should first check with an Internet service provider in your area. There are dozens of regional, national, and international Internet service providers.

Choosing Your Connection Mode and Provider

A number of factors need to be considered to determine the most appropriate mode

Types of Internet Connections

- Dial-up terminal-style connections to Internet hosts.
- TCP/IP network connections between your computer and the Internet.

Locating Internet Access in Europe

MERIK VOSWINKEL

The main network in Europe that delivers full Internet to its 1500 sites is EUnet, sometimes referred to as interEUnet. Of these 1500 sites, only a few offer public access, some on a commercial basis and some as an informal service to a few people outside their organization. Some sites specialize in providing the Internet to a company LAN. These solutions are costly and often require the purchase of an expensive router and an ISDN or leased line. These connections can cost up to \$10,000 or more per year. Most public access, however, is geared to a dial-up modem, an X25, or ISDN connections.

To establish an Internet connection, you first have to locate a site near you, preferably in your local calling area to keep the telephone cost minimal. Often a visit to the computer store of a local university or a call to a member of the computer science faculty will tell you who is offering Internet access in your area. Many times the university will itself be a supplier and offer reasonable fees. However, universities sometimes refuse business clients and refer them to public-access sites.

Visiting a university is often a great way to get started; you get to look over the shoulders of people while they're using the Internet. Most are evangelists to the Internet cause and will gladly offer help and advice. It is also a good place to get configuration (public domain) software and learn lots of tricks from experienced users who are sitting at the same computer that you plan to use to access the network. Internet access can take weeks to master. Dialing up a Unix computer and customizing the log-in to make it work with your terminal software and modem at home can be a daunting task for most users. In Europe, most public Internet sites don't yet have customer support to lead you through the process.

A quick way to locate an Internet site that will provide you with a connection is through the Internet itself. If you know someone with E-mail access to Internet users, you can search for a site that has

the best options. Most non-Internet E-mail services can also send mail to the Internet, sometimes after adjusting the E-mail address slightly. Shopping around with E-mail can also be useful for changing your site if you want to take advantage of better types of connections. KnoWare has gathered a list of the main European sites that offer Internet access on a commercial basis. To get this list, you can send an E-mail request to creon@accucx.cc.ruu.nl.

You can get access information from the main Internet site in any European country. You simply send a message with your request for a local Internet access. The main Internet site can answer your request, or it can pass the request on to a provider. The E-mail address you use in Europe is [postmaster@\[countryname\].eu.net](mailto:postmaster@[countryname].eu.net). You have to fill in the country name with the English-language name of your country. All the European Community countries are represented (i.e., Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the U.K.), as well as others (e.g., Austria, Finland, Iceland, Norway, Sweden, Switzerland, and Yugoslavia). You should use this address only if needed, so as not to overload the European postmasters.

Another way to locate a local supplier is on the Usenet News, the conferencing area of the Internet. Main non-Internet BBSes carry these newsgroups. You should read the groups alt.internet.access.wanted, news.new-users.questions, or the older alt.bbs.internet. You can post requests here for the name of a local supplier. Commercial sites scan these groups, and they sometimes contact you if you state your mail or E-mail address.

If all else fails, you can order a list of 1500 sites from the EUUG Secretariat, Ownes Hall, Buntingford, Hertfordshire SG9 9PL, U.K., 44-763-73039, E-mail euug@nic.eu.net. The problem with this list, however, is that it does not mention if a site offers public access.

Public sites often have a better ser-

vice for novices, while universities lean more toward computer-literate users. Public sites offer more options geared to dial-up access, while universities consider their campus networks their main target.

The Internet offers many services, but its main use is for E-mail, news, and FTP (file transfer protocol), as well as to request remote log-in (Telnet). The type of access that your site offers can limit you in these options. Some services give you a terminal connection to a Unix host. Your terminal connection can be via shell access, (anonymous) UUCP feed, or BBS software. This connection offers you E-mail, news, and sometimes FTP and Telnet.

Direct connections make you a node on a service provider's LAN, so you can run all your software on your own computer. You can connect directly with SLIP (serial-line IP) or PPP (point-to-point protocol) over a modem to the Internet WAN (wide-area network) or make a direct Ethernet connection to the Unix hosts. A recent development for Macintosh computers is the capability to connect with ARA (AppleTalk Remote Access) and MacTCP to the Internet. You need public domain programs such as Eudora for E-mail, The-News or News-watcher for news, and Fetch or Xferit for FTP. You can use Telnet to log into computers over the network. Several sites are offering similar solutions for MS-DOS, Amiga, Atari, and Unix workstations. These solutions are recent developments, designed by the Internet community for use over Ethernet networks. Public-access providers extend this network to your home with SLIP, PPP, or ARA. It makes the Unix-oriented Internet much easier to use, even by novices.

Merik Voswinkel is president of KnoWare (Utrecht, The Netherlands), a firm providing public Internet access. He works as a Mac and Internet consultant in the nonprofit sector. You can contact him on BIX c/o "editors" or on the Internet at creon@accucx.cc.ruu.nl.

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and provider for your connection to the Internet: Do you require remote log-in and file transfer? Or do you need services and applications that require real-time IP connection, such as WAIS and HYTELNET? Perhaps you require just an Internet E-mail link or Usenet News. The level of service that you need goes a long way toward determining the type of service you require.

Other considerations include the type of computer you'll be using and the types of connections your computer supports. It is much easier to get a Unix machine outfitted with a TCP/IP stack than it is to do the same with a DOS machine or an Amiga. Where you live is as important as the type of machine you'll use. If you're out in the country, telecommunications costs can make real-time IP access prohibitively expensive.

A direct IP connection is the most powerful and flexible solution, but it is also the most expensive to set up and maintain; thus, it is better for organizations than for individuals. A dial-up IP connection is best for an individual who needs the flexibility of multiple sessions. For people not at an Internet site, terminal access is often the most cost-effective solution to the Internet-access dilemma.

Indirect Connections

In addition to the direct connections listed above, there are several indirect ways for you to connect to the Internet or access its resources and community. First, you can get a dial-up terminal-type account to a Unix/Usenet BBS that is not directly on the network. Hundreds of dial-up Unix-based BBSes are all over the world and can be more accessible (and affordable) than the Internet hosts or service providers. If you primarily want E-mail, Usenet News, and archives but don't need real-time IP connection, BBSes may be good enough. In addition to providing an E-mail connection to the Internet, many BBSes include full Usenet News feeds and gigabytes of popular software archives (which are beginning to be distributed via CD-ROM). A number of other files can be retrieved via E-mail-based file transfer.

Other indirect ways for you to access the Internet are having an account with an Internet E-mail provider (i.e., an E-mail service directly on the Internet). Many of these providers offer 800-number access or an account with a commercial E-mail/BBS provider that has an E-mail gateway to the Internet, such as ATT Mail, CompuServe, and MCI Mail. Finally, you can download software from UUNET at (900) 468-7727 for 50 cents per minute (you just log in as UUCP, and you don't need a password; UUNET modem speeds are up to 19,200 bps with PEP protocol).

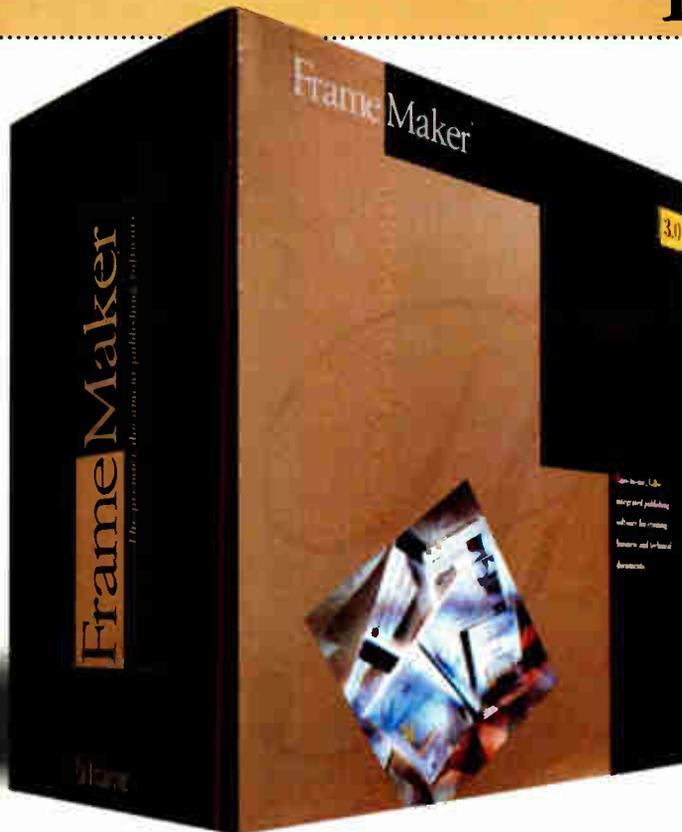
A Few Words About "Netiquette"

It is important to be aware that when you access the Internet, you are connecting into a large global community and to a vast network of resources. As a reminder to Internet users, Charlotte Moore of BBN Communications says, "The Internet allows you to contact thousands of systems and hundreds of thousands of users in a single act, deliberately or unintentionally, so it's important to be aware of who's paying for your use of Internet resources, and how much it costs."

More specifically, here are a few canonical tips to prevent your Internet usage from becoming disruptive. First, you should be careful how you use FTP and Telnet: You should try to use them during off-peak hours and not tie them up for too long. Second, you should use discretion: Don't send E-mail messages to a newsgroup or post anything you wouldn't be willing to see on the front page of tomorrow's newspaper. Finally, you should be sure to

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keep your password secret and report any possible security violations to your system administrator or other appropriate site personnel.

Getting More Internet Info

Even if you are an experienced Unix hand, you may be bewildered by the vast array of resources available through the Internet. One of the best places to get information is on the Internet. There are lots of "how-to" write-ups available on-line in ASCII and PostScript versions. Many sites and network service providers have their own user guide, and several general guides are available as well. Explore your system for on-line help files and programs, and ask your site contact personnel about training seminars.

Several resource books are available: Some are very basic, and some are focused on specific areas such as library catalogs, databases, and computing resources. New resources come up on the Internet almost hourly. In general, the more you make use of Internet resources, the more you'll be able to figure out how to use them and learn about new ones—and the more you'll get out of being on the Internet. ■

Daniel P. Dern is a freelance technology and business writer based in Newton Center, Massachusetts. He is the author of The Internet Guide for New Users (McGraw-Hill, forthcoming). You can reach him on BIX c/o "editors" or on the Internet at ddern@world.std.com.

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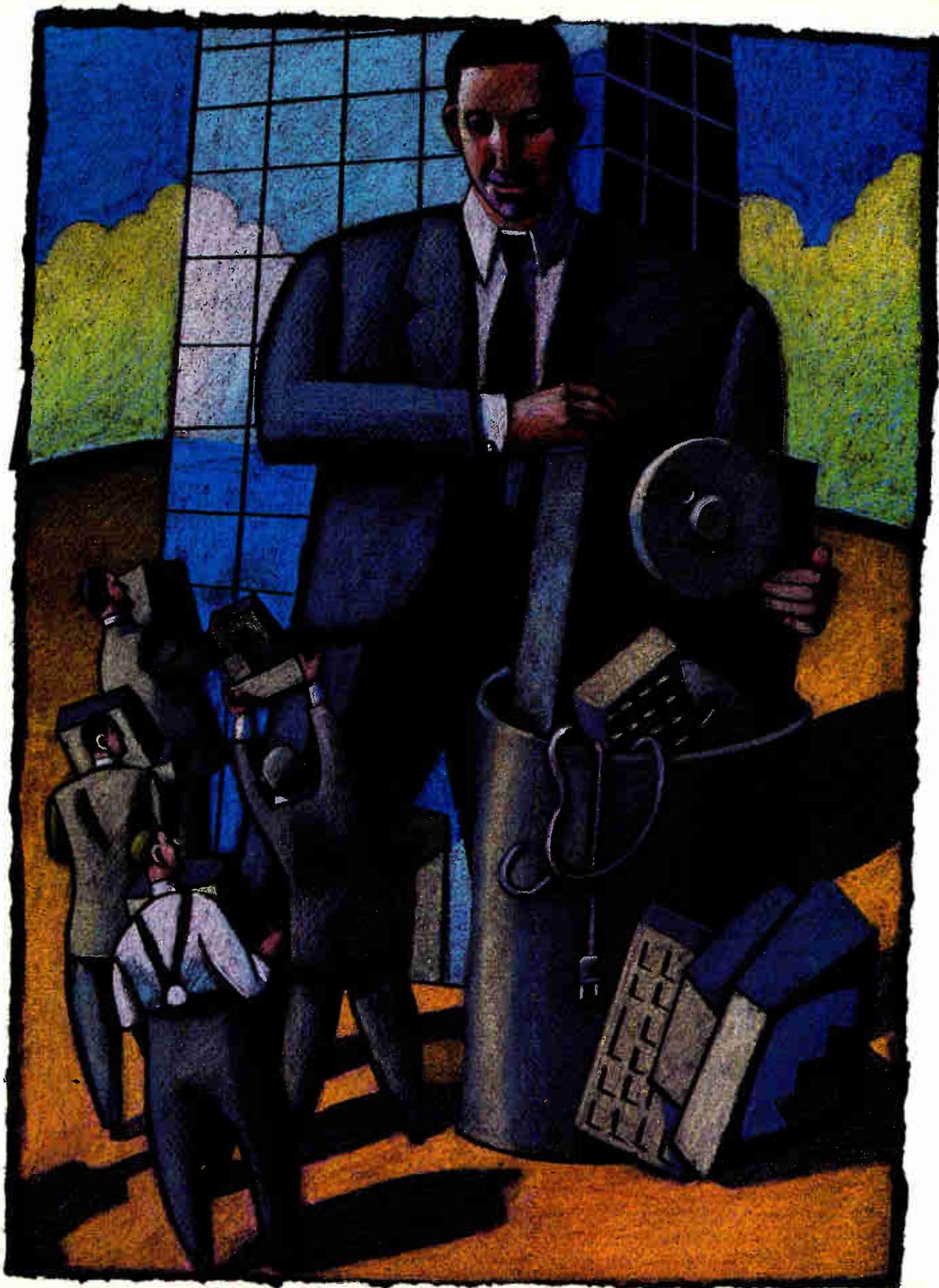
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OPERATING-SYSTEM TRENDS

Business users raise the expectations of desktop-based operating systems

JOHN DONOVAN

A few years ago, all it took for an operating system to gain acceptance was an inexpensive hardware platform and a good application base. Now more complex factors come to bear: How easy it is to use and to develop applications for? How stable is its technology base? Driving this change is the trend among businesses to downsize. These companies are abandoning their minicomputers and mainframes for networked desktop systems. The personal computer is proving itself capable of handling mission-critical tasks, but the corporate customer wants more.

The sophisticated operating systems of mainframes and minicomputers (e.g., DEC's VMS or IBM's MVS) support multitasking, virtual memory, security, robust file systems, and efficient system administration. All these features are incorporated into each of the desktop-based operating systems discussed in this State of the Art section. These operating systems—Microsoft's Windows NT, IBM's OS/2 2.0, Apple's System 7.0, Univel's UnixWare, Next's NextStep, and SunSoft's Solaris—combine the best of the mainframe/minicomputer world with the best of the desktop world. The result is a relatively bulletproof system designed to be implemented on a large scale and able to run familiar desktop applications with a familiar user interface.

In competing for the corporate customer, hardware has become a commodity, and the operating system has become the vehicle for the competition. The latest manifestation of how the operating system is the focus of the competition for the corporate customer is found in Microsoft's Windows.

The Server Is the Key

Windows covers a wide range of systems, from notebooks and pen-based computers to the desktop. Originally, Windows was intended to make it easier for people to use the PC, but recently, it has expanded its mission: to form the foundation for a better server in client/server computing through NT (see "Windows NT Up Close" on page 167). Mike Nash, NT marketing manager for Intel, describes the operating system as "kind of a best-of package. If you name all the things

you would want out of Unix, VMS, OS/2, DOS, and Windows, you will find they're all in NT." If it sounds like it's being developed as an ideal operating system for the server, that's because it is. All the serious operating-system contenders are vying to succeed in the corporate market by capturing the server.

The server is a key to operating-system marketing strategies because corporate networks are typically made up of a mix of clients: Accounting might use PCs while the marketing staff has Macs and the engineering department uses Unix-based workstations. That mix is slow to change because existing equipment and their applications tend to be preserved whenever possible. So, the developer has a better chance supplying operating systems on servers and letting the operating system's performance speak for its usefulness on new client machines. Witness the multiplatform support adopted by operating-system developers (see the figure).

Don't Forget the Developer

Another strategic target in the operating-system competition is the applications developers in large corporations. These developers are the focus of two

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conflicting pressures: downsizing (and the scattering of corporate information system resources) and the increasing need to develop applications faster. The beleaguered developer presents a critical support issue and a strategic opportunity to operating-system vendors. The operating system that best supports internal developers has a real edge in getting their company's business.

"One of the biggest problems you have in corporate America is getting an application developed," observes Mike Colleary, IBM's marketing manager for OS/2. "Corporations need applications that give them a competitive advantage, something that everybody and his brother can't buy off the shelf." According to Colleary, up to 2 million people worldwide are developing unique applications within companies. Naturally, he sees OS/2's strength as a development platform.

Support Is Critical

Once an operating-system vendor has set its sights on mission-critical applications and corporate information systems, it must address a number of complex issues—issues that historically have had little to do

O perating systems that best support internal developers have a real edge.

with technology. This implies a higher level of support for the customer than simply delivering a shrink-wrapped software package. The catch is that while corporate customers may demand premium levels of support, they also demand low prices. The challenge for the operating-system developer is to define a collection of capabilities that can reduce the cost of support without overburdening the operating system.

IBM's Colleary claims that that profile of the user is the model on which to build a support infrastructure. He says the op-

erating system should be as transparent to the user as possible and offer accessible help functions.

This is a new paradigm. Corporate customers are accustomed to having fast, effective, and comprehensive service and support from mainframe and minicomputer vendors. When something goes wrong with mission-critical applications, they expect a fast solution.

Arun Taneja, vice president of marketing for Univel, predicts that "the guy who is going to provide that cradle-to-grave service is the one that is going to win in terms of satisfying the MIS community and satisfying the Fortune 1000 community." Univel is targeting the systems integrators and system hardware OEMs as well. Taneja says that all the largest systems integrators are working with NetWare and are familiar with Unix, a situation that greatly improves Univel's chances of acceptance for its desktop operating system, UnixWare.

Corporate Change

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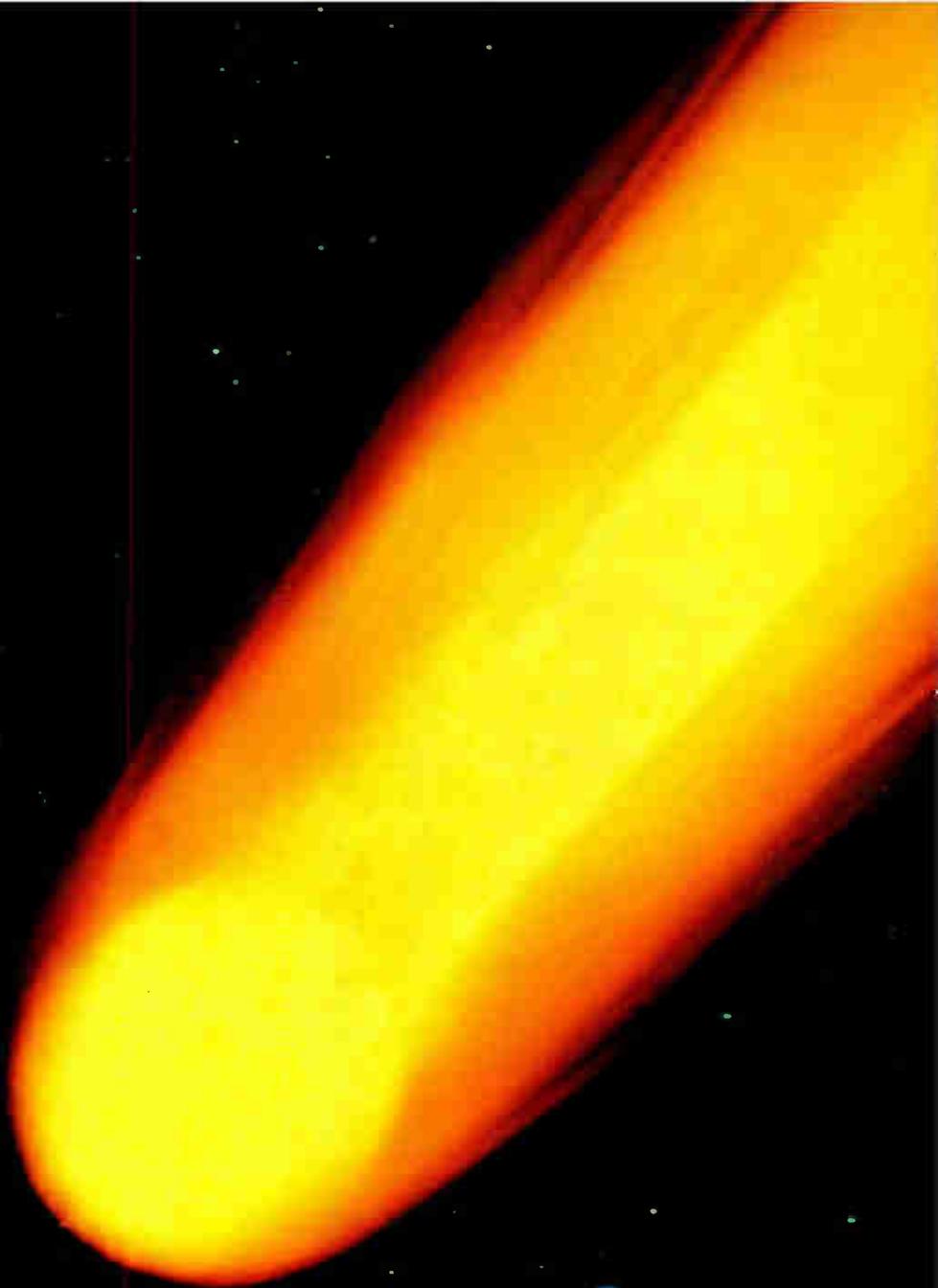
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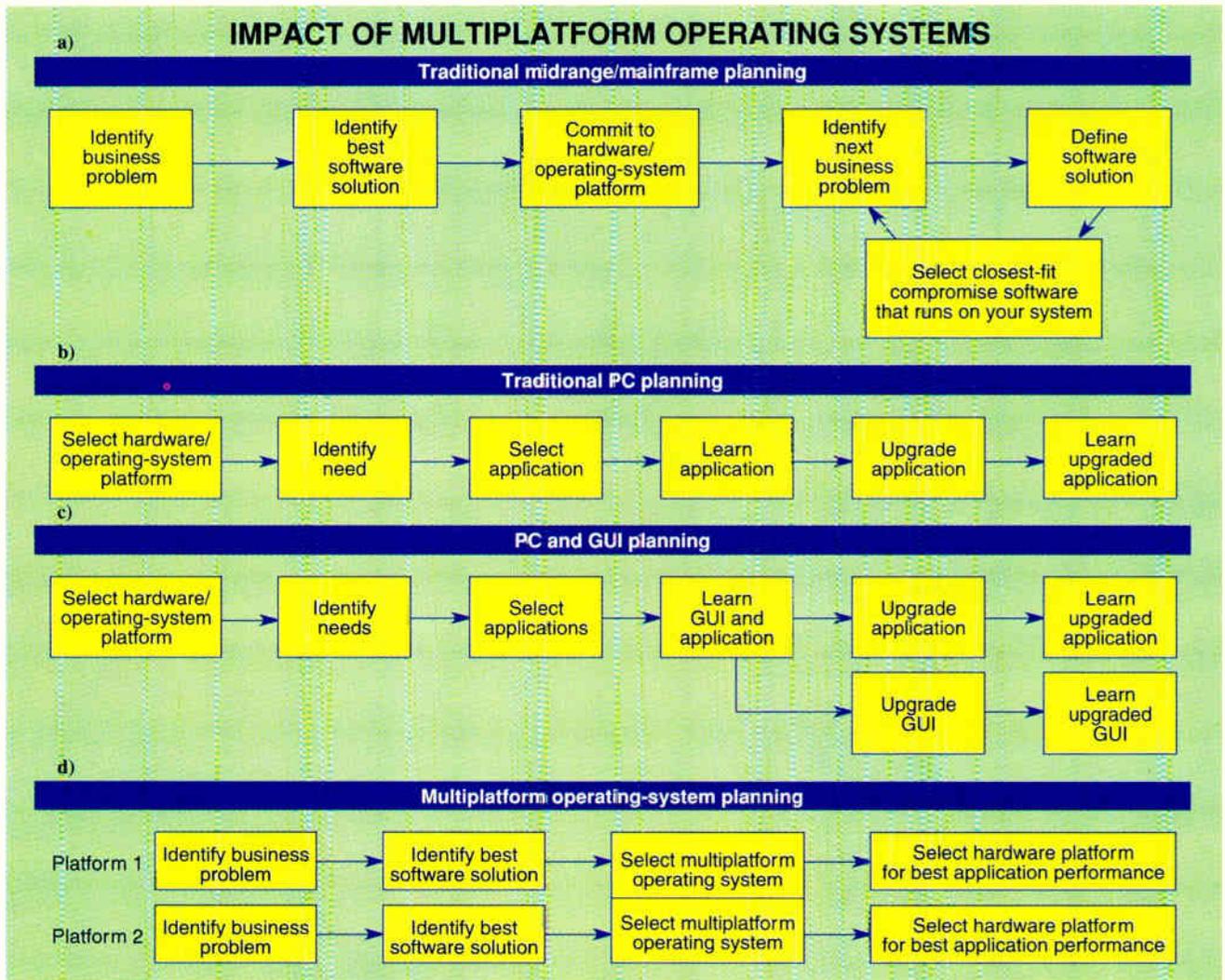


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(a) In the traditional midrange or mainframe world, information systems planners were forced to commit to one operating system and hardware architecture early in the life of the system. Their future choices of software were limited by what was available on their chosen platform. Often that meant that the software was not the best available but the best available for their platform. (b) With traditional personal computers, the breadth of applications available made better choices of applications possible, but each application had its

own learning curve. User training became a significant issue in large organizations, and resistance to needless upgrading of applications became common. (c) The arrival of the GUI on personal computers eased the training problem by providing a more intuitive user interface that was consistent across many applications. (d) The impact of the multiplatform operating system on information systems planning will be to let customers first choose the application that best serves their needs and then choose the most efficient hardware platform to support it.

evolution (see the table). These customers are no longer looking for raw technology; they want efficient tools. Corporate customers expect their tools to work consistently and at the least possible cost in time, effort, and money.

The current wave of what is variously referred to as *reengineering*, *rightsizing*, or *downsizing* has one immediate goal: to reduce the cost of doing business. Downsizing directly affects the development of operating systems by the changes it makes in both the information systems infrastructure and the expectations of the people

who own and use those systems. The other key motive behind corporate downsizing, heard most often from those users who prefer the term *reengineering*, is the flexibility that it offers.

The infrastructure of corporate information systems, at least for the purposes of this article, can be viewed from three perspectives—what it does, who supports it, and who pays for it. The move in recent years from mainframe-based information systems to those based on minicomputers and microcomputers was a user revolution driven by cost (primarily of the com-

puting hardware), freedom (of information access and exchange), and focus (the mainframe-based information system focused on corporate-level problems, often ignoring department-level problems).

It's Gotta Be Multiplatform

Changes in information systems have driven corporate users to clamor for technical solutions to their problems. When there's less money and fewer people to throw at problems, what's left but technology? One of the technical solutions that corporate users are now asking operating-system

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THE DESKTOP EVOLUTION

The evolution of the desktop has to be viewed from the directions of the user, the hardware, and the typical applications and data handled. The earliest PCs were clearly desktop machines for the computer programmer. By the mid-1980s, the PC had become an execution platform for stand-alone applications, with a greater emphasis on ease of use. The PC of today is still mainly an execution platform (now for the GUI), but the productivity gains it enables have gone beyond the single user to benefit workgroups. By the mid-1990s, the desktop system will be well along in the transition from a personal data-processing station to a personal information-access station.

	1982	1985	1992	1994
CPU	8088	286	486, 68040, RISC, and SPARC	P5, RISC, and multiprocessors
Storage	Floppy disk	Hard disk	Large, centralized hard disk	Large hard server
Video	Black and white or CGA	EGA	24-bit color	24-bit color
User interface	Command line	Pull-down menus, command line, and private resources	GUI, local single user, workgroup user, and shared resources via LANs	GUI; virtual workgroups; shared applications, data, and resources network; and personal, location-independent desktop
Applications	Single-task oriented, Lotus 1-2-3, and word processing	Graphics use growing, Lotus 1-2-3, word processing, DBMS, and TSR utilities	Graphically oriented, multitasking, use of TSRs, data sharing/linking, word processing, spreadsheets, DBMS, presentation graphics, communications, and custom-made mission-critical applications	Multitasking, agents, document-based, mission-critical applications common, and video conferencing
Data	Text and numerical files; simple graphics; updates via sneakernet; and files over 100 KB considered huge	Text and numerical files, more sophisticated graphics, and more emphasis on the presentation of data	Graphically presented, accessed via LANs, and some sound	Search by content, remote access, and multimedia

developers to provide is the multiplatform operating system.

Operating-system developers can no longer afford to support just one hardware platform. A successful sale of personal computers to a large installation represents big revenues to the operating-system developer—too big to be tied to the fate of any one hardware platform.

Network-Dependent Applications

As you migrate from a simple PC on a desktop running only personal productivity applications to enterprise-wide systems, each level adds user benefits. From a technology viewpoint, the transitions between these levels can be achieved through incremental additions. But from the corporate customer's perspective, each level adds other issues that a mission-critical system must address.

For an application in a networked environment to be robust, all the network's resources must be managed. It becomes a more difficult and costly implementation

process. For advanced operating systems, the key question that network-dependent applications raise is, How much of that network management responsibility should the operating system assume?

The operating system forms the foundation of the networked environment, and the system management functions (e.g.,

configuration, installation, and administration) become applications that lie on top of the operating system. But the operating system must be tailored to support network-dependent applications.

Information systems professionals are accustomed to having the access and controls that are provided by large host environments. What they are looking for is a stable operating system on the server and a stable, multifunctional operating system on the client. They want applications built on top of an operating system so that they can manage the networked resources easily.

For example, Colleary points to OS/2's Crash Protection feature, which protects the networked system from massive failure in response to an application crashing on a client. If an application running on a client pulls down your entire system, "you're not talking about a person being unable to work, you're talking about the entire organization or department not being able to function," Colleary says.

Corporate operating-system requirements

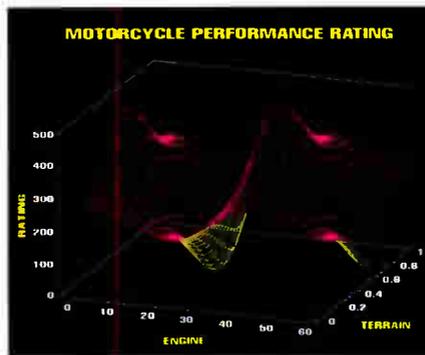
- Ease of use
- Ease of application development
- Multiplatform support
- Support for legacy applications
- Familiar user interface
- Stable technology base
- Security
- Vendor service and support
- Ability to work in a distributed environment
- Efficient system administration



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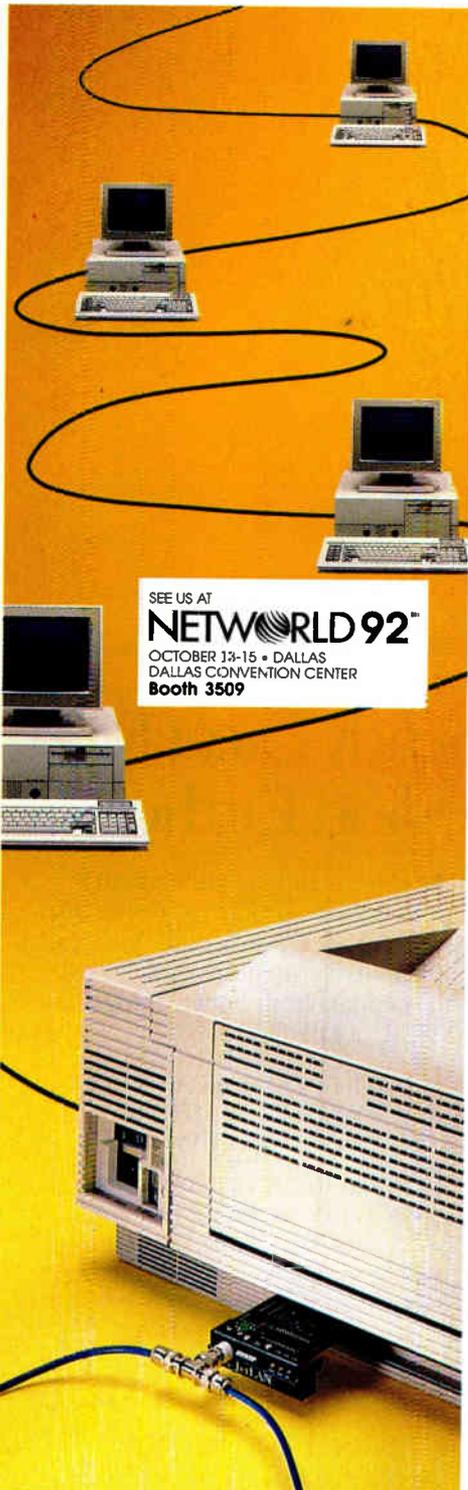
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OPERATING-SYSTEM TRENDS

The SDK Comes First

Intel's Windows NT goes to the beta-test stage this fall, but the Software Development Kit is shipping before that because Microsoft is trying to make it possible for developers to create 32-bit applications early. That approach is different from the old practice of shipping a new operating system and its development kit simultaneously. With the current approach, developers will have been able to test the

Developers can no longer afford to support just one hardware platform.

API and create solid applications for the new operating system much sooner.

IBM is also paying attention to the need for early information in support of a new operating system. For OS/2 2.0, it conducted an early development program that included 30,000 sites worldwide. Each site gained experience with the operating system and fed back its requirements to IBM for transition into OS/2 code.

Future Directions

Virtually all the operating-system developers are pursuing new technologies, such as support for multimedia applications. Delivery of some of these capabilities will require changes in hardware platforms or in customers' information systems. Some of the emerging technologies will be resource-intensive, perhaps requiring changes in the operating system to efficiently handle new tasks simultaneously.

If the convergence of the worlds of computing, telecommunications, and TV occurs as expected, the huge sales volumes of the consumer markets will become a dominating influence in the directions taken in operating-system development. But until the buying power of the consumer has been tapped, the needs of the corporate customer will set the course for operating-system evolution. ■

John Donovan is a senior analyst with WorkGroup Technologies, a market research firm in Hampton, New Hampshire. You can contact him on BIX as "jwd."

WINDOWS NT UP CLOSE

An in-depth look at Microsoft's
next-generation operating system

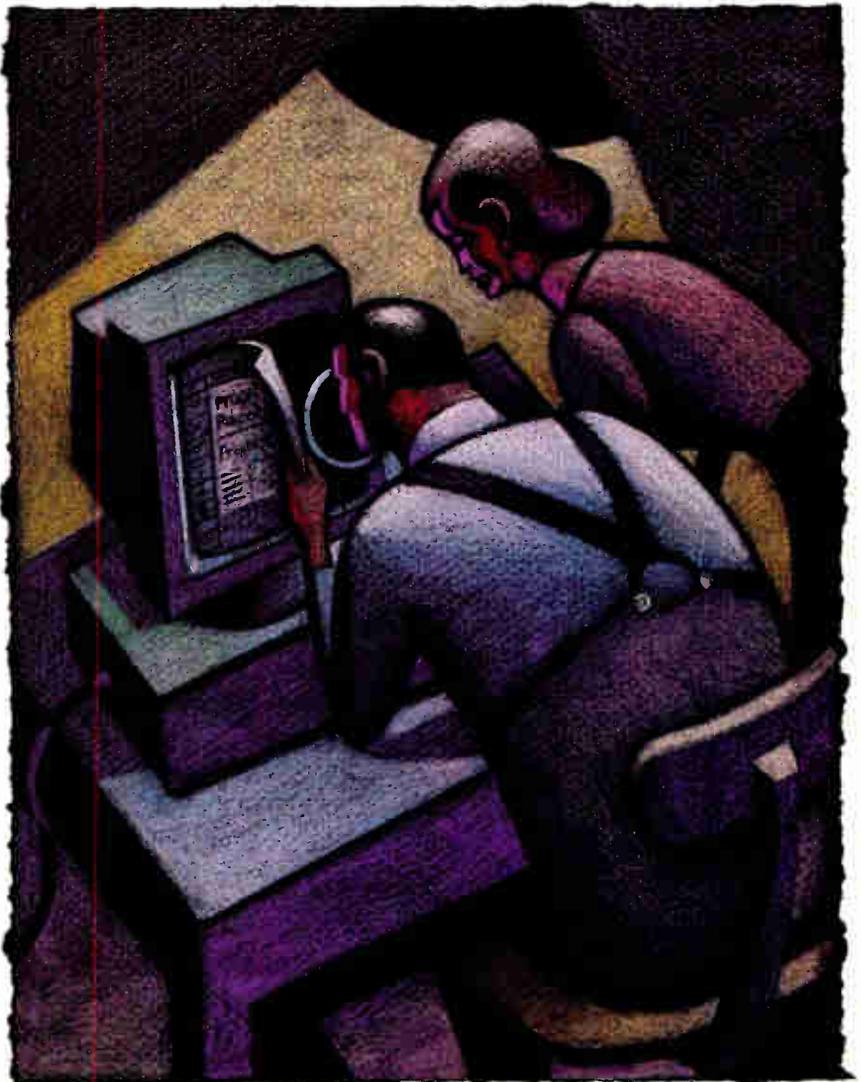
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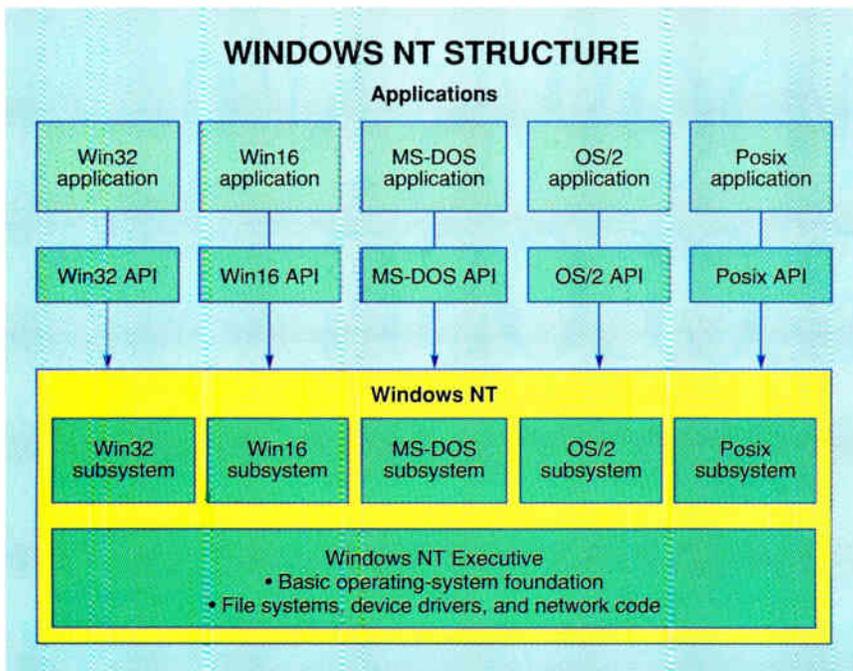
Microsoft's Windows NT operating system first booted in November 1989 on a hot RISC CPU and sported a next-generation interface. The CPU was Intel's 860. The interface was IBM's OS/2. Three years later, as NT nears commercial release, Microsoft's allegiance has switched to the Mips R4000 (along with uniprocessor and multiprocessor Intel 80x86 boxes) and, of course, to Windows. Some observers of the often seamy soap opera that has played out over the last few years question Microsoft's ethics. Others merely acknowledge the company's astute software engineering.

NT is, by careful design, a chameleon. Inspired by Mach, its microkernel adapts readily to any CPU and hosts various layered operating systems: 16- and 32-bit DOS, 16-bit Windows, 16-bit OS/2 (character mode and 80x86 only), Posix, and a 32-bit Windows-and-OS/2 hybrid called Win32 (see the figure). Because Win32 inherits the Windows 3.1 APIs and extension libraries, including OLE, the DDE Management Library, TrueType, and the multimedia extensions, Microsoft claims (and developers working with early versions of NT emphatically confirm) that 3.1 applications port readily to NT. When NT ships, it will run not only existing DOS and 16-bit Windows binaries but also Win32 versions of many popular Windows applications.

What's the catch? Well, don't be misled by the term *microkernel*. While the NT kernel is a petite 60 KB, the full system (as of the July beta) requires 12 MB of RAM and prefers 16 MB. Although it will probably shrink by the time it ships, NT's resource appetite will be well beyond what is standard for the corporate desktop.

continued





Windows NT layers a group of operating-system emulators on top of a common set of services. The NT executive manages memory, processes, and other primitive objects for the subsystems that emulate the Windows, OS/2, and Posix APIs, as well as for the applications that use those APIs.

You might think that makes NT look mainly like a platform for server applications. Clearly, it's going to cross swords with Unix, NetWare, and OS/2 in that arena. But effective enterprise computing requires capable clients as well as capable servers. Users may not need all of NT's high-end features, such as SMP (symmetric multiprocessing) and disk striping. Nonetheless, NT promises to eclipse DOS/Windows in terms of robustness, responsive multitasking, security, network awareness, and configuration management. If it delivers, many companies will conclude that these benefits more than justify the cost of hardware upgrades to support NT on the desktop.

Whether or not they have already standardized on Windows, businesses are waiting for a system that stays up reliably, can be remotely upgraded and reconfigured, and can smoothly integrate and dependably run DOS and Windows applications. Although both OS/2 2.0 and NT have the horsepower, NT offers two key advantages: It can adapt quickly to the leading-edge Intel and non-Intel hardware, and it directly supports the most popular interface—Windows.

Basic Building Blocks

Whether it finds itself running on a uniprocessor or a multiprocessor, a CISC or a

RISC system, the NT kernel sees the same view of the underlying hardware, thanks to a substrate called the HAL (hardware abstraction layer). There's a standard HAL for 386/486 AT-bus uniprocessor systems and one for R4000 uniprocessors. Makers of systems that break new ground must write HALs to support NT on their systems. NCR has written two: one for its four-processor 3450 and one for its eight-processor 3550. Compaq has written a HAL for the dual-processor Systempro, and Wyse has one for the three-processor 7000i. The HAL makes each machine's system bus, DMA controller, interrupt controller, system timers, and memory model look the same to the kernel. It also delivers the support needed for SMP.

The HAL can't perform alchemy, however. An SMP system requires that all processors have identical instruction sets, views of physical memory, and access to devices. Further, the hardware must provide cache coherency, and the processors must be able to interrupt each other. The HAL can't create symmetry out of an asymmetric set of parts.

The kernel, riding on top of the HAL, manages scheduling and context switching, exception and interrupt handling, and multiprocessor synchronization. It is not pageable or preemptible.

The object-based architecture that is NT's

hallmark flows from the kernel, which provides two classes of primitive objects. *Dispatcher* objects (e.g., threads, events, mutex semaphores, and timers) maintain a signal state and support scheduling and synchronization activities. *Control* objects (e.g., processes, interrupts, and device queues) carry data structures used by device drivers and the NT executive, which is the interface to user-mode subsystems such as Win32.

The kernel reserves some of these objects for internal use and exports others (e.g., processes, threads, events, and semaphores) to the executive, which packages them on behalf of user-mode subsystems. When a Win32 program asks the executive to create one of these objects, the executive encapsulates the raw object it received from the kernel—for example, by assigning it a name and a security descriptor.

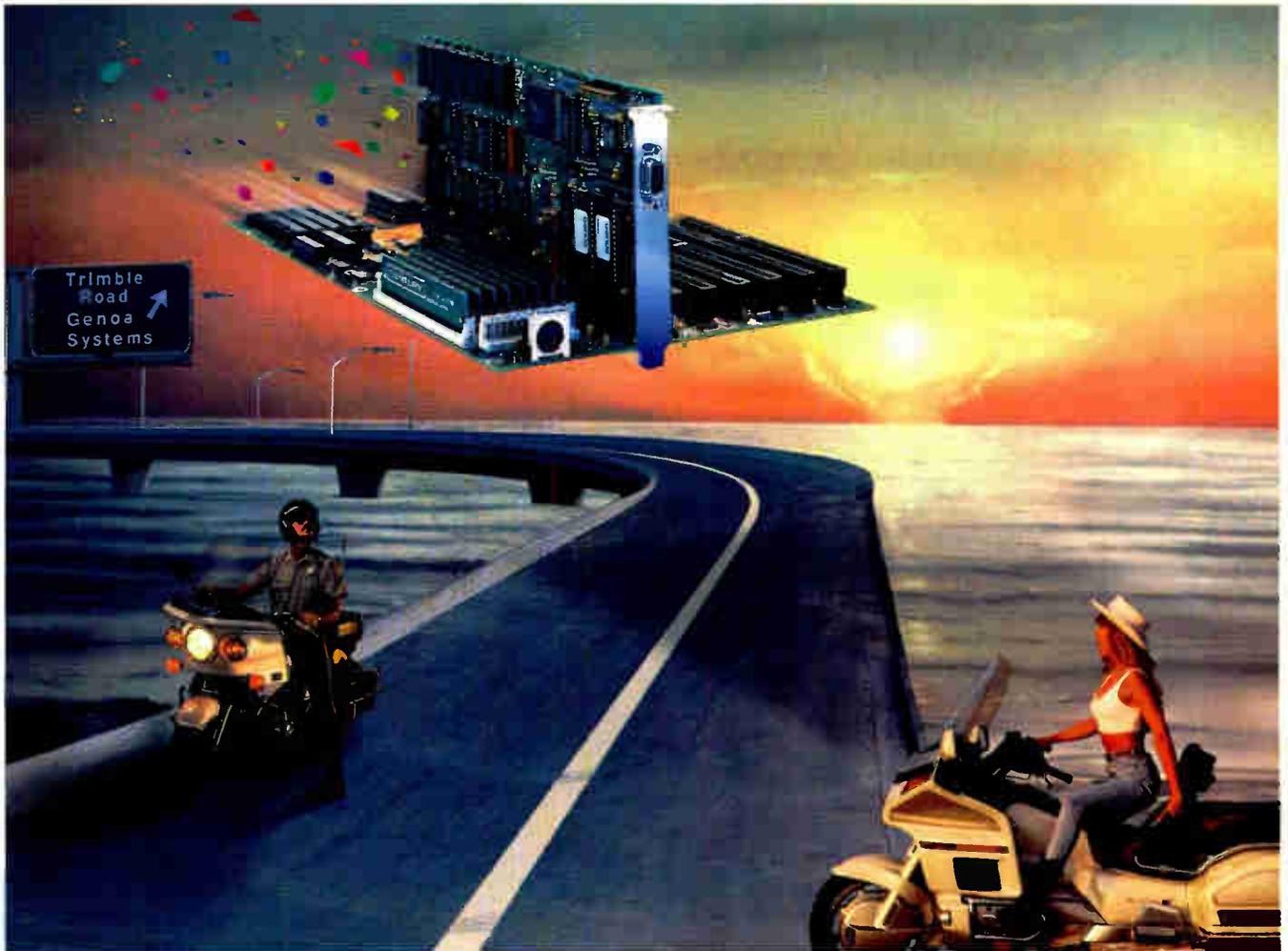
The kernel maintains data structures that support scheduling, such as a queue of threads that are ready to run and a matrix that describes running threads and their priorities. In an *n*-processor SMP system, the kernel guarantees that the *n* highest-priority threads will be running.

NT's scheduling is event driven. When something interesting happens to a user thread (e.g., a keyboard input message or notification that an asynchronous I/O operation has finished), its base priority receives a temporary boost and then gradually settles back to its normal state. This mechanism helps NT accommodate the unpredictable demands placed on it by users and devices. During quiet times, the kernel creates artificial events to keep things perking along. When it preempts a thread to run one with a higher priority, the kernel can assign the ready thread to any available processor. It favors the CPU on which the thread last ran, though, in case that CPU's secondary cache contains data still valid for the thread.

The executive dishes up a stew of basic services common to all the operating-system emulations layered on top of it. These include security, memory management, I/O, file systems, and IPC (interprocess communications). Like the kernel, the executive runs with supervisory privilege. Unlike the kernel, it is multithreaded and preemptible. NT achieves substantial parallelism on SMP machines even when it's executing single-threaded applications, because the work of supporting those applications is spread evenly across all available processors.

The HAL, the kernel, and the executive run in supervisor mode. The operating-system emulation subsystems, however, run in user mode. Each of these *environment servers* (e.g., Win32, OS/2, and Posix)

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has its own private, protected address space. A Win32 application is a client with respect to the Win32 subsystem and must rely on IPC to use its services. Win32, in turn, maintains a client/server relationship with the NT executive.

Windows 3.x packages its services into three modules: GDI (graphics), KERNEL (general support), and USER (window management). NT preserves this arrangement but splits the modules into client-side DLLs, which map into the address space of Win32 applications, and server-side DLLs, which run in their own address spaces. For example, the client-side USER module enables applications to call API functions (e.g., `CreateWindow`), but the server-side USER module implements the function. That implementation relies on executive services (e.g., memory management and security). For example, because a window is one of the objects to which NT attaches security, the `CreateWindow` call will ultimately invoke the executive's object manager and security subsystem.

The IPC mechanism that NT provides for these client/server interactions is an RPC (remote-procedure-call) protocol called an *LPC* (local interprocess call), which operates locally rather than across the network. Applications talk to their environment servers through LPC ports, and servers talk to each other and to the execu-

utive in the same way. Note that applications are tightly coupled to their supporting subsystems. Tantalizing though the prospect may be, there's no way an OS/2 or Posix application can call the Win32 API or vice versa.

Although NT is not yet a distributed operating system, its structure of communicating parts clearly points in that direction. Because first-generation NT systems won't be distributed, though, what are the benefits and costs of NT's client/server approach for stand-alone systems?

Modularity is an obvious benefit. Subsystems are literally snap-in components. If Microsoft decides to add an OS/2 Presentation Manager layer (an off-again, on-again promise), the support DLLs could, in principle, be plugged into an unmodified NT base. Performance is the obvious cost: It's expensive to switch contexts between client and server on every API call. But the kernel does provide a fast context-switching mechanism that pairs up a client thread with a server thread and enables the two to trade states (running and waiting) with minimal overhead.

Microsoft also recommends that developers rethink Windows programming in light of NT's client/server model. There are new APIs that execute GDI calls in batches, for example, and more of these batching APIs will appear in the final release. Programmers need to exploit these

WINDOWS NT UP CLOSE

and also cache return values where possible to reduce the number of trips across the client/server boundary.

Thanks for the Memory

NT preserves the Windows 3.x Local and Global memory management routines, but its flat 32-bit virtual-memory model renders the distinction between the two meaningless. Both `LocalAlloc` and `GlobalAlloc` return 32-bit values pointing into the 2-GB virtual address space that's visible to each process (the kernel reserves the other half of the 4-GB space that a 32-bit pointer can address).

There are three other ways to allocate memory. The standard C run-time routine, `malloc`, works just fine in NT because there's no need to worry about near versus far pointers. And two new mechanisms, the Heap and Virtual routines, offer additional control beyond that which the Windows 3.x API provides. Using the Heap functions, you can grab a chunk of memory and suballocate smaller chunks within it. This approach is handy for programs that deal with lots of objects smaller than the 4-KB pages that are the NT's fundamental memory management unit. It is also a way for a DLL, which normally allocates memory in the address space of its caller, to maintain its own private heap. The Virtual functions offer direct control over NT's virtual-memory mechanism.

As with OS/2 2.0, pages can be in three states: free, reserved, and committed. A process can reserve, or preallocate, a set of pages in the virtual address space and commit the physical pages to support those pages. This scheme works well for expandable data structures. NT exploits it, for example, to enable thread stacks to grow automatically. The Virtual API also enables processes to query and set the protections that govern committed pages.

NT also provides a feature that's in some versions of Unix, but not in OS/2: memory-mapped files. To use a memory-mapped file, you create a file-mapping object, which refers to a disk file, and create a memory-mapped view of the file. Why bother? The view permits random memory-oriented access to the file's data—a major programming convenience. More important, memory-mapped files are NT's primary mechanism for sharing memory among processes.

Windows 3.x programs, running in a common address space, share memory by default. NT's more robust architecture, which isolates processes from one another, requires an explicit means of sharing. Memory-mapped files offer an interesting solution to the problem. One advantage

WINDOWS NT UP CLOSE

over OS/2's shared-memory mechanism is that shared storage automatically persists in the form of the disk file that backs the mapped view. If you don't need or want that feature, you can create a mapping object using the special file handle `-1`. NT will point views mapped on that object directly at the system paging file.

Both the NT loader and the cache manager that supports all the NT file systems are heavy users of the memory-mapping service. That's just one example of something that seems generally true: NT is, in many respects, its own best client.

Processes, Threads, and DLLs

As in OS/2, threads are the dispatchable agents of execution, and processes form the context (e.g., an address space, a security profile, or a set of shared objects) in which that execution occurs. NT imposes no limit (other than available memory) on the number of threads a process can spawn. Because thread execution is conceptually (or, in the case of SMP systems, actually) concurrent, programmers have to carefully synchronize the way threads access shared data. Unix and OS/2 software developers already know the drill; however, for the programmers who have grown up with DOS and Windows, it is a new discipline—and, in all probability, the biggest conceptual hurdle that NT presents.

A programmer can synchronize threads running in a process by using a *critical section*. Once a thread claims ownership of a critical section that (purely by convention) guards a shared data object, it can safely modify the data. Other threads requesting ownership must wait until the owner relinquishes its claim.

Three additional objects—mutexes (mutual exclusions), semaphores, and events—support both intraprocess and interprocess synchronization. The latter technique relies on the objects' names, which are visible across process boundaries. Each object type has its own flat namespace, distinct from the file system's namespace.

A mutex object is a shareable version of the critical section. Threads vie for ownership of a mutex and agree to modify the shared resource it guards only when they own it. A semaphore maintains not just a simple binary state (owned/not owned) but also a counter. A server application that limits the number of client connections it can accept might use a semaphore to enforce that limit. An event object alerts one or more threads that something interesting (e.g., an I/O completion) has occurred.

NT's synchronization objects are standard constructs implemented in Unix, OS/2,

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and other operating systems. What's noteworthy about the NT implementation is its polymorphism. All synchronization involves waiting: A thread waits until it owns a mutex, until a semaphore's count is non-zero, or until an event occurs. The Win32 API maps all these waiting behaviors onto a single function call, which can operate on a mutex, a semaphore, or an event. Another function waits on a set of objects that collectively describe a compound condition.

These same two waiting functions work with other kinds of objects as well. When applied to a thread, for example, the result is like a `join` in Unix: Termination of the thread satisfies the wait. This polymorphism is both elegant and practical, and it flows directly from NT's object-based underpinnings.

Each thread created by a Win32 application has its own message queue, in contrast to the shared message queue of OS/2 PM and Windows 3.x. OS/2 PM's input model, derived from that of Windows, requires a multithreaded graphical program to dedicate a special thread to servicing the message queue. If that queue isn't continually drained, other applications starve for input, and the whole OS/2 PM interface hangs.

NT's per-thread message queues solve this problem. If a thread fails to service its queue, only the windows that are owned

by that thread will suffer. Windows that belong to other threads respond normally, as you can prove with a simple experiment.

If you start a lengthy search in the Win32 version of File Manager, for example, you will see the familiar "I'm busy" hourglass. That is because File Manager(32) is a straightforward port of File Manager(16), which is single-threaded (ideally the Win32 version should spawn a background thread to perform the search). However, when you move the cursor outside File Manager's frame window, the cursor reverts to normal, and you are free to interact with windows owned by other applications.

In Windows 3.x, a DLL shares its automatic data among all processes that load the DLL. In NT, a DLL maintains *instance data*: one copy for each calling process. To optimize the sharing, NT bundles the instance data as a set of *copy-on-write* pages, lazily allocating a second copy of a page only when the owning process writes to the page. NT also introduces the concept of *thread local storage*, which enables processes and DLLs to stash private per-thread data. The DLL model changes slightly from that of Windows 3.x to accommodate these two flavors of private storage. NT notifies a DLL when a process or a thread attaches to it or detaches from it so that the DLL can (if necessary)

create or destroy instance data or thread local storage.

File Systems and Device Drivers

NT supports three file systems: FAT (file allocation table), HPFS (High Performance File System—OS/2), and the new NTFS (NT File System). All share a common caching mechanism and can use the same fault-tolerant driver to achieve spanning or striping across multiple disks. The term *fault tolerance* is a misnomer, though, because neither of these techniques improves data reliability. You will need to upgrade from Windows NT to LAN Manager NT if you want mirroring, duplexing, or striping with parity (RAID [redundant arrays of inexpensive disks] level 5). Still, it's impressive that the base product lets you stripe data across a set of disks or join disks to create one logical volume. Even more impressive is that the fault-tolerant driver is simply a layer inserted between the file systems and the disk drivers, which know nothing about spanning or striping.

This layering of drivers pervades NT. At the device level, drivers for a class of device (e.g., a SCSI device or a network adapter) use a *port/miniport* model. The device-independent port driver implements the generic protocol for its class, and the device-dependent miniport driver enables a device to comply with the protocol. To write an NT driver for a device class that's supported by a port driver, you need only write a miniport driver. Because you write it in C, the miniport driver can move easily to any NT platform (and, Microsoft hints, to a forthcoming DOS 6 as well).

The task is simplified because the port driver handles a lot of the hard work. In particular, it helps sort out tricky thread-synchronization issues in an SMP environment where the thread that detects an interrupt and the thread that services an I/O request can run on different processors.

Will all this work as advertised? The proof will be in the pudding. If NT ships with rich support for a wide range of devices, you'll know that the layered driver model works. Note that NT already supports nearly all the printers that Windows 3.1 does, by virtue of having ported 3.1's umbrella printer driver, UNIDRV.

Device support is typically the Achilles' heel of a new operating system. If NT succeeds where OS/2 failed, Microsoft will have knocked down a major barrier to NT's commercial acceptance. By the way, NT device drivers and protocol stacks will load and unload at run time—a feature that NetWare 3.x supports but that OS/2 and most Unixes do not. Drivers that can be loaded at run time are convenient for

users and critical for servers that must run continuously and reconfigure on the fly.

Yet Another File System: NTFS

Those of us who remember the fanfare that accompanied the introduction of HPFS may wonder why Microsoft has chosen to build yet another file system. NTFS and HPFS are close cousins in many ways. Both support long (255-character) filenames, use extent-based allocation and b-trees, and store attribute data.

But NTFS adds key strategic features—most notably recoverability. It logs all op-

Key features

- Portability
- Symmetric multiprocessing
- C2 security
- 32-bit Windows support
- Peer networking
- DCE-compliant RPC
- OS/2 and Posix support

Future enhancements

- B-level security
- OLE 2.0
- PM subsystem

Drawbacks

- Current command-line scripting
- No integral 3-D graphics API

erations that affect the structure of a volume (i.e., creating, destroying, or extending files or directories) and treats them as atomic transactions against a database called the *master file table*. The log file is circular, and NTFS checkpoints it periodically to bound the worst-case recovery time. In the event of a crash, it replays the log to restore the file and directory structures existing at the instant of the crash and rolls back any transactions that were incomplete at the time. Because it journals changes, NTFS can recover a volume in seconds, as opposed to minutes for an HPFS *chkdsk* or even longer for a Unix *fsck*. Note that NTFS doesn't guard user data, and (initially) there will not be any APIs that applications can use to leverage NTFS's transaction tracking for their own purposes.

NTFS uses 64-bit addressing, so volumes and even individual files can grow to a healthy 17 billion GB (versus 2 GB for HPFS). It stores filenames on disk in Unicode, the 16-bit international standard that NT applies to all its internal character data.

Finally, NTFS is the only file system that NT can make secure. The mechanism NTFS uses to attach security descriptors to its files and directories is a generalization

of the extended attributes of HPFS. An HPFS file can hold up to 64 KB of extra data configured as a set of name-value pairs read and written by a special API. An NTFS file can contain multiple independent I/O streams, or data attributes. Standard file APIs operate on these streams using the syntax `FILENAME:STREAM-NAME`. Each stream has its own size and locks, although sharing occurs on a file-by-file basis.

File-system security is just the first application of NTFS attributes. They'll also prove useful for implementing foreign file systems on NT. Macintosh resource forks, for example, should fit neatly into NTFS. VMS-style file versioning would be another good use for these attributes. In the long run (1994 and beyond), a variant of NTFS will handle the storage requirements of the distributed, object-oriented, next-generation Windows that Microsoft refers to as *Cairo*.

Spy vs. Spy

When NT ships, it will be C2-certifiable. Wheels turn slowly at the National Computer Security Center, so certification may lag behind product release. A C2-secure system provides *discretionary access control*: The owner of an object dictates how other users may access it. More stringent B-level security—a future goal for NT—would require *mandatory access control*, which means that objects must carry sensitivity labels that govern access according to a systemwide policy.

The NT object model supports a uniform implementation of security and auditing across a broad swath of object types (e.g., files, processes, threads, semaphores, windows, and menus) and DDE, named pipe, and RPC transactions. When an application creates or opens a reference to a securable object, NT verifies that the object's security descriptor grants the application's user access. If the check succeeds, NT caches the resulting granted-access mask for the rest of the user's session.

A key feature of NT security is that applications can extend it to user-defined objects. For example, a database server might create its own security descriptors and attach them to its tables. In addition to normal kinds of read/write security, the server could secure database-specific operations, such as scrolling within a result set or performing a join. It would be the server's responsibility to define the meaning of special rights and perform access checks. But the checks would occur in a standard context, using systemwide user/group accounts and audit logs. The extensible security model should prove useful to implementers of foreign file systems (e.g.,

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Frequency of Releases	8.5	7.5	6.7	7.2	7.7	7.2
Response to User Request	8.8	7.5	7.8	7.0	7.0	7.3
Overall Satisfaction	9.3	8.7	8.5	8.3	8.0	7.9

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Ability to manipulate data	9.19	7.41	7.44	6.81	5.67
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Report writing capabilities	8.39	6.72	6.59	5.71	4.11
Ease of use of interface	8.51	7.05	6.15	6.10	6.10
Software integration capabilities	8.34	7.26	7.24	6.27	6.10
Ease of data retrieval	9.08	7.68	7.66	6.61	6.11
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Charges for training time	6.88	4.49	4.59	5.64	4.56
Provision for technical support	7.81	5.76	5.72	5.87	5.22
Provision for marketing support	6.89	5.88	6.09	6.13	3.80
Documentation & product information	8.74	6.73	6.56	6.45	5.56
Frequency of updates & revisions	8.35	5.88	6.34	5.57	5.00
Support Features Average	7.73	5.79	5.84	5.90	4.94
Overall Average	8.34	6.66	6.35	6.06	5.38

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NFS (Network File System) and Macintosh).

To simplify the use of security in client/server applications, NT introduces the notion of *impersonation*. If client and server talk through an RPC connection, the server can temporarily assume the identity of the client so that it can evaluate a request for access relative to that client's rights. Then the server reverts to its own identity. NT's usual polymorphism fails here, so there is a pair of Impersonate/RevertToSelf

routines for each flavor of IPC: named pipes, RPC, and DDE.

Tools of the Networking Trade

NT bundles the client and server capabilities of a LAN Manager peer server running on OS/2. An NT server can share files and printers with NT, LAN Manager 2.x, or other SMB/NetBIOS clients. Conversely, an NT server can use remote files and printers shared by NT, LAN Manager 2.x, or other SMB/NetBIOS servers. NT also

inherits mail slots and named pipes from OS/2 LAN Manager. Mail slots are unidirectional, and named pipes are bidirectional. Because both use the file-system API, they can ride on top of the file-system redirector and operate remotely (NT's asynchronous communication APIs can operate remotely for the same reason).

Like LAN Manager 2.1, NT uses TCP/IP or NetBEUI transports interchangeably, includes Unix tools (e.g., ping and telnet) and the standard MS-Net commands, and provides a Berkeley-style sockets library. Extended to support asynchronous I/O and the Windows programming model, the sockets implementation embodies the Windows Sockets specification recently completed by Sun Microsystems, FTP Software, and other TCP/IP vendors. LAN Manager 2.1 features available only in the NT version of LAN Manager will include domain (multiserver) administration, true fault tolerance, Mac services, and remote access.

NT also includes an RPC toolkit that conforms to the RPC protocol of OSF's (Open Software Foundation's) DCE (Distributed Computing Environment). NT-based RPC clients will interoperate with DCE-compliant Unix-based RPC servers and vice versa. Client-side versions of the toolkit will also be available for DOS and Windows. There's one nifty extension to the DCE model: On NT, an RPC server will automatically spin off a thread for each caller.

The toolkit supports various transports: named pipes, NetBIOS, TCP/IP, and NT's own internal LPC. The LPC option means developers can structure their stand-alone programs as collections of communicating parts and switch to a network transport to run the programs in distributed mode.

Although NT developers will face a bewildering array of network transports and IPC mechanisms, RPC is clearly the strategic choice. To drive the point home, Microsoft has used RPCs to enable many of NT's utilities to operate remotely. Print Manager, for example, handles true remote printing. There's no need to install printer drivers locally, because you can execute a print job on a remote machine using its printer driver. You can point NT's performance monitor, process viewer, and event-log viewer at your own machine or at a remote machine that you have access to.

The tool that views and edits the NT registry will work the same way. The registry, introduced with Windows 3.1, expands in NT to include configuration data for all devices, users, applications, and the system itself. Its CONFIG.SYS, AUTO-EXEC.BAT, and .INI files, as well as a

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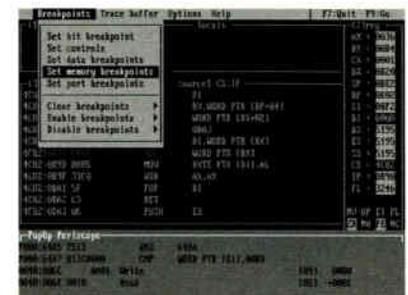
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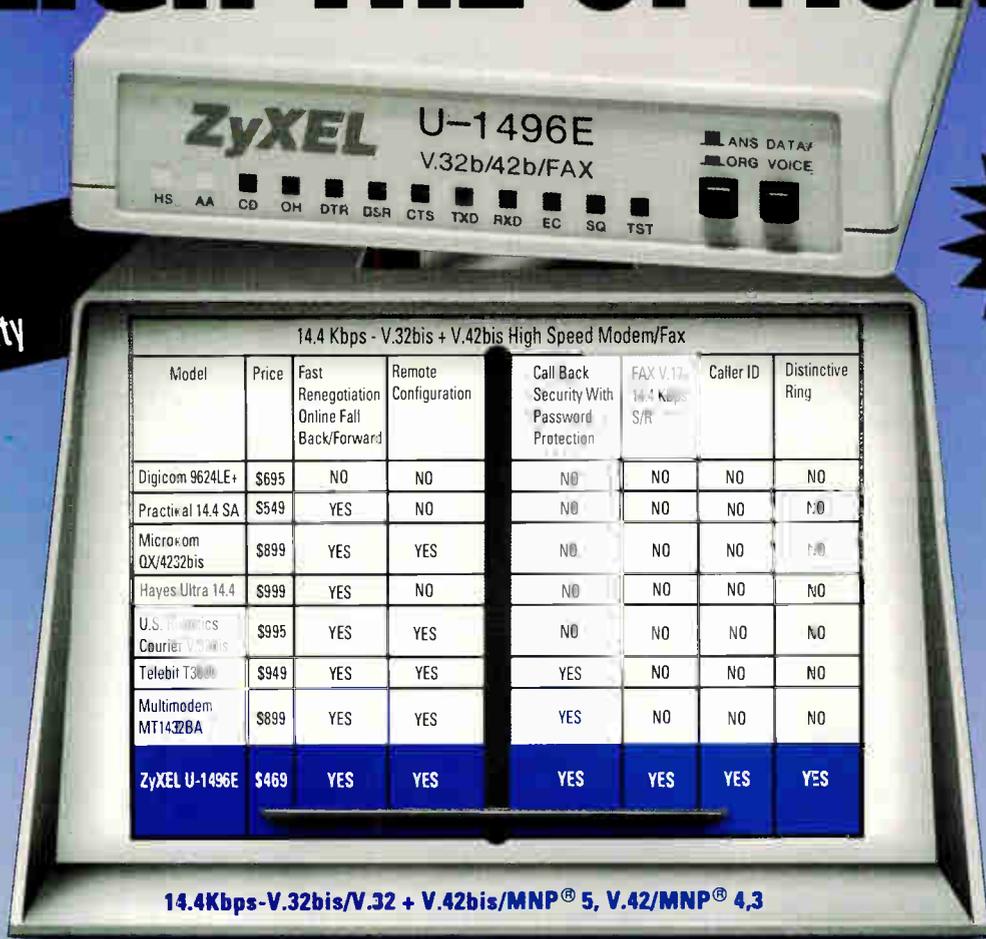
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whole lot more, are rolled into one database. RPC-enabled remote access to the registry will be a huge win for folks who manage and support NT installations. Each key in the registry carries an access control list, so RPC-enabled remote access need not compromise security. Finally, Microsoft claims that the interface definition language of the RPC toolkit will be the same as that used to define object interfaces in the Cairo environment.

Novell is working on an IPX/SPX stack and NetWare client for NT, and Microsoft hopes to bundle these components. As with the NetWare connectivity feature of LAN Manager 2.1, you'll still be running dual shells. But NT will integrate NetWare (and other service providers) more smoothly. It extends the Windows 3.1 network APIs for browsing and connecting to remote resources and provides an umbrella interface called the *multiprovider router*, which unifies the presentation of native and third-party services.

Win32 and Win32s

From the perspective of Windows 3.x, Win32 giveth and taketh away. It extends the Windows 3.x API set to support NT's

memory management, multithreading, IPC, network, and security features. It also beefs up Windows' file I/O, communications, and graphics APIs; adds powerful support for exception handling, debugging, and event logging; and provides a console API for building character-mode applications. At the same time, Win32 jettisons those parts of the Windows 3.x API specific to DOS or to 80x86 processors.

The file I/O routines plug a gaping hole in Windows 3.x and eliminate a major source of DOS dependency in Windows code. A nice feature of file I/O in NT is that all read and write operations are potentially asynchronous. Because the file-oriented functions also work with communications ports, named pipes, and mail slots—all of which can be redirected over a network—asynchronous I/O is widely applicable. New graphics routines support paths (i.e., collections of lines and curves); Bézier curves; and 2-D transforms used to rotate, reflect, or shear images.

Exception handling is another of those features that's as useful to NT itself as it is to user programs. The kernel, for example, guards the execution of every thread with a handler that guarantees the same

exit path in the event of normal or abnormal termination. A Win32 application can similarly protect any block of code with a *try* clause followed by either an *except* clause (exception handler) or a *finally* clause (termination handler).

Although this *try-except-finally* syntax is specific to the 32-bit Microsoft C Compiler 7.0 in the NT Software Development Kit, the underlying support is woven into NT and can be manifested in any language environment. The mechanism is a powerful tool for controlling the complexity of applications and improving their reliability. If an application's exception handlers exploit NT's event logger, the information fed into the logs will simplify remote product support.

To help bolster the market for NT, Microsoft plans to support a restricted set of NT applications on Windows 3.1 by way of a Windows extender called *Win32s*. If you write an NT program that calls only standard Windows 3.x APIs, you'll have written a Win32s program. The NT binary code (if compiled for 80x86) will run under Windows 3.1 using the VxD and DLL support of Win32s. Conversely, a Win32s program developed on DOS/

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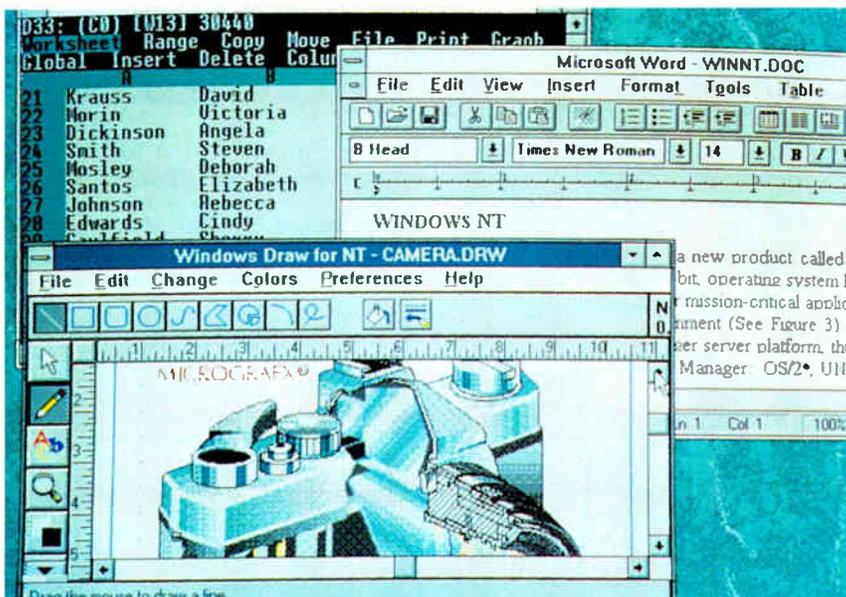
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Technical strengths aside, a big NT selling point is its familiar Windows GUI and its ability to run Windows 3.x applications. Companies moving to NT will not have to immediately reinvest in software and training if they've already standardized on Windows.

Windows is an 80x86 NT binary code.

Due this fall, Win32s enables developers to begin targeting NT while preserving Windows 3.x compatibility. Although the NT 32-bit flat-memory model is available to Win32s applications, the 16-bit limitations of the underlying Windows 3.x engine (e.g., 32-KB edit controls) still apply. Moreover, Win32s applications won't interoperate with 16-bit DLLs, and vice versa, a restriction that does not apply to Windows extenders available from Watcom and Rational.

Even though Microsoft has said that Win32s will stretch the Windows 3.x API to include Win32 enhancements not specifically ruled out by the limitations of DOS and Windows, details remain cloudy. Microsoft does continue to insist that a forthcoming multithreaded MS-DOS 6 will support a full-featured Win32, constituting a true "NT Lite" for low-end hardware.

In the short run, developers will have to choose whether to target NT, DOS/Windows, or both. Because Win32s will accept the full Win32 API (returning errors for unsupported calls), it's possible—although inconvenient—to build split-personality programs that exploit advanced Win32 functions on NT but can live without them on DOS.

Running DOS and 16-bit Windows Software

DOS and 16-bit Windows programs run on 80x86 and R4000 versions of NT (see

the screen). Both platforms use the same DOS emulation layer made from the DOS 5 source code (minus its file system, which isn't needed). That layer talks to an IEU (instruction execution unit). On 80x86 hardware, the IEU takes the form of a virtual 8086-mode monitor that traps I/O and sensitive instructions. On the R4000, the IEU is a version of Insignia Solutions' SoftPC, an 286 emulator. The IEU simulates hardware and software interrupts, manipulates registers, and dispatches the VDDs (virtual device drivers) that emulate standard AT motherboard devices. The VDDs run in user space, where they can't affect NT's integrity.

The DOS emulator loads TSR programs low or high, provides XMS (Extended Memory Specification) and DPMI (DOS Protected Mode Interface) memory, presents text in a window or full-screen, and supports Clipboard cut and paste. DOS programs see the underlying NT file systems and can call the named pipe and mail slot network APIs. NT multitasks DOS sessions preemptively and performs idle detection.

One or more Win16 programs multitask cooperatively in one DOS session. Calls to the Windows API "thunk" (i.e., widen function-call parameters from 16 to 32 bits) directly through to their Win32 counterparts. This stands in contrast to the OS/2 2.0 model. Lacking a 32-bit Windows layer, OS/2 must rely on its DOS emulator to support Windows. Even on the R4000, NT can run Win16 programs handily.

A Windows application may spend 60 percent of its time executing Windows code. Therefore, while a Win16 program might spend 40 percent of its time slogging through the Insignia emulator, the balance will be spent running as fast as a Win32 program.

Because the Win16 and Win32 APIs are compatible, Clipboard, DDE, and OLE exchanges across the thunk boundary present no problem. The integration is seamless; when you run a Windows program on NT, you can't tell whether its mode is Win16 or Win32.

OS/2 2.0's support for DOS device drivers is something NT doesn't even attempt. Microsoft's justification is that allowing the DOS subsystem direct access to hardware would violate NT's security and reliability. Ceding this territory to OS/2 is a bit of a gamble. But if NT attracts sufficient native driver support, it will pay off.

The Crystal Ball

The NT development team missed the target date for a feature-complete beta release by just three months. That release, widely distributed as of the July developers' conference, worked so well that some tool vendors are already shipping commercial products to other NT software developers—pretty impressive for a from-scratch effort amounting to over 3 million lines of C and C++. "And that doesn't include comments and white space," quips senior engineer Darryl Havens. "We only count the semicolons."

Not all the pieces have fallen into place. Although Microsoft will be licensing Silicon Graphics' 3D GL graphics library, it's unclear how that will tie into Win32. For now, Win32 inherits the Windows 3.x graphics model with its 2-D raster orientation. Win32 also inherits the underpowered DOS batch language. Object-based scripting is on the horizon for Windows in the form of OLE 2.0, but that won't appear in time for the first release of NT.

It's clear, though, that NT is built to go the distance. Workgroup-capable right out of the box and outfitted with tools geared for building distributed software, it will represent a challenge to NetWare as much as to Unix and OS/2. And in view of the relentless pace of hardware innovation, next year's multiprocessing, drive-array-equipped server will land on your desktop the year after that. When that dream machine shows up, NT will know what to do with it. ■

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OS/2 AT THE CROSSROADS

IBM's desktop operating system
has all the tools, but it needs some direction

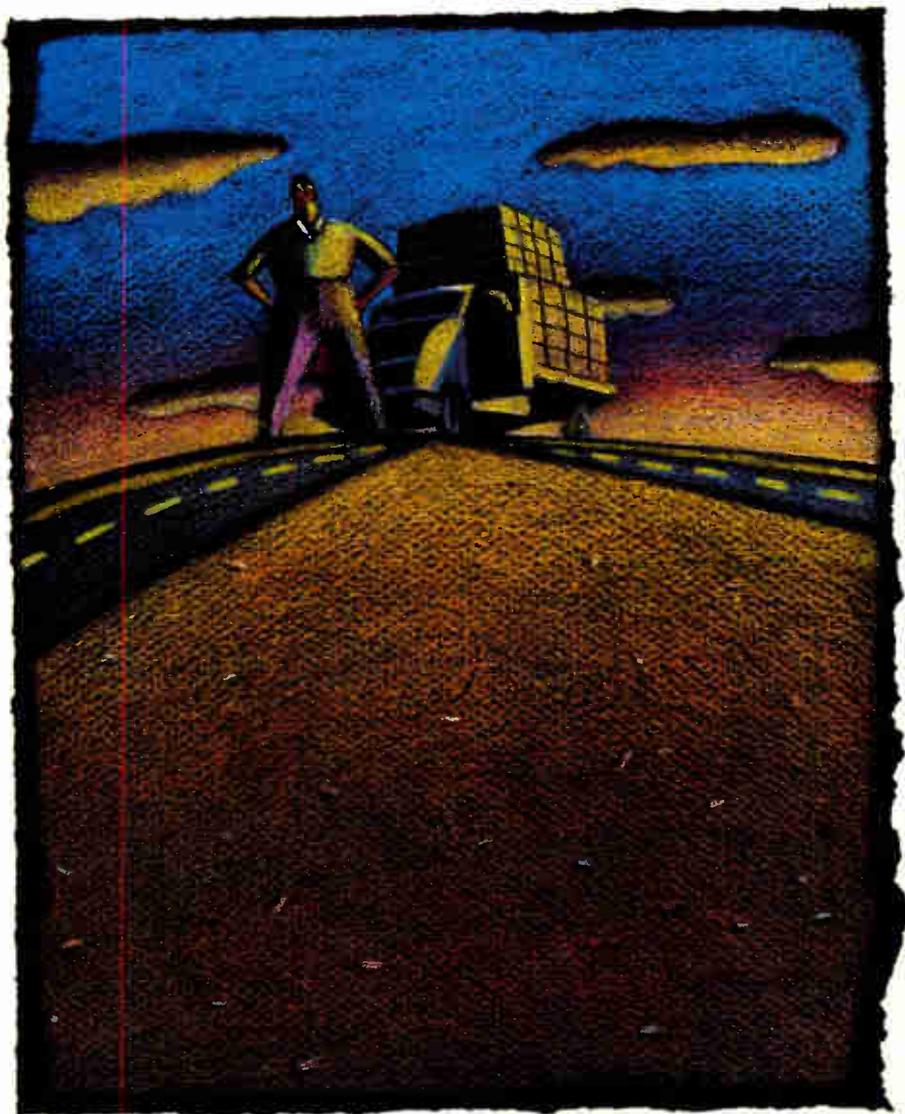
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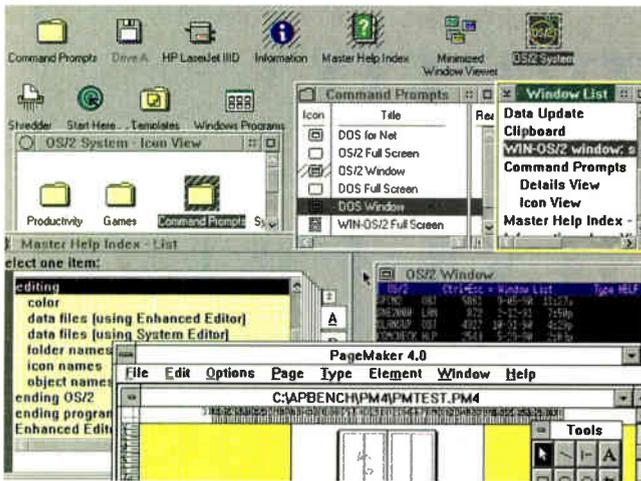
Since its introduction in 1987, OS/2 has garnered more than its share of both praise and scorn and has been the hope and the death of a few software companies. For all that, OS/2 still hasn't found its niche. But IBM believes in OS/2—should you?

From a technical standpoint, there's a lot to be said for OS/2, and in particular OS/2 2.0. It's a 386-based protected-mode architecture that works well on basically the same computers that do a good job running Windows 3.1: 386-class machines running at 25 MHz and higher, with 8 MB or more of RAM. The OS/2 difference is its robustness.

I'm writing this article with the OS/2 System Editor, the OS/2 version of Windows Notepad. I'm also running the Windows Clock program in a window of its own. At the same time, I'm watching the computer play Chess against itself, and I'm monitoring the system with Pulse. Chess is one of the free programs that comes with OS/2, and it doesn't play a bad game at that. However, my main interest in Chess is as a CPU overloader. You can make the computer play both white and black and set the player strength level anywhere from pushover to expert. Set white and black to the expert level, and you've got a pretty busy computer.

That brings me to Pulse, another free goody that comes with OS/2. Pulse is a CPU-utilization profiler, and I mention it as an example of how OS/2's underlying framework is superior to that of Windows 3.1. There really is no way to write a CPU-utilization profiler for Windows, because it uses a cooperative multitasking structure. If you're running five Windows programs, and one program wants to hog all





OS/2 2.0's Workplace Shell GUI is a model of consistency. Many OS/2 features, such as Print Viewer, take advantage of the Workplace Shell's object-based paradigm to deliver improved productivity.

as well as the smaller but important niche markets that include 16-port RS-232 boards and data acquisition boards? IBM has learned from the compatibility problems of OS/2 1.3 and now allows DOS device drivers to virtualize in a DOS session—quite a neat answer. Windows 3.1 allows a DOS program to directly modify any hardware that's not on Windows' do-not-touch list, which is one reason why it has been easy for purveyors of niche hardware to adapt their products to Windows. But NT offers no solution for those people, making their DOS and Windows 3.1 products unable to run under NT. Is this a flaw? To some, yes; to others, it's the price that must be paid for an airtight software platform.

The Workplace Shell

A discussion of the state of OS/2 would not be complete without a mention of the WPS (Workplace Shell). I have never liked GUIs, but I'm finding that I'm getting along pretty well with this one (see the screen).

WPS looks like it was designed by one person rather than a committee: It's got a consistent thread running through the way it operates. I've often been surprised by the kinds of things on the WPS screen that support the shell's object-based paradigm. Even things like the Print Viewer are examples of how much an object-based way of looking at things can make a user interface a productive tool.

Market Talk

Technological issues aside, how's OS/2 doing? In a word, badly. IBM claims that it has shipped 700,000 copies since the March release. With 110 million PCs out there, that means a market share measured in tenths of a percent. Worse yet, there are relatively few people writing code for OS/2.

There is, however, a small but significant part of the computing market that is quite happy with OS/2: the COBOL crowd that wants to save a few cycles on their mainframes. I do a lot of work for companies with large-scale processing systems, written in COBOL, that have been on mainframes for years. These companies are not downsizing in the usual sense, because they are happy with their mainframes. Instead, they are doing their initial coding and testing on OS/2-based computers running Micro Focus COBOL with the Animator debugger (it's practically an industry standard). It's not a huge market, but it's a solid one—at least for now.

Earlier, I compared some of OS/2's architecture to Windows 3.1's, and 3.1 came off looking badly. Lest I be taken to task for not telling the whole story, all the good

the CPU time, there's nothing that the other programs—or Windows itself—can do about it. With OS/2, all the programs that demand the CPU's attention are forced to wait in line. I see an occasional delay in getting my text onto the screen, but it's almost imperceptible.

Protected, But Not Bulletproof

OS/2 makes good use of the protected modes of the 386 family, the protected mode of the 32-bit 386, and the mode of the Virtual 8086 that makes DOS multitasking possible. In general, it's impossible for one program to make another crash or to crash the operating system. It is easy for a buggy program to crash itself, but no operating system can address that problem unless the protected mode is extended to protect software from programmers.

Although robust, OS/2 is not bulletproof. It uses the protected mode to protect one program from another, but it shares memory usage among programs that utilize the GUI support provided by the GPI (Graphics Programming Interface). After a program returns from a GPI call, there's enough information left on the program's stack to allow the program (if fired for evil, not good) to directly modify data structures in the GPI. This is unlikely, but it is a possibility—although an anomaly, given that operating systems seem to be evolving toward complete protection.

The fact that OS/2 isn't completely secure has its good points. At least for a while, the majority of the programs that run under OS/2 2.0 will be Windows and DOS programs, and there's something that OS/2 can do for those programs that even Microsoft's heavy hitter Windows NT can't do. Most DOS programs directly address the PC hardware either through memory addresses or I/O addresses. Protected mode means protection for the I/O

addresses, so any PC operating system that wants to exploit protection and still support DOS programs must make a tough decision: how to allow DOS programs to continue to directly address hardware.

The most common approach—and one that makes about 70 percent of the DOS programs happy—is to create a virtual PC, complete with virtual I/O addresses. The addresses are connected to programs that are drivers for hardware (e.g., a virtual keyboard, video, a disk, a serial port, and a parallel port). As long as the virtual drivers are relatively efficient, you have the best of both worlds: DOS programs think they're twiddling hardware while, in fact, the operating system retains control of it. Windows 3.1, OS/2 2.0, and NT all take this route.

But what about the nonstandard hardware that's becoming standard (e.g., fax boards, tape drives, and CD-ROM drives),

Key features

- Workplace Shell GUI
- Preemptive multitasking
- Multithreaded
- 32-bit virtual memory
- DLLs
- Named pipes and mail slots

Future enhancements

- Windows 3.1 support
- 32-bit imaging model

Drawbacks

- Lack of user/developer acceptance
- Nonbulletproof protected mode
- Inadequate device support out of the box

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things that I said about OS/2 2.0's robustness applies to NT—and more. That is one of OS/2's big problems in market acceptance: It is caught up in a squeeze between Windows 3.1 and NT. Had IBM brought OS/2 2.0 to market in early 1990—as it could have, albeit without Windows 3.0 support—I believe that it would have been able to develop a firm foothold on the high-end desktop market. Another example of the squeeze play can be seen in my earlier discussion of protection: Windows 3.1 has less of it than OS/2 2.0 does, but NT has more of it.

Further on down the Road

In the near future, you will see several things in OS/2. First, its GUI will get a much-needed shot in the arm from the Micrografx 32-bit engine, due out soon and perhaps available by the time you read this article. OS/2 will also support Windows 3.1 programs, something that it cannot do now.

One thing I haven't heard much about is where IBM plans to position OS/2 as a server platform. OS/2's main use as a server is under LAN Manager and its cousin, the IBM LAN Server. But Microsoft is moving toward NT as its platform for LAN

Will OS/2 2.0 programs run under Taligent?

Manager, and IBM seems to be more firmly in Novell's camp with each passing announcement. IBM should clarify this soon.

OS/2 needs better device support. While it needs a powerful computer to run on, OS/2 also needs one that is plain. I've despaired of ever getting my Ultrastor 22CA ESDI controller to work under OS/2. In contrast, the prebeta version of NT supports many Super VGA boards, SCSI devices, and accelerators. If IBM really wants OS/2 to be a success, it must ship in the box support for the 20 most popular LAN adapters, Super VGA boards, bus mastering SCSI and ESDI controllers, CD-ROMs, and tape drives.

OS/2 also needs a clear long-term commitment from IBM. With Taligent on the horizon, why develop for OS/2? Will OS/2 2.0 programs run under Taligent, will they have to be compiled, or will there be no compatibility at all? All IBM will say is that "there will be a migration path." One developer asked me, "Does migration path mean that my application will go south when I try to run it on Taligent?"

In addition, OS/2 needs documentation. It ships on a couple of dozen floppies, with a few short pamphlets describing the installation process. Once you've got it up and running, there is an extensive Master Index of all the help information. It's quite good, but the installation has got to be daunting to someone accustomed to seeing manuals. In fact, that's a problem that I've heard many companies cite when considering whether or not to go to OS/2. □

Mark Minasi writes and conducts basic and advanced seminars on Windows, OS/2 2.0, and OS/2 1.3 to 2.0 migration and is the author of the book Inside OS/2 (New Riders Publications, 1992). His firm, Mark Minasi & Co., is based in Arlington, Virginia. You can contact him on BIX as "mjminasi."

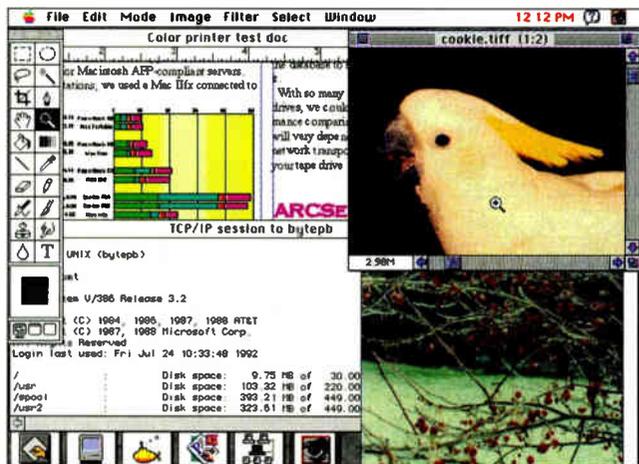
The Future of System 7.0

Apple's Mac operating system is its road to the PowerPC

TOM THOMPSON

Apple will continue to expand the capabilities of its operating system to differentiate it from other GUI-based operating systems. New features will be oriented toward providing users with a complete but easy-to-use work solution (see the screen). Some features will be obvious modifications to the GUI itself; others will lurk behind the screen, supplying crucial facilities (e.g., color matching). Also, Apple plans to move the Mac OS to the PowerPC, the RISC processor developed by the Apple-IBM-Motorola alliance (see "The Future of Personal Computing?" February BYTE).

The Mac OS's modular design and its expandability (via software patches called *extensions*) will be used to add new features without jeopardizing compatibility with the existing software base. Earlier examples of this abound: MultiFinder added cooperative multitasking retroactively



The Mac System 7.0 GUI is the one that all others are measured against. As a totally integrated environment, it works seamlessly with the environment while providing a high degree of ease of use.

to all existing Macs; 32-Bit QuickDraw revamped the QuickDraw imaging engine for handling 24-bit color; and QuickTime

added time-based data manipulation required by multimedia to color Macs. All these extensions added new capabilities

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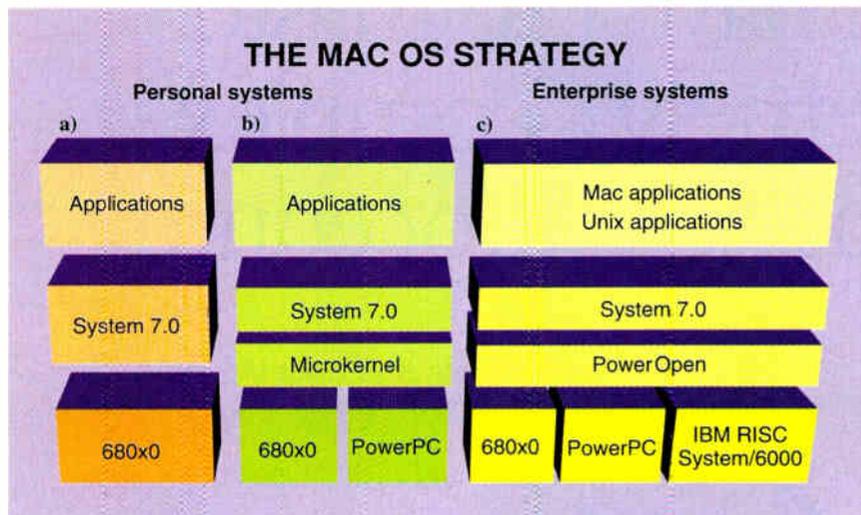
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(a) The current Mac OS implementation. (b) In the future, a microkernel will supply hardware services using multithreaded code. On top of the kernel, System 7.0 provides operating-system services, with the microkernel communicating to either a 680x0 CISC processor or a PowerPC RISC processor. (c) The PowerOpen architecture will provide hardware services for enterprise computing, which can use Mac and Unix applications or the Taligent operating system.

without affecting the compatibility of most applications software.

System 7.0, Apple's latest operating system, consolidates many of the just-mentioned extensions (the exception is QuickTime, which arrived after System 7.0's release) while offering improvements such as a built-in file-search function, keyboard navigation, peer-to-peer file sharing, and IAC (Interapplication Communication). It provides the new base on which Apple plans to build its future operating-system enhancements. Because of this strategy, users clinging to System 6.0.x should plan to upgrade soon or be left behind.

The Immediate Future

Apple's System 7.1, due for release this month, will fix some bugs now found in System 7.0 and offer new features. There are some significant changes as well. First, System 7.1 will address global markets by using a 2-byte character-storage scheme. This provides system-level support for languages using large character sets, such as kanji. Second, it can use either Type 1 PostScript or TrueType fonts on-screen and for printing. PostScript Level 2 printing support will be provided. Finally, this operating system will be a *reference* version: When Apple introduces a new computer, a "personality" extension will patch System 7.1's structure to recognize and use the new hardware. This eliminates the proliferation of operating-system revisions that occurred under System 6.0.x when a new Mac was introduced.

Apple will add other features and utilities incrementally through the extension mechanism to minimize compatibility problems. Announced new features include AppleScript, a control language similar to DOS batch commands or Unix shell scripts; a store-and-forward mechanism

Key features

- Use of extensions to add features while maintaining compatibility with applications software
- Advanced color capabilities
- Interapplication Communication
- Peer-to-peer file sharing

Future enhancements

- Ability to handle large character sets
- PostScript Level 2 printing support
- Ability to use Type 1 PostScript and TrueType fonts for both printing and on-screen display
- AppleScript control language
- Open collaboration environment

Drawbacks

- Inconsistent cooperative multitasking

called the *OCE (Open Collaboration Environment)*, which integrates mail, messaging, and document validation; and QuickDraw GX, a new imaging engine.

A brief look at QuickDraw GX is instructive because it illustrates the tightrope Apple walks in providing new features without compromising compatibility. QuickDraw GX is an object-based imaging system (i.e., it treats text, lines, polygons, and bit-mapped images as objects with specific characteristics), unlike QuickDraw's pen-oriented imaging system (where you draw a line by setting a pen's characteristics and then moving the pen to different screen coordinates). QuickDraw GX handles algorithmic fonts, and it also provides systemwide color-matching support.

QuickDraw GX does not use QuickDraw's data structures or code, so it can coexist with QuickDraw in the same computer. This enables existing applications to run and allows application designers to migrate their code to the new imaging architecture as necessary. This situation is identical to that of QuickTime, which doesn't interfere with the existing software because it bypasses QuickDraw completely.

Kernels and RISC

Despite these improvements, System 7.0 still has fundamental design flaws. Cooperative multitasking works, but it's only as good as the worst-written application. It places the job of sharing processor time with other applications on the application designer, not on the operating system. The processor is still saddled with screen drawing and moving bytes to some peripherals. These are jobs better off-loaded to coprocessors and DMA channels.

To achieve this end, Apple plans to re-vamp and consolidate hardware-specific functions into a microkernel, which will be the foundation for a preemptive time-sliced operating system, with memory protection, demand-paged memory, and semaphores for task coordination. The kernel will be multithreaded to provide DMA and asynchronous I/O. Apple will make the kernel's size and hardware requirements lightweight so that it can run on as many Mac models as possible. A series of extensive patches and new system resources will be used to implement the microkernel on existing systems. The rest of the operating system and applications will lie atop the microkernel (see the figure).

To make the migration of Mac software to a PowerPC-based Mac as painless as possible, Apple will implement a 680x0 object code emulator so it can run existing applications. Although emulation typically

End PC Envy

A Window on the Network

As you can see, DOS programs run alongside Microsoft Windows programs. You've seen this all before in our DESQview, right? Yes, but now there's more. DESQview/X lets you access and control a wide variety of PCs and workstations through your own PC. This feature is called remote computing.

In the example to the right, Lotus 1-2-3 is running in its own 386SX PC. The window at top center is a DOS window running on a remote 486 PC under DESQview/X. Below left is a FrameMaker file running on a remote IBM RS/6000 workstation in another part of the company.



Brand and Platform Freedom

DESQview/X runs on 386SX PCs and above. And from within windows on those PCs, you can use programs* running on any number of remote DESQview/X PCs if your network supports NetWare or NetBIOS. Add DESQview/X's optional network interface for TCP/IP networks and you can also access programs running on IBM RS/6000s to HP 9000 to Sun workstations. And it works the other way, too: these workstations can view and use DOS and MS-Windows programs in their windows.

* DOS graphics programs currently run only on your local PC.

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You can change menus, add sub-menus. Add menu items that run remote programs. Change commands. DESQview/X gives you a menu to use for your macros. And if you prefer a graphical desk top instead of a menu, DESQview/X's Application Manager gives you buttons for opening a set of programs used in a project or even for launching remote programs. What's more, you can specify window size and color. And if you are using DOS text programs, you can set them up so that the font changes size as you change the size of the window. We call this feature scalable DOS windows (see the Lotus 1-2-3 window at the lower right of the screen).

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affects performance, it won't be as severe for Mac software. Apple has done extensive code profiling that shows most Mac applications spend 66 percent or more of their time in Mac Toolbox code. If the Mac Toolbox is implemented in RISC code, the application spends most of its execution time in high-speed native RISC code instead of in the slower emulator. The microkernel design will provide a consistent foundation for the operating system to use to access hardware resources, regardless of the processor. Development tools such as

RISC compilers and a 680x0 object binary translator from Echo Logic will be available to facilitate application ports to RISC code.

This strategy means that users will not have to abandon their favorite 680x0 applications to use a PowerPC-based Mac. They can run them with reasonable performance using the system's built-in emulator until applications written in RISC code become available.

Finally, portions of the Mac OS and Mac applications are going to move to other plat-

forms. For example, QuickTime is supported by Silicon Graphics' Unix workstations as a data standard, and a QuickTime player has been demonstrated running under Windows 3.0. Claris has ported its FileMaker Pro database application to Windows, and you can expect more applications to make the move in the near future. □

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GUIs, Applications, and Unix

A graphical interface and more popular applications are the keys to Unix's success

MARY HUBLEY

Unix vendors are shifting gears. Their operating system is maturing, and the market has become more competitive than ever before. Rather than obstructing each other in the name of dominance, the vendors are cooperating to make Unix a powerful force within the Intel-based desktop market. Without this cooperation, the traditional non-Unix desktop operating systems will continue to dominate. But if Unix vendors pull together, the desktop market will be the grand prize.

The race for the desktop market has forced rival Unix vendors to collaborate. Archenemies UI (Unix International) and OSF (Open Software Foundation), the two most influential Unix consortiums, are finally working together to form a united front. They perceive Microsoft NT and other desktop operating systems as a threat to Unix, competition powerful enough to eliminate individual Unix vendors from the desktop market. Their strategy is to stand as a united group of vendors, empowering them to successfully combat non-Unix desktop vendors.

Users view Windows and DOS as easy to implement because versions are identical between platforms. To ensure that all Unix versions are similar, all the vendors must implement standards such as Posix, ANSI, Motif, and X/Open XPG. The goal is to make the differences among Unix versions indistinguishable to the end user.

Unix vendors are already working toward these goals. The most important accomplishment has been an industry consensus on a GUI: OSF/Motif. GUIs are



SunSoft's Solaris adds value to its USL SVR4 core with a built-in GUI.

critical because features such as desktop icons, drag-and-drop capabilities, and windows make Unix look like its competition. With GUIs, the complexities of Unix are masked. Further, a standardized GUI provides for the same interface regardless of the hardware platform being used.

OSF/Motif has been accepted by a majority of vendors as the standard Unix interface. With a standard GUI, Unix can compete in the ease-of-use category with other desktop operating systems. Motif allows you to do most of what command lines used to do, including sending mail,

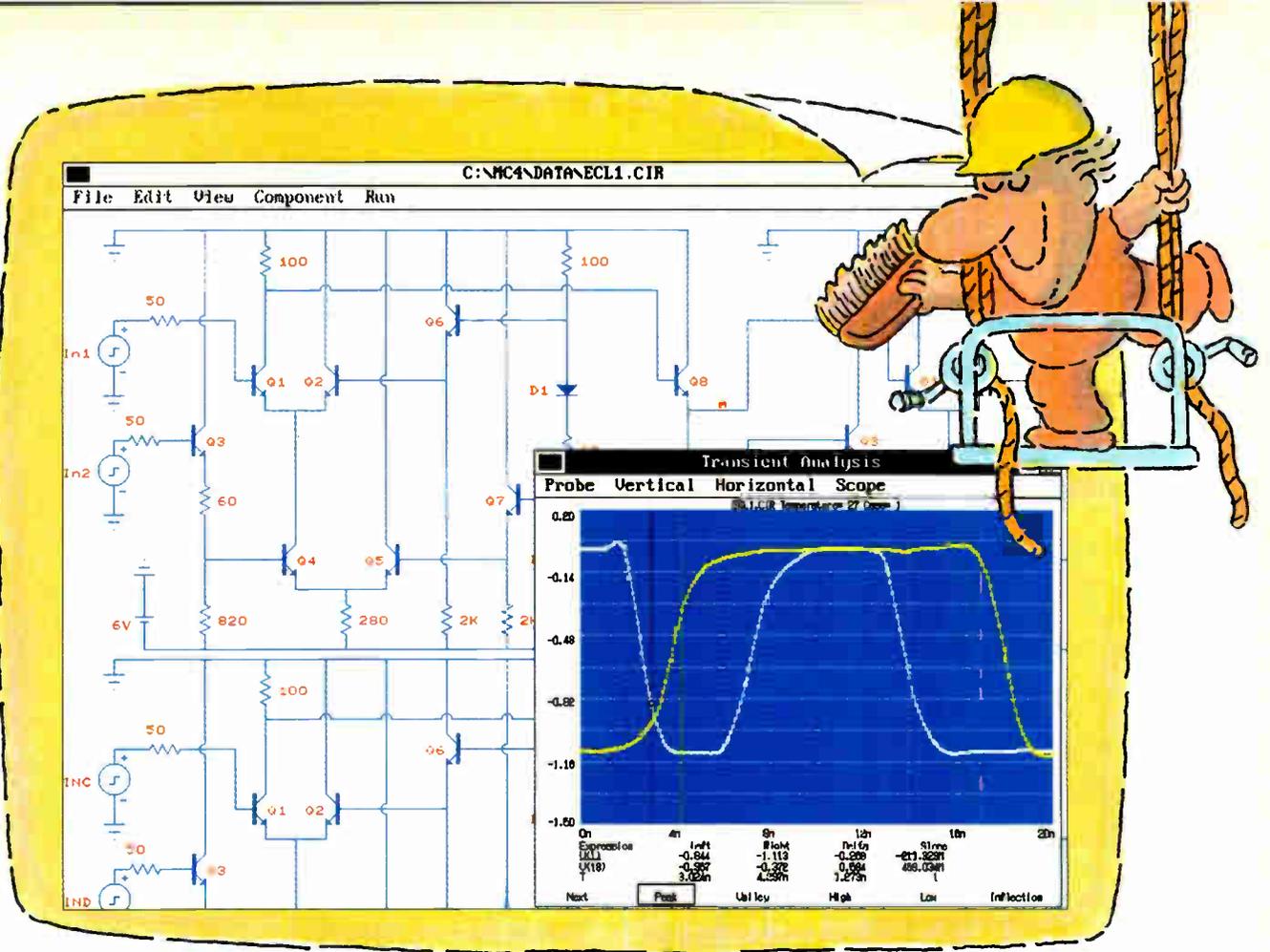
opening and manipulating files and applications, and even performing system administration functions. Motif runs on all Unix platforms, increasing its desirability in environments where there are computers from several vendors.

Applications Compatibility

Applications compatibility among Unix versions also moves Unix closer to desktop acceptance. ABIs (application binary interfaces) allow Unix applications to run on different hardware platforms within an architecture without any recompiling or reengineering. For example, in the Intel architecture, vendors make their binary implementation of Unix conform to the ABI specification. The applications written to the specification should be ABI compatible, allowing, for example, Lotus's shrink-wrapped software to run unchanged on Intel boxes from Unisys, NCR, and Olivetti.

But ABIs are architecture dependent: If you want to run an application on Intel, SPARC, or Mips systems, the application must be reengineered for each CPU. The good news is that Unix versions are similar, and minimal reworking is required—programmers should have to change applications only where there are hardware interfaces and operating-system extensions.

The SVID (System V Interface Definition) ensures that Unix implementations are binary compatible within an architecture, and it defines what an operating system has to look like (i.e., what the interface calls should be) to be ABI compatible. Almost all Unix versions comply with the

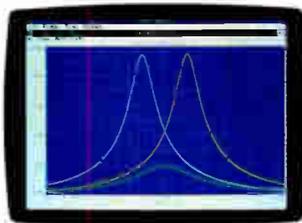


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SVID, even those not in the System V camp. This includes the next version of OSF 1.1, which Hewlett-Packard, DEC, and IBM are planning to implement. Most other Unix vendors already have SVID, many of whom base their operating systems on Unix System V release 4.0, including NCR, Unisys, The Santa Cruz Operation, SunSoft, and Olivetti.

Work Continues: The Future ABI
SVID is not the end; more work must be done on ABIs. The most pressing area of development is in value-added Unix, where vendors enhance their versions by adding extensions (e.g., built-in GUIs, real-time facilities, and extra administrative tools). However, value-added extensions affect compatibility.

For instance, Unix SVR4.2 is SVID-compatible with other SVR4 versions. But SVR4 is licensed to other vendors, many of whom add value to their versions, which affects their compatibility. SunSoft's Solaris is an example of a value-added SVR4 because it has a built-in GUI (see the screen). Incompatibilities between SVR4.2 and Solaris exist on the GUI level, but the two operating systems are compatible be-

neath the interface. Thus, if you take away Solaris's GUI, you can still use SVR4 applications. Although SunSoft and Unix Systems Laboratories are devoting a great deal of time to the development of commonality between Solaris and SVR4.2, this problem signals a larger trend in Unix operating systems: Value-added graphical operating systems (e.g., Solaris) are here to stay.

GUI-based Unix systems are especially important in the desktop market, where ease of use and ease of training are critical issues. According to David Sandel, UI's vice president of worldwide marketing, "Unix products obviously have the graphics capabilities, but they're not compatible. Without support for graphical-based systems in the [ABI] standard, we won't get enough shrink-wrapped software to compete on the desktop."

Applications Software

Applications software is the real battleground. If Unix vendors want to devour desktop dollars, DOS and Windows applications had better be available for their systems. The desktop market demands PC applications. Even though there are thou-

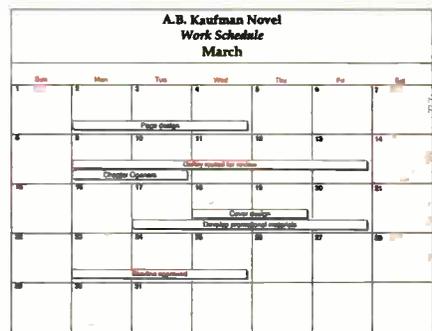
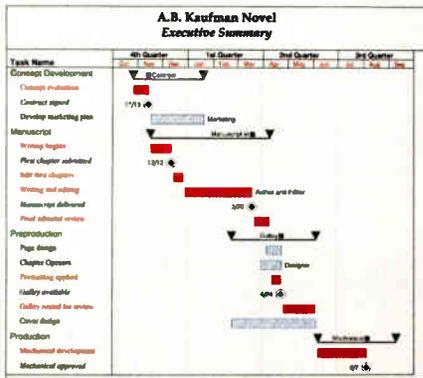
sands of scientific and commercial applications written for Unix, PC users want the applications they know best. Most people will not learn a new application or spend any money for training if the old application works just as well or better than the new one.

Popular applications in the PC world began working their way over to Unix a couple of years ago. Today, the most successful PC products are running on Unix, including Lotus 1-2-3, Microsoft Word, and WordPerfect 5.0. However, only the best-known applications have a Unix equivalent. The majority of DOS applications are simply not available for Unix. Businesses depend on their critical applications; they cannot afford to change just because an operating system provides better programming, scalability, or vendor independence. For those critical applications that are not available in Unix versions, many companies have explored the following alternatives.

Emulators, such as SoftPC from Insignia Solutions, are probably the easiest solution. They simulate DOS on a Unix system. The downside to this technique, however, is that they make applications run as

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slowly as they would on a 286-based PC.

Plug-in boards that slide into a CPU slot, such as SunConnect's SunIPC, also allow Unix machines to run DOS. Unfortunately, they cost more than software emulators.

Virtual-mode simulators, such as Merge from Locus Computing and VP/ix from SunSoft, use the virtual 8086 mode of 386 and 486 processors to simulate PCs running DOS. Virtual-mode simulators allow several DOS applications to run simultaneously and let Unix run in a shell under DOS.

Porting is the most time-consuming solution. It requires extensive rewriting of an application, but the resulting software becomes truly Unix-based. Hunter Systems' XDOS has been used by many companies to assist in porting efforts, expanding such notable products to the Unix market as Borland's dBase and XyQuest's XyWrite.

Networking offers another way to make DOS and Unix systems work together, and it allows an easy migration from DOS-only operations. Two methods are generally used: Unix file servers can be added to PC LANs, or PCs can be modified to communicate in Unix Ethernet networks. In

the first method, Unix file servers can be accessed through LAN operating systems (e.g., Novell's NetWare for Unix and Microsoft's LAN Manager for Unix). These operating systems provide DOS PC users access to Unix file-server facilities such as E-mail, file and resource sharing (e.g., printers), and remote access. In the other method, Unix-based Ethernet networks afford PCs access to Unix networks without a server. Resources can be shared through TCP/IP and related software and Ethernet adapter boards.

So, What's the Future?

The biggest trend is GUI-based desktop Unix. SCO Open Desktop was the first in the field, and now others are following suit by converting their character-based Unix versions to graphical-based packages. In addition, as Motif becomes universally accepted, the number of applications that can run on Motif is growing rapidly.

Why should you buy Unix instead of Windows, OS/2, or other operating systems running on the desktop? Because it offers more flexibility: It's the only operating system that can be expanded to the mainframe. Networking capabilities are

Key features

- Consistent GUI across platforms
- Application compatibility across platforms
- Only operating system expandable to mainframes
- Built-in networking
- Large command set

Future enhancements

- Real-time services
- Desktop versions from key vendors, such as SunSoft
- Built-in GUIs
- Extra administrative tools

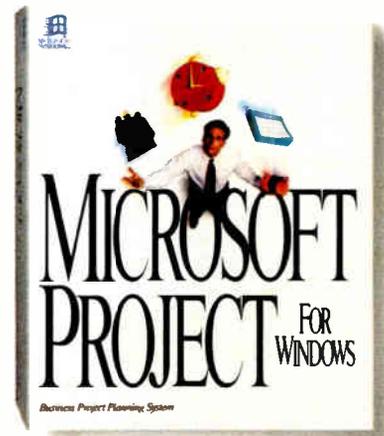
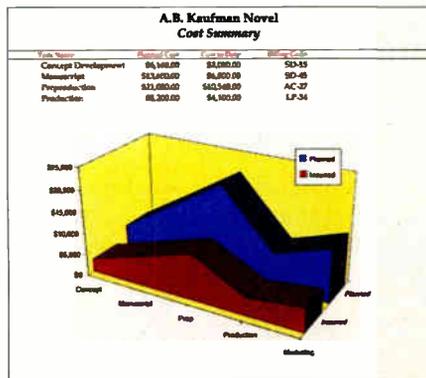
Drawbacks

- Shortage of shrink-wrapped applications
- GUI-level incompatibilities among versions
- Negative market perceptions
- No easy way to run PC applications

built in. And the command set is huge, allowing Unix to accomplish more complex

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tasks than its desktop counterparts. In addition, if you want to take advantage of the powerful RISC-based platforms, Unix offers you the widest choice.

Beyond technical advances, marketing is key to Unix's success on the desktop. It is up to the Unix vendors to drive the Unix market on the desktop. They must bring in independent software vendors,

show them the growth potential of Unix, and assist in porting their software. The vendors must also educate end users about Unix's benefits and demonstrate its new ease of use and its complete compatibility among versions.

Price, ease of use, and a wider selection of applications has made DOS and Windows successful. Only by meeting the

competition head-on will Unix triumph on the desktop. □

Mary Hubley is senior editor of Datapro Reports on Unix Systems & Software, a publication of the Datapro Information Services Group of McGraw-Hill devoted to the Unix and open-systems markets. You can reach her on BIX c/o "editors."

NextStep: The Sleeper

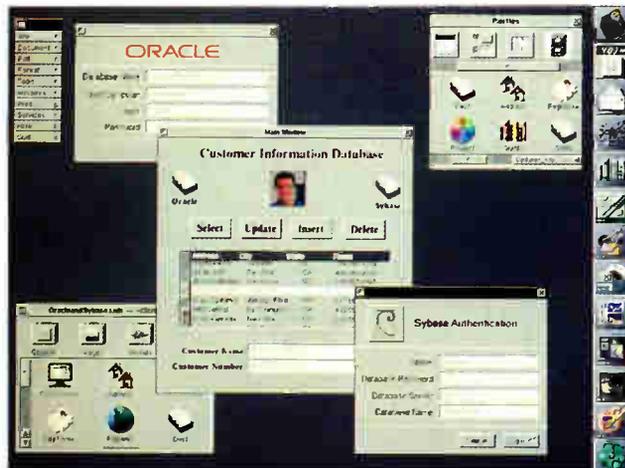
Next's object-oriented operating system offers now what others promise for later

TOM YAGER

From anyone's perspective, Next has chosen an unusual tack. On the hardware side, Next has taken up Motorola CISC processors (i.e., the 680x0) at a time when traditional backers (e.g., Sun) are abandoning them. Next systems are inexpensive compared to other Unix workstations, but that has its price: These systems have almost no internal expansion capability (save memory and disk), and the only case opening in Next's fashionably black pizza box is for a floppy drive. But you won't hear any Next users complaining; most of them are fanatically devoted to their systems.

The beauty of the Next is far more than skin deep. Its standard operating environment, NextStep, is probably the most respected piece of software on the planet. The reason it attracts so much attention is that, unlike almost every other popular operating system, NextStep doesn't short-change anyone. Users, developers, and integrators all reap the benefits of NextStep's object-oriented scheme. No one who works with a Next machine feels like a second-class citizen. In contrast, the immensely popular Windows environment does not extend its benefits to developers, at least not if those developers use Microsoft's own C/C++ tools (which run under DOS).

That NextStep makes its users happy is obvious (see the screen). A distinct departure from traditional Unix systems, everything on the Next is handled graphically, and the average user never deals with the operating system or even realizes it's there. It retains the Mac-style global menu (a single menu bar that changes depending on which application has the focus), but on the Next, the menus are presented in movable vertical windows. Icons for commonly used applications are gath-



The NextStep interface makes it the easiest-to-use Unix. It features icons for commonly used applications and a Mac-style global menu.

ered along the edges of the display, and any running application displays an icon that you can double-click on to instantly move its window to the top of the stack and make it the focus. The Next uses a Unix-style hierarchical file system, and a graphical browser is provided.

The combination of NextStep's interface features makes it, by far, the easiest Unix system to use. It reigns as the best example of Unix done right: It's aimed at ordinary users rather than traditional Unix users. Because of all this, the Next is finding its way into domains that were once dominated by PCs and Macs.

Next's ease of use doesn't limit its functionality, because networking and E-mail, distributed applications, integrated audio, network printing, and other desirable functions are all wrapped in point-and-click interfaces that make them accessible to all classes of users. That's all standard with NextStep. While there are third-party enhancements for other systems that provide

pieces of that functionality, Next is the only vendor bundling all of it with every system it sells.

Treated Like an Object

The underlying reason for Next's success is objects. Where traditional Unix treats everything as a file, NextStep understands and manages objects at an operating-system level.

The developers benefit from the system just as much as the users because the development environment for NextStep applications uses GUI power to make the process easier to manage. Blocks of code become objects that programmers can paste into other applications. Changes take place at the object level, and as long as the new object understands the same message set as the one recognized by the object before it, you are not required to chase around and change other modules. This modularity is not layered. Objects are an integral part of NextStep, and the object-

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oriented development environment is included with every system.

Thanks to NextStep, the Next has found its greatest appeal in the corporate community, where systems are configured for specific needs. NextStep makes customizing a system easier than anything else I've seen. Applications become icons, and the development tools make it easy (and, I dare say, fun) to create custom graphical applications that, thanks to NextStep's standard object library, look and act as good as any commercial program. What might take days of procedural programming to accomplish elsewhere can be reduced to a few hours of tying existing objects together under NextStep.

If your application is graphical or depends on high-quality text, you have the full power of Display PostScript at your disposal. And once you've invested that effort, you know that what you've built will run on any Next in (or out of) the house. The level of applications you can create in the standard environment is much higher on Next than anywhere else.

Next machines incorporate an ease of networking previously found only on the Mac. Every machine has Ethernet, and all it takes to get Nexts talking to each other is to plug them into the same thin-wire or twisted-pair LAN. A new system will register itself at boot time with a designated configuration server. Without any further effort, the system immediately gains ac-

Key features

- Object-oriented
- Well-integrated GUI
- Integrated audio
- Easily networked
- Easily customized

Future enhancements

- Intel-based PC version
- NetWare and AppleShare client-network access
- Mac file-system support
- Distributed objects
- Database kit

Drawbacks

- Few shrink-wrapped applications
- Demanding software creates minor performance issues
- Completely proprietary (except for Display PostScript)
- No RISC platform support

cess to all public resources. This, too, is a boon for large installations, because it reduces system setup to finding desk space and outlets.

Coming Soon to a PC near You

For the moment, only users of Next's own workstations can experience these benefits. But perhaps as early as the end of the

year, NextStep 3.0 will be available for 486-based PCs for under \$1000 (\$2495 for the developer's version).

Aside from the new platform support, NextStep 3.0 will also make NetWare and AppleShare client-network access standard. It also adds Mac file-system support, reading Mac floppy and hard disks and making them appear as Next file systems. A database kit will allow programmers to create object-oriented programs that transparently access popular networked databases. This new release also introduces distributed objects, extending NextStep's object messaging to allow objects to reside anywhere (e.g., within the same application, on the same system, or across a LAN or wide-area network).

Next has the advantage of already being where most other workstation manufacturers would like to be. While everyone is reportedly making ease of use and developer support priorities now, Next had those primary goals from the start. There isn't any high-performance machine that offers as many benefits for so little money and effort. As the application count rises (there are fewer than 300 applications for the Next, not counting the custom programs that NextStep supports so well), NextStep will doubtless be seen on many more desks. □

Tom Yager is a BYTE technical editor. You can reach him on BIX as "tyager" or on the Internet at tyager@bytepb.byte.com.

Univel's Trim Unix

UnixWare looks great, and it's less filling

MATT TRASK

In a time when *downsizing* has too many negative connotations, Univel, the joint venture of Novell and Unix Systems Laboratories, has used the term *rightsizing* to describe the use of its new UnixWare product as a solution for mission-critical applications. Univel has aimed UnixWare squarely at the Fortune 1000 market.

UnixWare will be sold in two versions—a Personal Edition for single-user desktop systems and an Application Server for multiuser and network server use. The Personal Edition can run on a 16-MHz 386SX system with 6 MB of RAM, but the recommended configuration is a 25-MHz 386SX or higher with 8 MB of RAM and

a 120 MB hard drive. Application Server can run on a similarly configured system, but the recommended environment is a 33-MHz 486 with 12 MB of RAM and a 200 MB hard drive.

Just the Essentials for the Desktop

The main attraction of UnixWare is that it has been slimmed down significantly to operate on smaller desktop systems. How was such a feat accomplished? Several years back, a guru described Unix as "a small, fast, efficient, portable operating system, upon which every graduate student in the universe has played pin the tail on the donkey." A great deal of the difficulty and bloat associated with Unix was

brought on by the inclusion of hundreds of utility programs, such as `tar`, `uucp`, and `cpio`.

Univel has removed much of this extraneous functionality and replaced it with an easy-to-use GUI and a set of system administration tools for tasks such as installation and backup. The GUI offering is based on X Window System 11 release 5 and includes both the Open Look and Motif desktop managers (see the screen). Installation is said to be as simple as that for Windows 3.1, and it can be performed from a CD-ROM or a network as well as from a disk or tapes.

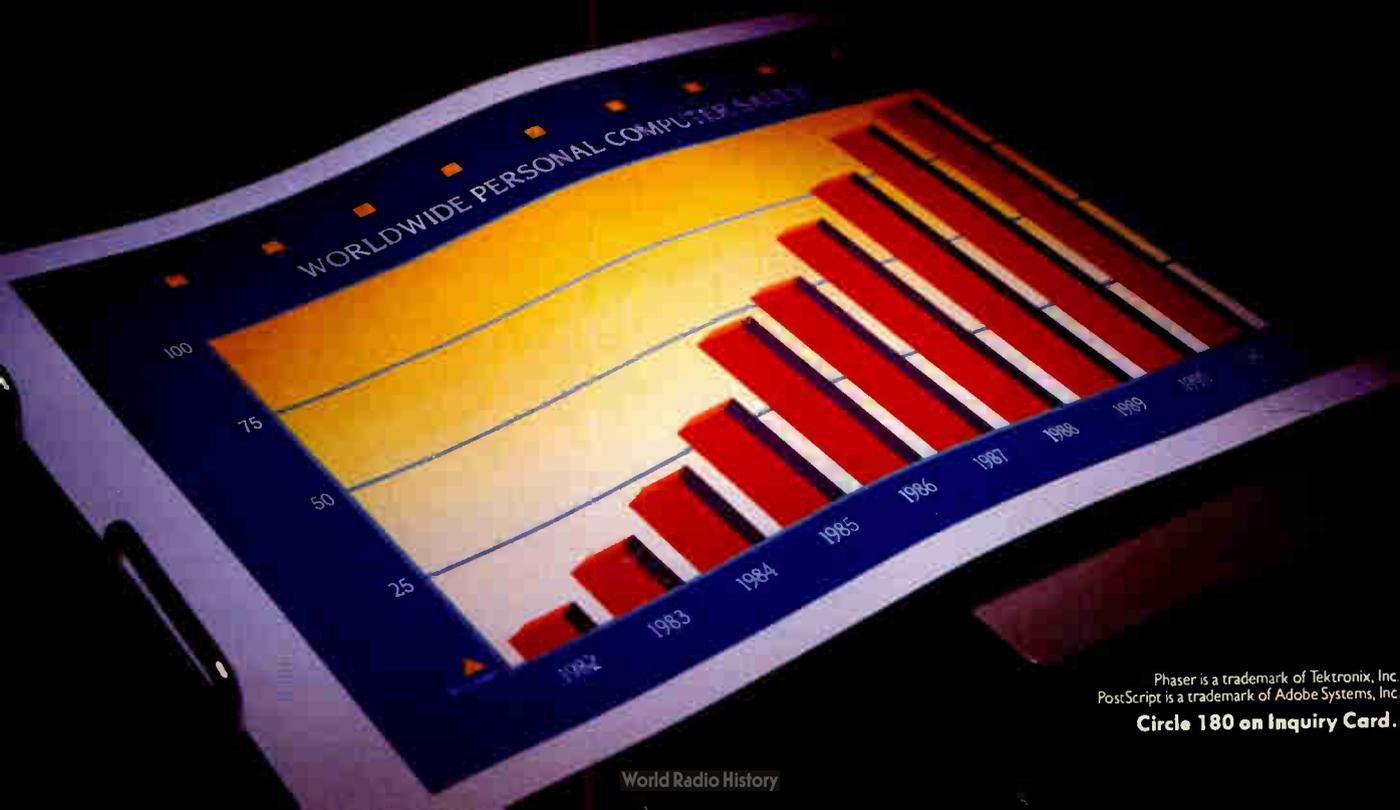
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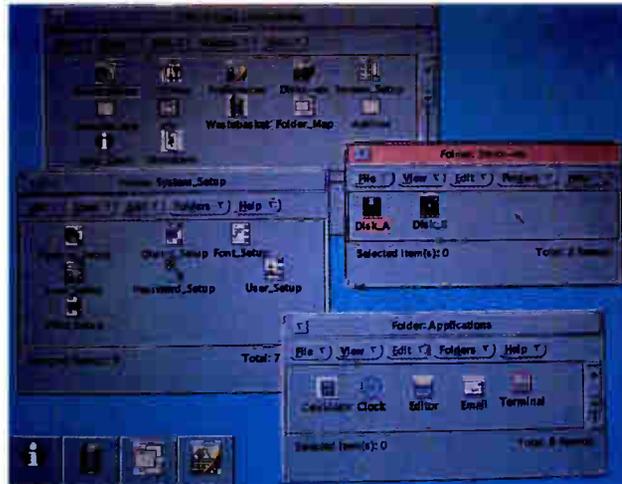
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UNIVEL'S TRIM UNIX



UnixWare's GUI offering is based on the X Window System and includes both the Open Look and Motif desktop managers. The screen here is actually USL's SVR4.2, on which UnixWare is based. Except for minor differences in the icons and header bars, the screens will be similar.

networking protocols (including IPX/SPX, NCP, and SAP) directly into the Unix kernel. This will allow transparent interoperability with NetWare LANs, which are used in the corporate environment. The traditional Unix connectivities that are based on the NFS (Network File System) and TCP/IP networking protocols are available as an add-on package and are still necessary for connecting UnixWare systems to the Internet and other Unix systems.

UnixWare Application Servers will not be able to run NLM (NetWare loadable module) applications, but developers can create new distributed-server applications that take advantage of this environment. Univel claims that UnixWare is capable of running all the traditional Unix applications, as well as DOS and Windows programs, without any performance degradation.

The expected development tools (e.g., an ANSI C compiler and debugger) are available as an optional package. Other development kits provide support for NetWare programming, device driver devel-

opment, and GUI programming. A package called Moolit is available for GUI development with both Motif and Open Look. Programmers can also choose to develop command-line or full-screen type applications.

Univel's use of the USL Unix System V release 4.2 kernel provides significant security enhancements over older versions of Unix. The standard security level is certifiable at C2 and can optionally be tightened to B1 or B2. In contrast, DOS and Windows cannot be certified as secure, and Windows NT will be certifiable at the C2 level.

Things to Come

What is the status and the availability of UnixWare? During the summer, the initial releases were shown to a limited audience, and a full beta test program was planned for August. The final product is expected to ship to end users this fall.

Unix has always been a hacker's heaven and a great development environment for programmers. It has held a stable niche in the computer market for a great many years, during which true believers insisted that someday Unix would take over the desktop. They said all that was required was to hide the command line with an attractive graphical front end and to provide easy-to-use system administration tools.

Univel has done this. The improved connectivity to corporate LANs, ease of installation, and removal of extraneous functionality should make this new product much more accessible to desktop end users. ■

Matt Trask is president of Communica, a system software consulting firm based in Cape Cod, Massachusetts, that specializes in personal computers. You can reach him on BIX as "matt.trask."

Key features

- Runs easily on a standard Intel-based desktop
- Open Look and Motif desktop managers
- Simplified installation
- Integration of Novell's networking protocols
- Good security

Future enhancements

- None announced

Drawbacks

- Cannot run NetWare NLMs

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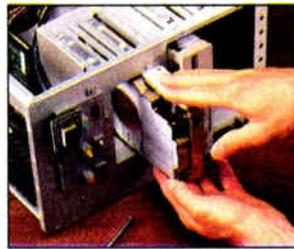
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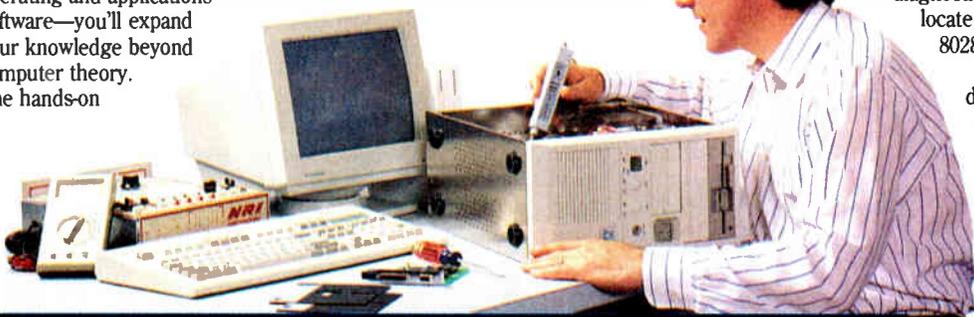
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A representative sampling of software companies that have announced support for IBM's OS/2 2.0, Univel's UnixWare, or Microsoft's Windows NT.

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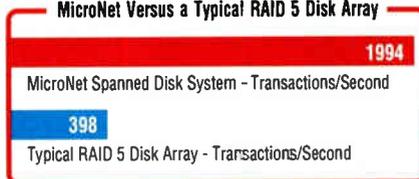
But there is another side to the story. Your data needs protection. If a server goes down, rapid data recovery is essential. Mirroring the hard disc system creates an on-line duplicate of the data, should

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THE NEW WAVE OF REMOVABLE STORAGE

**The BYTE Lab helps you
find the right removable
data storage system**

**RAYMOND GA CÔTÉ
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are hungry than ever. And most of you are swimming hard to keep afloat in the daily data streams—intraoffice E-mail, electronic stock reports, spreadsheet reports, and interoffice faxes. Today, more and more information is being transmitted as graphical images: faxes, forms, charts, electronic circuit diagrams, photos of the new corporate headquarters, and on and on. At this rate, in 10 years you'll be adding gigabyte drives to your systems and seeing them fill in a day or two.

Add to the explosion of data the growing importance of security, and you have an obvious need for a removable-storage system. In this month's Solutions Focus, we take a look at some of the options in removable storage and try to sort out the field by analyzing each class of device for performance, cost, reliability, and suitability for primary and secondary storage across all major platforms.

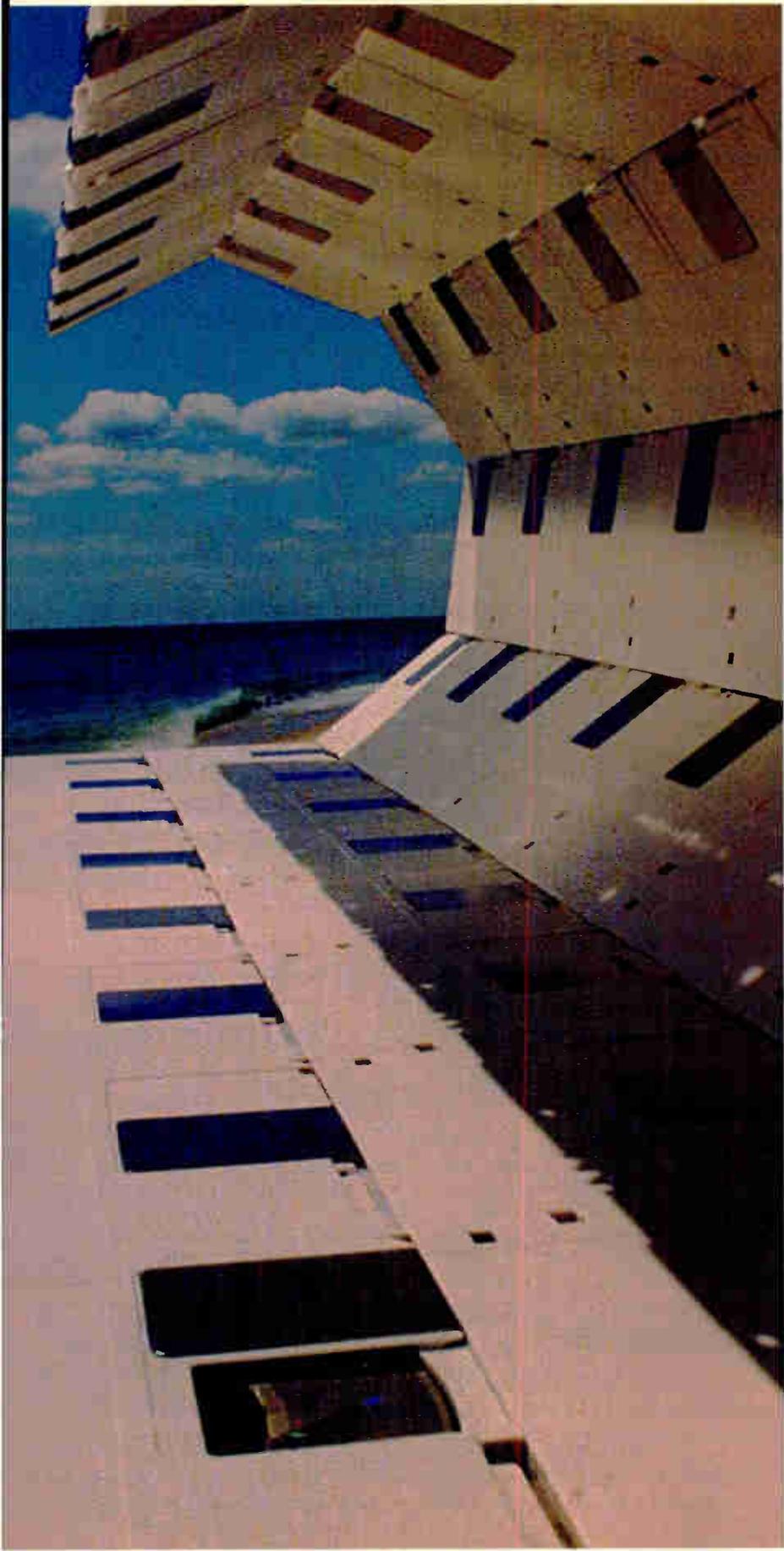
To this end, we have taken a sampling of products from each category: (1) MO (magneto-optical) drives (Epson America's OMD-5010-100, Image Network Technology's Infinita 128, Ocean Microsystems' Vista 128, Panasonic's LF-3000, Pinnacle Micro's PMO-650 and REO-130S, Relax Technology's Rewritable Sierra 128, and Sony's RMO-S350); (2) floptical drives (Procom Technology's Floptika 20); (3) magnetic-cartridge drives (Omega's Bernoulli Transportable 90 Pro and Bernoulli PC Powered 90 Pro, Microtech International's R50, Peripheral Land's Infinity 88, and SyDOS's 88e); (4) docking drives (Mass Memory Systems' Disk Pack and Quantum's Passport XL); and (5) parallel-port drives (Disctec's RoadRunner XD-120, MicroSolutions' Backpack, and Sysgen's Mobile Disk MD120).

In each case, we evaluated the hardware mechanisms so as to differentiate the performance of each class. Based on those evaluations, we're able to make recommendations about which applications are best suited for each type of technology. We

Do you ever have the feeling that the data gremlins get together at night and make up more data to tuck away on your drives? No matter how large the new drive you've added to your system, it is soon filled.

Applications keep getting fatter, especially with the trend toward graphical interfaces. Operating systems are more storage-





BYTE ACTION SUMMARY

■ WHAT IS REMOVABLE STORAGE?

Alternatives to fixed hard drives designed to help you deal with growing sets of data.

■ LIKES

Convenience and expansion capabilities are pluses. With MO (magneto-optical) media, data won't be prey to stray magnetic fields.

■ DISLIKES

Removable drives are relatively slow, but they sure beat the wait with tapes. Most of these drives are not the best solution for primary storage.

■ RECOMMENDATIONS

Removable hard drives are the answer if security is your primary concern. Parallel-port devices are a good choice if you will be shuffling the drive around from one system to another; they are also a good solution for expanding the drive capacity of notebook computers. But for most removable-storage applications, the future belongs to MO. If you can, wait for the market to develop, speeds to increase, and prices to drop. Among the MOs tested in this review, we pick the Rewritable Sierra 128 from Relax Technology.

also selected a price/performance stand-out in the MO category.

In our performance evaluations, we did not use the special drivers, adapters, or software that you can usually buy from authorized dealers. Our intent is to help you choose the type of removable storage that is right for your needs. You should then seek out the dealer with the best overall package. (For an overview of the basic specifications for each device, check out the table on page 200.)

Another important consideration is the cost of the media used in the drives. For a comparison of the costs of the various removable-storage technologies, refer to the table and to figure 2. The MO drives offer a clear advantage.

Catching the Wave

The classic solution to "putting data on the shelf" has been tape of one form or another. Solutions ranging from traditional, and still acceptable, nine-track tape to sophisticated DAT (digital audiotape) let

REMOVABLE-STORAGE DRIVES

When evaluating the features of removable-storage drives, you should consider the cost of the unit as well as the adapter card. Average seek time provides a good starting point for determining suitability for primary storage. Fixed hard drives usually have seek times ranging from 19 to 28 ms. (● = yes; ○ = no; N/A = not applicable; MC = Micro Channel.)

MAGNETO-OPTICAL DRIVES

Vendor	Epson America	Image Network Technology	Ocean Microsystems	Panasonic	Pinnacle Micro	Pinnacle Micro	Relax Technology	Sony Corp. of America
Model name or number	OMD-5010-100	Infinita 128	Vista 128	LF-3000	PMO-650	REO-130S	Rewritable Sierra 128	RMO-S350
Internal or external	Int.	Int.	Ext./Int.	Ext./Int.	Ext.	Ext.	Ext.	Ext.
External unit size (in.)	N/A	N/A	2.1 x 9.7 x 10.4	3.8 x 6.2 x 10	7.4 x 10.1 x 3.7	2.2 x 6.8 x 8.8	4 x 1.6 x 5.8	9.7 x 11.2 x 2.9
Weight (lbs.)	1.53	1.76	8	7.7	7.4	4.8	1.76	9.9
Platforms supported	Mac, PC, Next, Sun	Mac, PC	PC	Mac, PC	Mac, PC, PS/2, Sun	Mac, PC, PS/2, DEC, Sun	Mac, PC, PS/2, Sun	Mac, PC, PS/2
Internal or external power supply	N/A	N/A	Int.	Int.	Int.	Int.	Int.	Int.
Transfer speed in MBps	0.768	4	0.5	4	4.2	0.625	4	7.25
Average seek time (ms)	38	45	35	40	19	38	39	40
Interface (SCSI, parallel port)	SCSI	SCSI-2	SCSI	SCSI	SCSI	SCSI	SCSI-2	SCSI-2
Interface adapter available	○	●	●	●	●	●	●	●
Brand of interface adapter	N/A	Adaptec	Adaptec, Future Domain	Panasonic	Adaptec, Future Domain	Adaptec, Future Domain	Trantor, Future Domain	Adaptec
Cost of adapter	N/A	\$265	Varies	\$175	Included	Included	included	\$350 to \$450
Warranty	1 year	1 year	1 year	1 year	1 year	1 year	1 year	1 year
List Price:								
Standard configuration	\$1000 OEM quantities	\$1699 w/ interface adapter	\$1999	\$2195; Int. version, \$1795	\$3995 to \$4195	\$1995 to \$2395	\$1299 to \$1749	\$2295
Options			256-MB drives	Interface adapter and software				SCSI adapter
Media:								
Size in MB	128	128	128	128	650	128	128	128
Manufacturer	Epson, Sony	Ricoh	Several sources	Panasonic	Digital Optical Tech.	Epson, Sony	Ricoh	Epson, Sony
Cost per disk or cartridge	\$64	\$70	\$67	\$89	\$199	\$79	\$49	\$64
Cost per MB	\$0.50	\$0.55	\$1.91	\$0.70	\$0.30	\$0.61	\$0.38	\$0.50

you back up, archive, and safely remove files from your primary system. Tape storage has one overriding problem: accessibility. Retrieving files from tape can be a long and tedious process. Magnetic tape is a sequential, not random, access device and is unsuitable for use as a primary-storage medium. Long-term storage is its best use.

Between the high-speed, high-accessibility features of your primary hard drive and the low-speed, low-accessibility characteristics of a magnetic tape system lies the fuzzy realm of secondary storage. The secondary-storage devices we discuss have several common traits: They all provide a removable medium, they are slower than standard fixed hard drives, and the cost

per megabyte is less than that of a standard hard drive. Except for the Bernoulli PC Powered 90 Pro, all the products reviewed connect through either a SCSI peripheral interface or a system's parallel port.

Lights and Flux

Magneto-optical drives (see photo 1) represent some of the newest technology available in the marketplace. Combining lasers with relatively conventional magnetic write heads, MO drives and disks represent a high-density, reliable storage option.

Figure 1 shows how an MO drive works.

A fixed semiconductor laser bounces light off a mirror mounted on the end of a movable arm located directly under the rapidly spinning disk. A magnetic write head is positioned on the opposite side of the disk (this head is large enough to cover the radius of the disk).

Writing data to the disk is a two-step process. First, the magnetic write head is turned on so as to write 0 bits to the disk. The laser is used in high-power mode to heat the disk surface to the Curie point (i.e., about 180°C). Once the surface is heated, the magnetic field exerted by the write head produces a change in magnetic polarity on the disk. As the disk quickly cools, it retains this new magnetic polarity. On the second pass, the polarity of the

EXPANDABLE MASS STORAGE

REMOVABLE-STORAGE DRIVES

MAGNETIC-CARTRIDGE DRIVES					DOCKING DRIVES		PARALLEL-PORT DRIVES			FLOPTICAL DRIVE
lomega	lomega	Microtech International	Peripheral Land, Inc.	SyDOS	Mass Memory Systems	Quantum	Disctec	Micro-Solutions	Sysgen	Procom Technology
Bernoulli Transportable 90 Pro	Bernoulli PC Powered 90 Pro	Microtech R50	Infinity 88	SyDOS 88e	Disk Pack	Passport XL	Road-Runner XD-120	Backpack	Mobile Disk MD120	Floptika 20
Ext.	Ext.	Ext./int.	Ext./int.	Ext./int.	Ext.	Ext./int.	Ext.	Ext.	Ext.	Ext.
2.7 x 9.8 x 11.8	2.7 x 6.7 x 10.7	2.5 x 9.7 x 10.7	2.4 x 9.8 x 9.8	2.6 x 9.7 x 9.7	5.7 x 4.5 x 9.8	9.4 x 9.4 x 2.3	3.2 x 6.1 x 2.3	4.2 x 7.9 x 1.7	7.8 x 4.7 x 2	2.4 x 9.6 x 10.5
8.1	6.1	7.2	4.5	7.5	5.2	8.5	1.5	2.5	2.3	6
Mac, PC, PS/2	PC, PS/2	Mac, PC, PS/2	Mac, PC, Next, Atari	PC	Mac, PC, PS/2, DEC, Sun, TI	Mac, PC, PS/2	PC	PC	PC	Mac, PC
Int.	N/A	Int.	Int.	Int.	Int.	Int.	Ext. or battery	Ext.	Ext.	Int.
20	20	2	1.25	4	5	1.4	0.2	0.33	0.25	0.2
30	30	25	20	20	17	18	19	19	19	80
SCSI	SCSI	SCSI	SCSI	SCSI, parallel	SCSI-2	SCSI-2	Parallel	Parallel	Parallel	SCSI
●	●	●	●	●	●	●	N/A	N/A	N/A	○
lomega	lomega	Microtech	PLI	SyDOS	Bustek	Future Domain	N/A	N/A	N/A	N/A
Included	Included	PC, \$229 MC, \$499	\$100	\$499	\$589	PC, \$194 MC, \$214	N/A	N/A	N/A	N/A
1 year	1 year	2 years	2 years	2 years	1 year	2 years	1 year	1 year	1 year	1 year
\$949 \$713 (Mac) \$949 (PC)	\$855	\$1299	\$1099	\$1299 w/ interface adapter	\$1158	\$1201	\$1450	\$795	\$895	\$585
Interface adapter, \$265	Interface adapter, \$265		Carrying bag		Double docking bay; 52-MB to 1.05-GB drives	50- to 240-MB drives				
90	90	50	88	88	105	105	120	100	120	20.8
lomega	lomega	Ricoh	SyQuest	SyQuest	Mass Memory	Quantum	Disctec	Teac	Sysgen	Insite, 3M, Maxell
\$229	\$229	\$129	\$199	\$278	\$1099	\$629	\$1450	\$795	\$895	\$45
\$12.04	\$12.04	\$2.58	\$2.26	\$3.15	\$10.40	\$5.99	\$12.08	\$7.95	\$7.45	\$2.15

magnetic field is reversed. This time, only the portions of the disk that represent 1 bit are written.

The laser reads the MO disk in low-power mode. Due to a process known as the Kerr effect, the plane of polarized light is rotated when it reflects from a magnetized surface. In MO drives, the polarization plane rotates clockwise when reflected from a 1 bit, and counterclockwise when reflected from a 0 bit. This polarization shift is easily detected and translated into a stream of electrical 0s and 1s.

The Perfect Answer?

Unlike conventional hard and floppy drive technology, which requires a read/write head to come very close to, or to actually

touch, the rapidly spinning magnetic disk. MO components can maintain a safe distance. Thus, head crashes are not a problem, nor is there the wear problem associated with floppy disks, which require physical contact.

Because MO disks must be heated before their stored magnetic fields can be changed, they are impervious to the magnetic fields normally encountered in the office or travel environment. Gone are the concerns about placing a telephone on your disks, storing them too close to a fluorescent lamp, or passing them through an airport x-ray machine. (Note: it's not the x-rays that cause problems, it's the magnetic field emanating from the motors in the conveyor system that erases the disks.)

MO cartridges are fairly robust. They can be dropped without much concern. If the case breaks, you can simply transfer the disk to a new case as long as the disk surface has not been scratched. Epson goes so far as to recommend that if you spill coffee on a disk, simply wipe it off. Disk-cleaning kits are available for removing spills of sugary beverages that may leave a film that will prevent the laser from reading the data.

MO drives are also fairly inexpensive. Right now, the drives are more expensive than the cartridge-based units such as those made by SyQuest, but the media costs are less, especially when you look at the cost-per-megabyte ratio.

MO is starting to sound like the ultimate



Photo 1: A collection of internally and externally mounted MO drives.

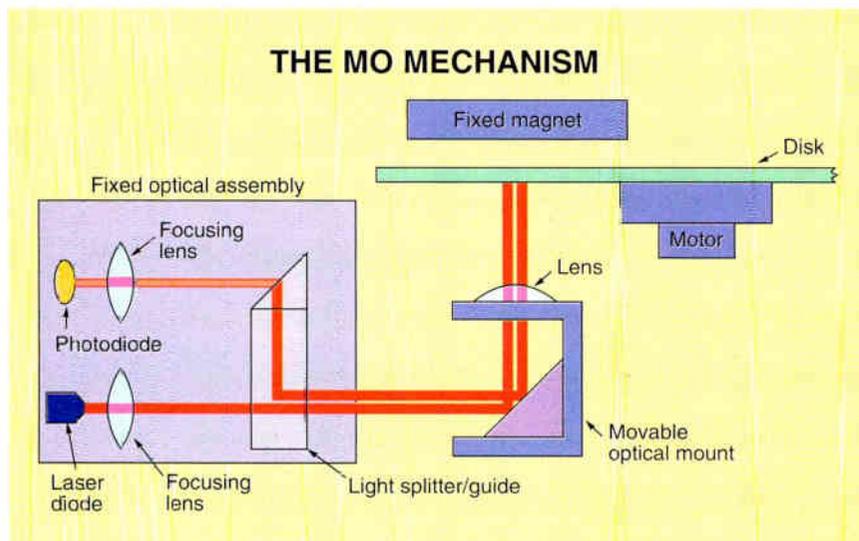


Figure 1: MO drives use a combination of lasers and magnetics to write data. As the laser heats the disk, the magnet writes the data onto the surface. A low-power laser beam is used to read the data back. One sizable advantage is the ability to read and write information without getting close to the spinning magnetic medium. Wear and tear on the MO disk is slight.



Photo 2: MO drives generate large amounts of heat. Ricoh mounts a small fan on the back of its drive to blow air through the mechanism and out the front of the drive.

nally mounted MO drives can come with their own ventilation systems, designers of internally mounted MO drives are not able to take into consideration the heat and airflow characteristics of every computer system.

Ricoh has addressed this problem by mounting a small squirrel-cage fan (see photo 2) at the back of its MO drive that blows air through the drive and out the front. Although the fan doesn't get in the way if you are installing the system in an externally mounted box, you must consider the added protuberance if you want to mount this drive inside your PC case. Due to the increased heat generated by these drives, you really should avoid mounting them internally. Many of the smaller PC cases are already pushing the heat constraints to the limit. Replacing older 386SX and 386DX chips with the accelerated clock-doubler chips only adds to the heat burden. For now, MO drives appear relegated to external boxes.

MO Performance

As the benchmark results in figure 2 show, MO drives are slower than standard SCSI hard drives, but not so much slower as to make it impractical to use them for primary as well as secondary storage. The judicious arrangement of Windows swap files on your primary hard drive and the addition of an efficient disk cache will produce acceptable, but not stunning, performance.

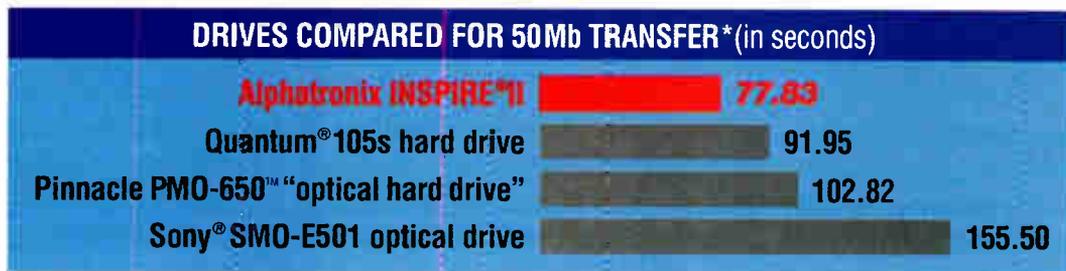
One aspect of the MO disk that is not yet being exploited is its ability to store read-only data as well as read/write data on a disk. During manufacturing, small physical data pits can be stamped onto the disk to represent a stream of data. These pits alter the laser beam in much the same manner as magnetic polarity, producing a stream of 0 and 1 bits. This is the technique now used to stamp manufacturing and positioning information onto MO disks. Possible uses of this technology include reference works that allow customization and reusable workbooks that students can write in during a course and then are erased at the end of the term.

The one unknown about MO disks is storage life. Although laboratory tests indicate a 10-year period, the disks have simply not been around long enough, nor been made in sufficiently large quantities, to indicate how long you can leave them on the shelf and still expect to find your data. The fact that the disk must be physically heated to change the magnetic contents is a definite plus, but only extended use will provide the final answers.

MO drives are a reasonable solution to the expanding primary-storage problem.

continued

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optical drive is now
the world's fastest.

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*Read 50 Mb data stored in sequential sectors at 32 Kb/read request. Complete details of benchmark environment and procedures available upon request. Alphatronix, the Alphatronix logo, and Inspire are U.S. registered trademarks of Alphatronix, Inc. Other trademarks and product names are the property of their respective owners.

For Macintosh information circle 64; for IBM/Compatible information circle 65; for UNIX information circle 66 on inquiry card.

EXPANDABLE MASS STORAGE

They provide reasonable performance at a reasonable price, with the added benefit of using a disk that is basically immune to extraneous magnetic interference.

The Optical of Our Eye

When it came to selecting the best MO drive, we were hard-pressed to find clear differences among the drives. Our benchmark testing returned very similar performance results across the different mechanisms. Specialized drivers can improve a drive's performance, but we see a clear trend away from proprietary configurations. In most business settings, you will be better served by a standardized adapter and driver solution that accommodates the addition of other SCSI devices.

Given this philosophy and our benchmark findings, we suggest that you should not be unduly concerned about a drive's performance. Developments in MO tech-

nology will produce drives with faster access times, but for now MO performance is too close to call.

Performance being equal, we examined price and software bundles. Keep in mind that there are many other MO resellers in the market, including Liberty Systems (Santa Clara, CA), Rodime Systems (Boca Raton, FL), and GCC Technologies (Waltham, MA). Shop around before making your final decision.

Among the MO drives evaluated here, we liked the Rewritable Sierra 128 from Relax Technology best. The Ricoh mechanism has been on the market for some time and seems reliable, and the fan helps allay any concerns about the drive overheating. The MO cartridges are reasonably priced. The Relax catalog lists a 128-MB cartridge for \$49 and a set of five cartridges for \$225. Five cartridges would give you 640 MB of storage capacity for

less than 35 cents per megabyte. The drive itself costs \$1299 for the Mac kit and \$1399 for the PC kit (with an interface card). Relax also offers a package for the Sun platform for \$1749. If you already have a SCSI adapter card, you'll pay even less. That all adds up to the best pricing among the group of MO drives reviewed here. We think Relax Technology offers the best total package.

The Floptical Future

There is something very comforting about 3½-inch floppy disks. They are familiar, rugged, and highly portable. Several of them fit comfortably in a pocket; they don't bend; and we don't go into shock when they are dropped on the floor. The primary limiting factor is their relatively small capacity: 720 KB to 1.44 MB

REMOVABLE-STORAGE DRIVE PERFORMANCE

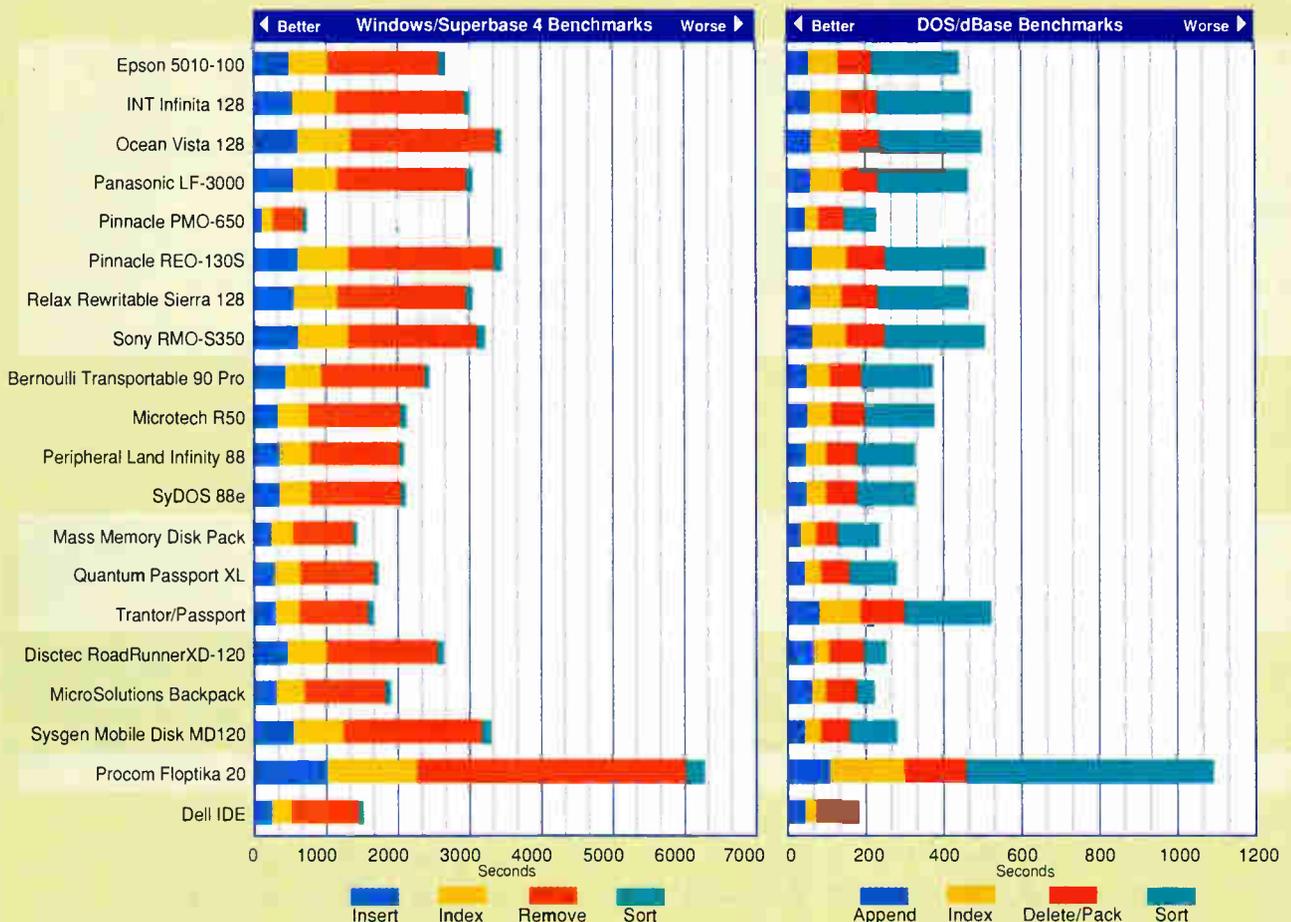


Figure 2: Our benchmark suite includes file I/O-intensive applications under Windows and DOS. In some cases, you can expect better performance using vendor-supplied drivers. Products are grouped by technology.

(or 2.88 MB with the newest technology).

Floptical disks take this comfortable size and pack the equivalent of an early 1980s hard drive (i.e., 21 MB) inside. The key is optical servo positioning. Floptical drives are closely related to standard 3½-inch floppy drives.

Figure 3 shows how the floptical technology works. Magnetic read/write heads are positioned on both sides of the disk and touch it as it spins. What differentiates this setup from standard floppy drive technology is the addition of an optical sensor that sits beside the bottom head. This sensor detects an optical positioning pattern that has been laid down on the floptical disk. The increased positioning accuracy acquired by using this pattern, in addition to the use of a very thin magnetic head, allows data tracks to be positioned an order of magnitude closer together than on standard floppy disks.

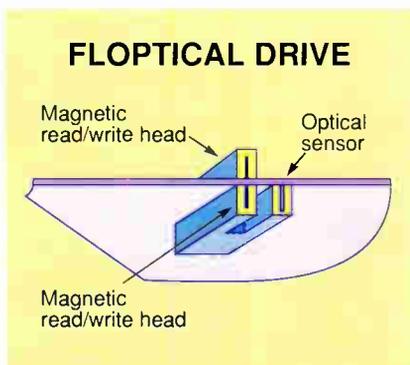


Figure 3: Floptical drives function similarly to standard floppy drives. In fact, they can read and write standard 720-KB and 1.44-MB floppy disks. The special 21-MB floptical disk contains an optical track that allows highly precise head positioning.

A primary selling point of the floptical drive is its ability to read and write normal 720-KB and 1.44-MB floppy disks in the same drive used for the 21-MB floptical disks. This added functionality requires a magnetic write head with the dual capability of writing both extremely thin and normal magnetic patterns.

Along with all the benefits of floppy drive-style technology come some of the disadvantages. Floptical drives are not fast. Since the drives spin at normal floppy drive speeds, performance is equivalent to that of floppy drives. You probably won't be doing a lot of database work or program development on these drives. Also, the floptical disks are as sensitive to stray magnetic fields as normal floppy disks. Thus, you have to keep them away from telephones, monitors, and other sources of magnetic interference.

The cost per megabyte of floptical disks, coupled with the benefit of random access, makes them ideal candidates for keeping spare copies of frequently accessed files.

Currently, all floptical drives are licensed from Insight Peripherals, so they will not vary much from vendor to vendor. The performance and features offered by Procom's Floptika 20 are generally what you can expect from other floptical drives. With that in mind, you can focus on finding a floptical drive with the best price and software bundle, without worrying much about hardware differences.

Disks with Wings

If you want your data to fly—really fly—then Iomega's Bernoulli drives are the answer. A continuing problem with many drive technologies is the need to get

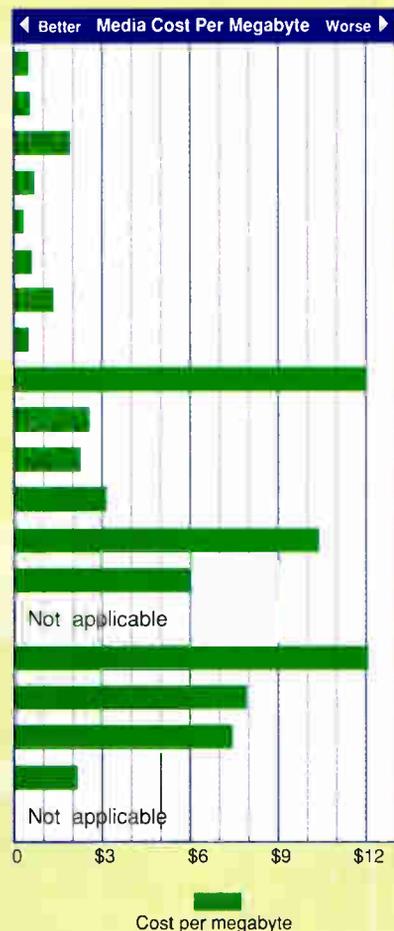
the disk very close to, but not touching, the magnetic read/write heads. Bernoulli drives solve the problem of positioning by forcing the disk to approach the heads, rather than have the heads approach the disk. The rapidly rotating disk is flexible, like a normal floppy disk, and drags along the surrounding air as it moves. When the air mass encounters the restricted airflow between the disk and the read/write heads, it accelerates. The air on top of the disk moves faster than the air on the bottom of the disk. According to an effect first documented by Daniel Bernoulli, an eighteenth-century Swiss mathematician, the pressure exerted by the airstream increases as the speed of the airstream decreases. Thus, the slower-moving air under the disk presses it toward the upper read/write head. The newer Bernoulli 90-MB cartridges stand this effect on its head by using a second disk, which is pulled down by the Bernoulli effect to approach the lower read/write head. (See figure 4.)

Due to the Bernoulli effect, the read/write head never actually touches the magnetic disk. In traditional hard drives, the read/write head "flies" over the spinning disk. However, when the power is suddenly removed, the disk spins down and the head can touch the disk surface, causing a crash. More important, physical jolts and shocks can bounce the head, causing it to crash into the disk surface. Since the Bernoulli drive pushes the disk toward the head, rather than having the head fly over it, it becomes much more difficult for the head to contact the surface. This results in a highly reliable device, particularly in an environment where you may move an external hard drive, either intentionally or accidentally. The Bernoulli is a very good choice if you need to send your cartridge through the mail. The trade-off is a high cost-per-megabyte ratio.

Hard-Working Bernoulli

Aside from the flying disks, the Bernoulli drive uses fairly conventional floppy drive-style technology. The performance of the Bernoulli is a bit better than that of the MO drives, but the same caveats apply when using the Bernoulli drive for primary storage. It works extremely well as expandable secondary storage. We have had an earlier version of the Bernoulli drive in the BYTE Lab for over five years, and it is still chugging away with the original cartridges.

The newest Bernoulli device, Iomega's PC Powered 90 Pro, draws power directly from your computer, adding some convenience but requiring a proprietary adapter card. The power connector hangs off the interface card and plugs into your PC's



Based on cost per megabyte, MO cartridges offer the best value.



Photo 4: A collection of alternative drives. Removable hard drives best answer security requirements, but you won't want to ship them from place to place. Parallel-port-based drives are suitable for moving large files among machines or increasing the storage capacity of portable computers.

unconscious move that you don't necessarily notice that the computer is still writing to the drive.

We have taken a very small sampling of removable SCSI hard drives to represent the category. There are many drives of this kind on the market. Many hard drive vendors also sell removable versions of their products. You should evaluate them much as you would a fixed hard drive, while taking into account the mechanism used for removability.

Through the Interface

Although they are only peripherally related to the problem of expandable storage, interfaces that connect hard drives and other SCSI devices to a system's parallel port are becoming more and more popular. These parallel-port connections are either hard-wired to a hard drive, as the MicroSolutions Backpack is, or, as with the Trantor T338 MiniSCSI (a \$159 parallel-to-SCSI host adapter), translate the signals from the parallel port into a SCSI port.

As the benchmark figures show, these systems are much faster than you would first expect. Their primary benefits are portability and the ability to connect to just about any computer with a parallel port without having to install internal hardware.

Parallel-port drives are a boon to our BYTE Lab testing. They allow us to con-

figure a single drive with our test requirements and then quickly copy the information over to any test system—no interface cards, no network setup, no need even to open the system's case.

We have been using the Backpack for some time and can recommend it as a portable storage tool. In fact, the parallel port is becoming a popular way to connect to a number of storage devices: floppy drives, tape backup systems, and even CD-ROM drives. Like MicroSolutions, Liberty Systems (Santa Clara, CA) has a full line of parallel-port devices. Other vendors include Vision Logic (San Jose, CA) and Tidal Technology (Alameda, CA). Always Technology (Westlake Village, CA) sells a parallel-to-SCSI device not unlike Trantor's adapter.

To the Test

We tested all the removable storage devices on a pair of identical Dell 325P (25-MHz 386DX) desktop computers. On both machines we used the bidirectional parallel ports and installed Adaptec 1542B SCSI adapter cards. We also used the Trantor T338 MiniSCSI host adapter on some of the devices to test for compatibility.

All the SCSI-based devices were tested using CorelSCSI device drivers (see the Reviewer's Notebook on page 254 for more discussion of our testing scenario). This was done to ensure that all the devices could work as part of a daisy chain rather than having to depend on any one manufacturer's device driver. We were

also seeking a level playing field for testing the hardware mechanisms. Each drive mechanism is sold by a number of different resellers, each offering its own drivers and added value in the form of software and support.

All the devices were tested with a subset of the standard BYTE application benchmark suite of programs. Under DOS 5.0 we used dBase IV, and under Windows 3.0 we used Superbase 4.0. The database programs provided an I/O-intensive test of each device that corresponded to the way it would be used in the real world.

We did not run into a lot of surprises. The floptical drive was slowest, running at standard floppy drive speeds. The MO drives were next in line, a bit slower than the Bernoulli and SyQuest-based drives. The removable hard drives ran at normal hard drive speeds. The biggest surprise was the performance of the parallel-port drives, the Backpack in particular. Our first thought was that they couldn't be that fast, but in reality they run fast enough for normal, but not intense, usage.

Know Your Needs

In the final analysis, you must weigh your particular need for expandable mass storage against your requirements for speed and immediate access. If you typically need to ship multimegabyte databases between offices, then floptical drives may be your best choice. The additional speed provided by MO drives and their resistance to random magnetic effects add up to a safe and secure option.

The cartridge drives enjoy the advantage of having been around for a while. The 44-MB SyQuest cartridge, in particular, has become a standard transfer medium on the Mac; whether the 88-MB drive will inherit that audience remains to be seen. You should consider the removable hard drives if security is your main concern.

Parallel-port devices do not require internal cards, so they're a good choice if you routinely need to move a drive around from one system to another. They are also good for expanding the drive capacities of notebook computers.

The Best Deal

MO looks to us like the wave of the future. The Pinnacle Micro PMO-650, a new 5/4-inch 650-MB MO drive, gave us a glimpse of the possibilities. It is expensive—too expensive to recommend now—but that should change as the market develops. The important point about the PMO-650 is its speed. It has a 19-millisecond access time and outperformed

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every other device we tested here, most notably on the Windows benchmark suite. The cartridges cost \$199, which works out to a mere 30 cents per megabyte.

For now, you'll have to accept an access time of about 40 ms if you buy any of the 128-MB MO drives currently available. But in such a hot market, you can expect developments to occur quickly. The drives will get faster, and further competition should drive prices down. Keep an eye on the MO vendors for special pricing and software bundles. You should be able to find some good buys. The MO car-

tridge's cost per megabyte is already quite reasonable.

Out of the sampling of MO drives we covered for this Solutions Focus, the Relax Technology Rewritable Sierra 128 is the best deal. The prices for both the drive and the cartridges are the lowest of the group, and the Ricoh mechanism is a proven performer. If you're thinking of buying today, it's a great choice.

On the other hand, you may decide to sit back and wait for the market to develop further and for speeds to increase. But you probably shouldn't wait for too long. For

many applications, MO is now the way to go. ■

Raymond GA Côté is a BYTE Lab editor continuing his 15-year love affair with computers as tools and toys. Ray has worked in industry designing interpretive languages and user interfaces. His main interest is the creation and maintenance of reliable software. Stanley Wszola is a BYTE Lab testing editor. You can reach them on BIX as "rgacote" and "stan," respectively. You can also reach Ray on the Internet as rgacote@byteph.byte.com.

COMPANY INFORMATION

Adaptec, Inc.

(1542B SCSI adapter)
691 South Milpitas Blvd.
Milpitas, CA 95035
(408) 945-8600
fax: (408) 262-2533

Circle 1320 on Inquiry Card.

Corel Systems Corp.

(CorelSCSI)
1600 Carling Ave.
Ottawa, Ontario,
Canada K1Z 8R7
(800) 836-7274
fax: (613) 728-9790

Circle 1339 on Inquiry Card.

Disctec

(Disk Technologies Corp.)
(RoadRunner XD-120)
925 South Semoran Blvd.,
Suite 114
Winter Park, FL 32792
(800) 553-0337
(407) 671-5500
fax: (407) 671-6606

Circle 1321 on Inquiry Card.

Epson America, Inc.

(OMD-5010-100)
20770 Madrona Ave.
Torrance, CA 90509
(310) 787-6300
fax: (310) 787-5350

Circle 1322 on Inquiry Card.

Image Network Technology

(Infinita 128)
9661 Telstar Ave., Unit A
El Monte, CA 91731
(800) 334-6684
(818) 454-1617
fax: (818) 454-1655

Circle 1323 on Inquiry Card.

Iomega Corp.

(Bernoulli Transportable
90 Pro)
1821 West 4000 South
Roy, UT 84067
(800) 456-5522
(801) 778-1000
fax: (801) 778-3450

Circle 1324 on Inquiry Card.

Mass Memory Systems, Inc.

(Disk Pack)
1414 Gay Dr.
Winter Park, FL 32789
(800) 347-5722
(407) 629-1081
fax: (407) 628-3862

Circle 1325 on Inquiry Card.

MicroSolutions Computer Products, Inc.

(Backpack)
132 West Lincoln Hwy.
DeKalb, IL 60115
(815) 756-3411
fax: (815) 756-2928

Circle 1326 on Inquiry Card.

Microtech International, Inc.

(Microtech R50)
158 Commerce St.
East Haven, CT 06512
(800) 626-4276
(203) 468-6223
fax: (203) 468-6466

Circle 1327 on Inquiry Card.

Ocean Microsystems, Inc.

(Vista 128)
246 East Hacienda Ave.
Campbell, CA 95008
(800) 262-3261
(714) 898-1340
fax: (714) 373-9979

Circle 1328 on Inquiry Card.

Panasonic Communications & Systems Co.

(LF-3000)
2 Panasonic Way
Secaucus, NJ 07094
(800) 742-8086
(201) 348-7000

Circle 1329 on Inquiry Card.

Peripheral Land, Inc. (PLI)

(Infinity 88)
47421 Bayside Pkwy.
Fremont, CA 94538
(800) 288-8754
(510) 657-2211
fax: (510) 683-9713

Circle 1330 on Inquiry Card.

Pinnacle Micro

(PMO-650, REO-130S)
19 Technology
Irvine, CA 92718
(800) 553-7070
(714) 727-3300
fax: (714) 727-1913

Circle 1331 on Inquiry Card.

Procom Technology, Inc.

(Floptika 20)
2181 DuPont Dr.
Irvine, CA 92715
(800) 800-8600
(714) 852-1000
fax: (714) 852-1221

Circle 1332 on Inquiry Card.

Quantum Corp.

(Quantum Passport XL)
500 McCarthy Blvd.
Milpitas, CA 95035
(800) 624-5545
(408) 894-4000
fax: (408) 894-4558

Circle 1333 on Inquiry Card.

Relax Technology, Inc.

(Rewritable Sierra 128)
3101 Whipple Rd.
Union City, CA 94587
(510) 471-6112
fax: (510) 471-6267

Circle 1334 on Inquiry Card.

Sony Corp. of America

(RMO-S350)
655 River Oaks Dr.
San Jose, CA 95134
(800) 352-7669
(408) 432-0190

Circle 1335 on Inquiry Card.

SyDOS, Inc.

A Division of SyQuest
Technology
(SyDOS 88e)
6501 Park of Commerce Blvd.,
Suite 110
Boca Raton, FL 33487
(800) 437-9367
(407) 998-5400
fax: (407) 998-5414

Circle 1336 on Inquiry Card.

Sysgen, Inc.

(Mobile Disk MD120)
556 Gibraltar Dr.
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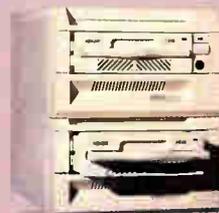
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HARDWARE

Fast 486 File Servers

**STEPHEN PLATT, TADESSE GIORGIS,
LESLIE REISZ, AND STEVE APIKI**

Fast, crash-resistant networks depend on many factors: workstation performance, properly managed protocols, and well-placed bridges, to name just a few. Ultimately, however, most network requests will end up at a file server, and most of the data shuffled across the LAN will cross the disk of a server at one time or another. That puts most of the load of your network squarely on the shoulders of a few file servers.

Upgrading or adding additional high-performance servers is especially attractive in these days of rapidly deflating hardware prices. But systems show substantial differences in performance and ease of operation as well as price. For this review, we tested the performance and gauged the configurability of 12 50-MHz 486DX- and 486DX2-based file servers under NetWare and Unix: the Acer America AcerFrame 1000, the Advanced Logic Research PowerPro, the AST Research Premium SE 4/50, the Compaq Systempro/LT, the DEC DECpc 450ST, the Dell 450SE/2, the Everex Step 486DX2/50 EISA Tower, the Gateway 2000 50-MHz 486DX2 EISA, the IBM PS/2 Model 95 XP 486, the NCR 3447, the Northgate 486 EISA DX2, and the Tangent MultiServer. The table details each configuration.

These systems do not, in general, represent the top-performing systems from each manufacturer's line. You can find faster drive array-based systems from each of these vendors or configure your own with third-party hardware; you could also choose top-of-the-line Tricord or NetFrame "superservers." We gathered this group together based on price. These 12 servers are the least expensive machines from major system vendors that met our minimum server criteria for capacity and performance—namely, 1 GB of mass storage, a 50-MHz 486 or 486DX/2, and 16 MB of RAM.

Testing Servers

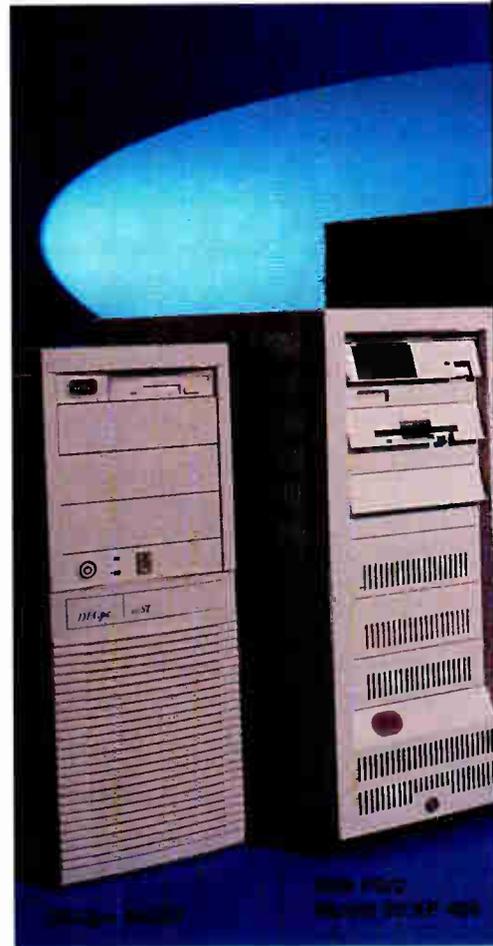
We benchmarked these systems at the National Software Testing Laboratory using BYTE's standard Novell NetWare and Unix network benchmarks. These tests break server performance into two basic categories: message passing and file I/O.

Message passing consists of repeated packet transfers between server and workstations; it's a measurement of the throughput of the physical network. For testing file servers, the most relevant numbers are those generated by the file I/O tests. In these tests, workstations open, read, and write files on the server using either sequential- or random-access patterns. The file I/O tests measure true server throughput; disk I/O speed is the most important factor, but processing speed and network I/O performance also contribute. You can find further details of each test in the suite in "File Servers Face Off," February BYTE.

We used Novell NetWare 386 version 3.11 to test all the servers. We equipped each EISA server with two Novell NE3200 32-bit EISA Ethernet adapters, balancing network load across two segments. IBM and NCR supplied 32-bit Micro Channel Ethernet cards for these tests; IBM supplied 3Com cards, and NCR supplied Cogent E/Master III adapters.

Most of the servers ran SCO Unix System V release 3.2.4, but there were a few exceptions. We tested NCR's 3447 with AT&T Unix SVR4, the company's primary Unix version. Neither Tangent's nor Gateway's servers would run release 3.2.4 (they lacked driver support), so we ran these under SCO release 3.2.2. Finally, since IBM's main Unix platform is its RISC System/6000 series, we didn't test the Model 95 under Unix.

Because SCO Unix doesn't currently support Novell's NE3200 (it will in an upcoming release), we used Mylex's LNE-390A as the standard test adapter. Mylex's



drivers don't support dual interface cards, so we were limited to a single segment. Since Cogent's cards don't support Unix, NCR included a Western Digital WD8003 16-bit Micro Channel adapter for the Unix tests.

Twelve 286-based diskless workstations formed our LAN test-bed. Half the workstations were independent units; the other half were constructed from NSTL's LAN-Box, a collection of single-board workstations housed in a single test fixture.

We tested each server with four, eight, and 12 clients in each environment. The figure shows the aggregate throughput for each server for each test (message passing and sequential and random I/O). Note that the figure shows total throughput on the network—that is, the sum of the throughput seen by each client on the network.

Performance Considerations

The benchmark figures represent a network "saturation curve" for each type of task and for each server. Each curve starts low, peaks at some median number of

BYTE ACTION SUMMARY

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They are 486 systems with high storage capacity and a 32-bit bus for high-speed networking.
- **LIKES**
Performance of all systems, regardless of price, is roughly equivalent under NetWare. Compaq's and NCR's systems stand out under Unix.
- **DISLIKES**
ALR's, Gateway's, and Northgate's systems are difficult to configure and maintain.
- **RECOMMENDATIONS**
For NetWare, the DEC, Dell, and Everex systems provide the best mix of price, performance, usability, and features. Compaq's Systempro/LT and NCR's 3447 are the best machines for Unix.



clients, and then begins to decline. At the lowest levels, all the servers are unsaturated (i.e., used at less than total capacity); you can add additional clients without affecting per-node transmission rate. Once a server is saturated, you can expect total throughput to remain constant while you see a linear, or worse, decay in throughput as seen by each client. Throughput decays further as you add additional clients.

Saturation behavior is critical in determining server performance. Network saturation levels depend on five basic factors: server processing speed, server disk subsystem, server interface card, network substrate, and client performance. Of these, the network substrate and client performance did not limit performance and remained constant for each server, so we'll focus on the other contributing factors.

Naturally, a fast CPU and memory subsystem is more responsive to client requests. Moreover, processing power contributes to faster file I/O in the form of faster cache buffers and request processing. Half of these servers are built around Intel's 486DX2, while the rest use a full

486DX. Yet the top performer on BYTE's NetWare message-passing test is a DX2 machine. This demonstrates that a strong disk/memory and memory/network interface is much more relevant to server performance than whether or not the system is based on a DX2 processor.

Fast disk performance is critical to server throughput. As the number of clients increases, disk and buffer thrashing can occur. Buffers can become filled and then discarded before they are used, if the buffer is needed by another client's operations. Also, disk operations that may be sequential on a per-client basis become effectively random as client operations are intermixed. The majority of these systems use a caching SCSI drive controller and fast hard drives to help enhance performance.

Finally, NIC (network interface card) performance also contributes to the mix. While we tested the EISA systems on the same cards, the Micro Channel machines (IBM's and NCR's) required other NICs. Most notably, NCR's 16-bit NIC limited the 3447's throughput on our Unix tests.

How They Did

Most of the servers performed similarly under NetWare. Message passing showed the most variation, with Acer's and ALR's systems generally performing best. However, some of the faster systems (the PowerPro and Premium SE 4/50) failed to complete this test when running with 12 clients. According to ALR, increasing message buffers under NetWare solves the problem, but we restricted each server to a common configuration. The NCR 3447 failed to complete the test even at four clients: NCR was examining the problem as we went to press.

On the I/O tests, all the servers show large increases in I/O processing when increasing the load from four to eight clients, and a smaller increase in throughput when the load is increased to 12 clients. This indicates that with a total load of 12 very active clients, some servers remain unsaturated. The random I/O tests show a virtual tie for top performance, although the NCR 3447 trailed the others by a noticeable margin. Ironically, the NCR 3447 easily bested the other systems on sequential I/O.

Unix I/O tests saturated most of the servers, which is indicated by declining performance curves. Compaq's Systempro/LT, with the high-performance IDA-2 array controller, was much faster than the rest of the systems on both Unix I/O tests.

continued

FEATURE COMPARISON — 486 SERVERS

Price and disk drive capacity are the two most critical points of comparison when looking at server characteristics that don't affect performance.

	AcerFrame 1000	ALR PowerPro	AST Premium SE 4/50	Compaq Systempro/LT	DECpc 450ST	Dell 450SE/2
Price^{1,2}	\$13,065	\$14,266	\$12,595	\$15,478	\$8249	\$6770
Processor/memory system						
Processor type	486DX	486DX/2	486DX	486DX/2	486DX	486DX/2
Processor speed (MHz)	50	50	50	50	50	50
RAM ¹ (MB)	16	17	16	16	16	16
Maximum RAM (MB)	128	205	80	256	192	128
External cache ¹ (KB)	256	256	256	512	0	128
Maximum external cache (KB)	256	512	256	512	128	128
Mass storage						
Total hard drive storage ¹ (MB)	1040	1070	1200	1360	1061	1352
Tested configuration	Two 520-MB drives	Two 535-MB drives	One 1.2-GB drive	Four 340-MB drives	One 852-MB drive, one 209-MB drive	One 1.4-GB drive
Total hard drive bays	Seven half-height	Nine half-height	Seven half-height	11 half-height	Five half-height	11 half-height
Hard drive interface	SCSI	SCSI	SCSI	Compaq IDA-2	SCSI	SCSI
Drive controller cache	4 MB	0	4 MB	4 MB	0	0
Floppy drive (MB)	1.44	1.44	1.44	1.44	1.44	1.44
Expansion bus						
Bus type	EISA	EISA	EISA	EISA	EISA	EISA
Number of slots	Eight	Eight	10	Seven	Six	Eight
Peripherals						
Video type	VGA	VGA	VGA	VGA	VGA	VGA
Serial ports	Two	Two	Two	Two	Two	Two
Parallel ports	One	One	One	One	One	One
Mouse port	Yes	Yes	Yes	Yes	Yes	Yes
Power supply capacity (W)						
	350	300	300	355	254	300
Operating systems						
NetWare version tested	NetWare 3.11	NetWare 3.11	NetWare 3.11	NetWare 3.11	NetWare 3.11	NetWare 3.11
Unix version tested	SCO Unix 3.2.4	SCO Unix 3.2.4	SCO Unix 3.2.4	SCO Unix 3.2.4	SCO Unix 3.2.4	SCO Unix 3.2.4
Novell-certified	Yes	Yes	No	Yes	Yes	Yes
Service/support						
Warranty	1 year	1 year	1 year	1 year	1 year	1 year
On-site service	Optional	Optional	Third-party	1 year	Optional	1 year

¹ As tested.

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Low Cost, but a Few Headaches

As we mentioned earlier, price was a key consideration for us in choosing servers. Of these machines, Gateway's was the least expensive, coming in at \$5174; the PS/2 Model 95 was by far the most expensive, at \$19,375. A few very good machines came in at under \$10,000, including the DECpc 450ST, the Dell 450SE/2, the Step 486DX2/50, Northgate's system, and Tangent's MultiServer.

Of course, factors like ease of configuration and expandability are also important in evaluating servers, and that information isn't always easily gleaned from feature tables. What follows is a summary of our experience with each of these machines. We have focused primarily on the problems we encountered while running each system.

Acer America AcerFrame 1000

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ALR PowerPro

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RAM ¹ (MB)	16	17	16	16	16	16
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Tested configuration	Two 520-MB drives	Two 535-MB drives	One 1.2-GB drive	Four 340-MB drives	One 852-MB drive, one 209-MB drive	One 1.4-GB drive
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Novell-certified	Yes	Yes	No	Yes	Yes	Yes
Service/support						
Warranty	1 year	1 year	1 year	1 year	1 year	1 year
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FAST 486 FILE SERVERS

FEATURE COMPARISON — 486 SERVERS

Everex Step 486DX2/50 EISA Tower	Gateway 50-MHz 486DX2 EISA	IBM PS/2 Model 95 XP 486	NCR 3447	Northgate 486 EISA DX2	Tangent MultiServer
\$9537	\$5174	\$19,375	\$10,660	\$6299	\$6980
486DX/2	486DX/2	486DX/2	486DX	486DX/2	486DX
50	50	50	50	50	50
16	16	16	16	16	16
64	64	64	192	128	128
256	64	0	128	128	256
256	64	0	128	256	256
1200	1040	1200	1340	1354	1352
One 1.2-GB drive	One 1.0-GB drive	Three 400-MB drives	Two 670-MB drives	One 1.2-GB drive	One 1.2-GB drive
Eight half-height SCSI	Six half-height SCSI	Seven half-height SCSI	12 half-height SCSI	Seven half-height SCSI	Six half-height SCSI
0	64 KB	512 KB	0	0	4 MB
1.44	1.44	1.44	1.44	1.44	1.44
EISA Six	EISA Eight	Micro Channel Eight	Micro Channel Seven	EISA Eight	EISA Eight
MDA	VGA	VGA	VGA	MDA	MDA
Two	Two	Two	Two	Two	Two
One	One	One	One	One	One
Yes	Yes	Yes	Yes	No	No
250	200	329	294	220	450
NetWare 3.11	NetWare 3.11	NetWare 3.11	NetWare 3.11	NetWare 3.11	NetWare 3.11
SCO Unix 3.2.4	SCO Unix 3.2.2	Not tested	AT&T Unix SVR4	SCO Unix 3.2.4	SCO Unix 3.2.2
No	No	Yes	Yes	No	No
1 year	1 year	1 year	1 year	1 year	1 year
1 year	1 year	Optional	Optional	1 year	1 year

four-disk arrays are available) are mounted in the bottom of the cabinet, adjacent to the SCSI controller. The back of the cabinet has two large cable restraints, which organize complex setups and relieve strain. However, the cutouts for accessing adapter connections in the back are too deep, making it tough to work with thin-net T-connectors.

We had no problems installing either NetWare or Unix. However, the Systempro/LT was the one server we tested that did not allow NetWare and Unix to reside on separate partitions on the same drive. Installing Unix on the Systempro/LT requires committing the entire drive.

DEC DECpc 450ST

The 450ST's cabinet was one of the smallest of the servers we've seen. It does not have wheels or handles, but its small size and low weight make it easy to move around. However, it's not very expandable, with only one internal and four external drive bays. We installed NetWare and Unix and ran our tests without problems.

Dell 450SE/2

The 450SE/2 has an excellent case. Of average size, it has wheels and hand-hold points on the front. Cards mount vertically; this places the adapter backplates on the top of the server instead of in the rear. This placement makes accessing the connectors much easier.

Installation of both NetWare and Unix was extremely smooth, and we had no difficulty running our tests.

If you're running
**Unix, the Compaq
Systempro/LT
is a top performer.**

Everex Step 486DX2/50 EISA Tower

NetWare and Unix worked well on the Step 486DX2/50, but as with other systems using Adaptec's SCSI host adapter, we encountered some minor problems reconfiguring the drivers when reinstalling NetWare. However, once we got through Adaptec's documentation, the server ran quite well.

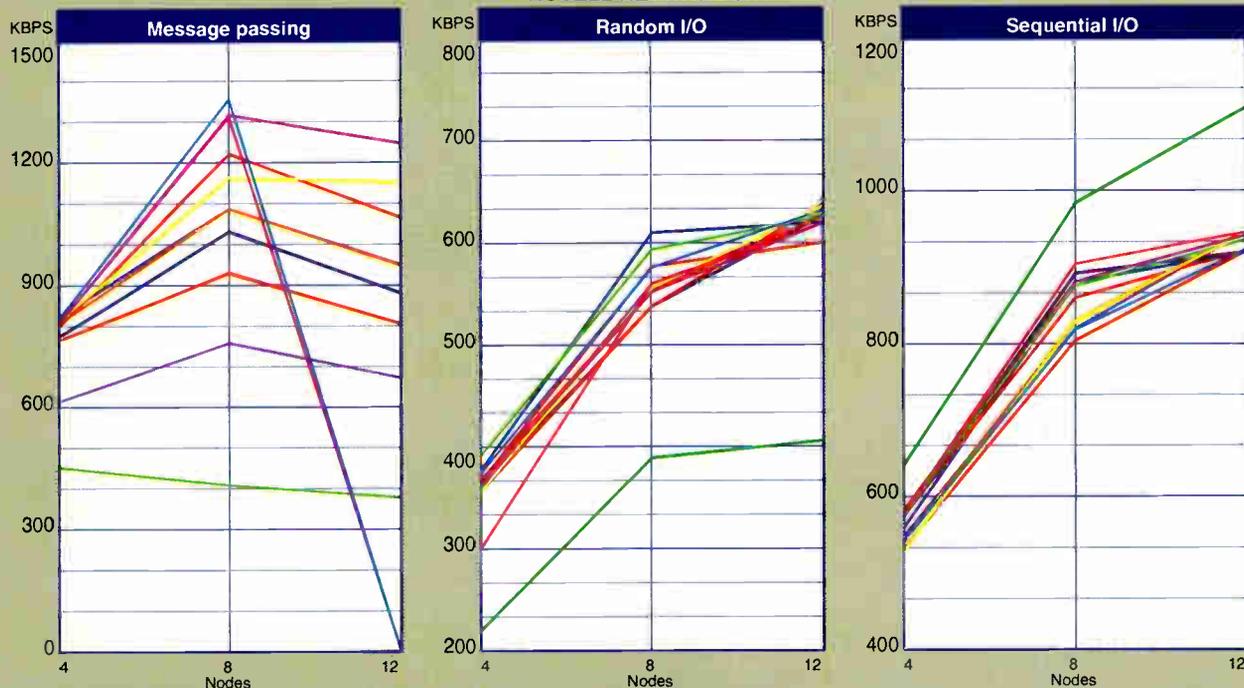
Gateway 2000 50-MHz 486DX2 EISA

We had trouble with Gateway's system running Unix. The difficulties were with Unix drivers for the drive controller. The drivers Gateway provided would not work with SCO Unix 3.2.4. We spoke to Gateway's technical-support people, but they appeared to be unaware of SCO's latest revision.

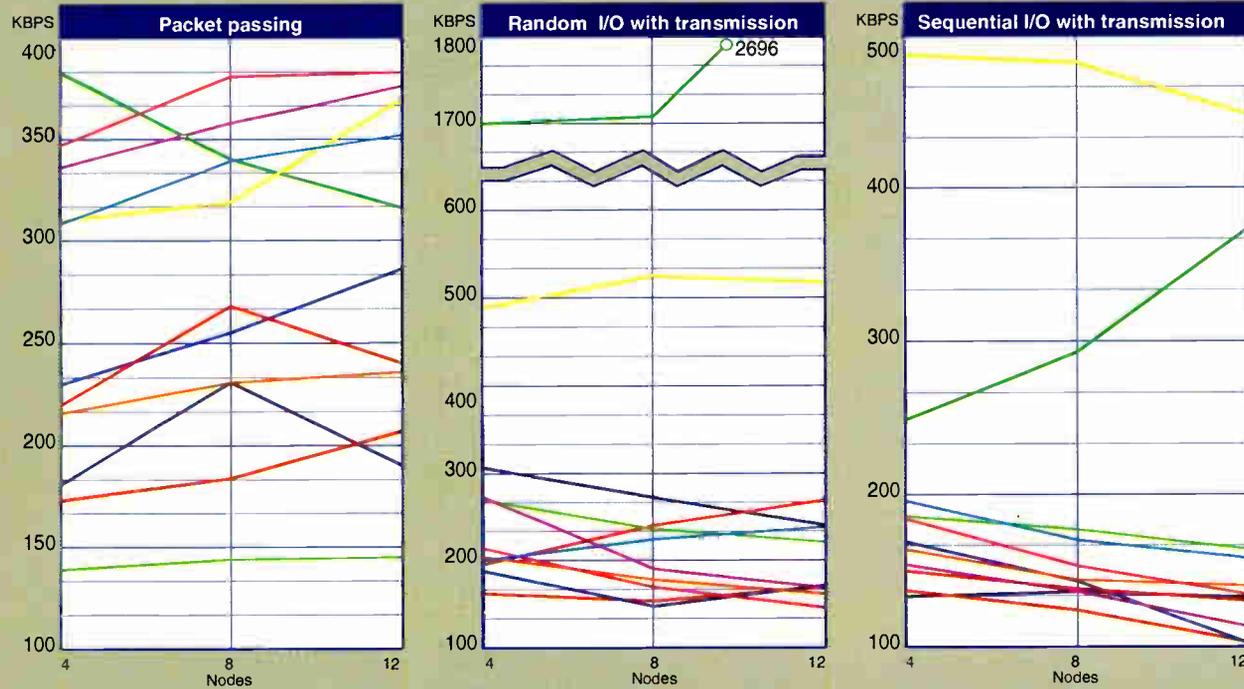
We reinstalled version 3.2.2 of SCO Unix and ran the disk drivers with the earlier release. Although the operating system then installed cleanly, an early test crashed the server. Upon rebooting, we discovered that the test data file system

BYTE NETWORK BENCHMARKS

NOVELL NETWORK 3.11

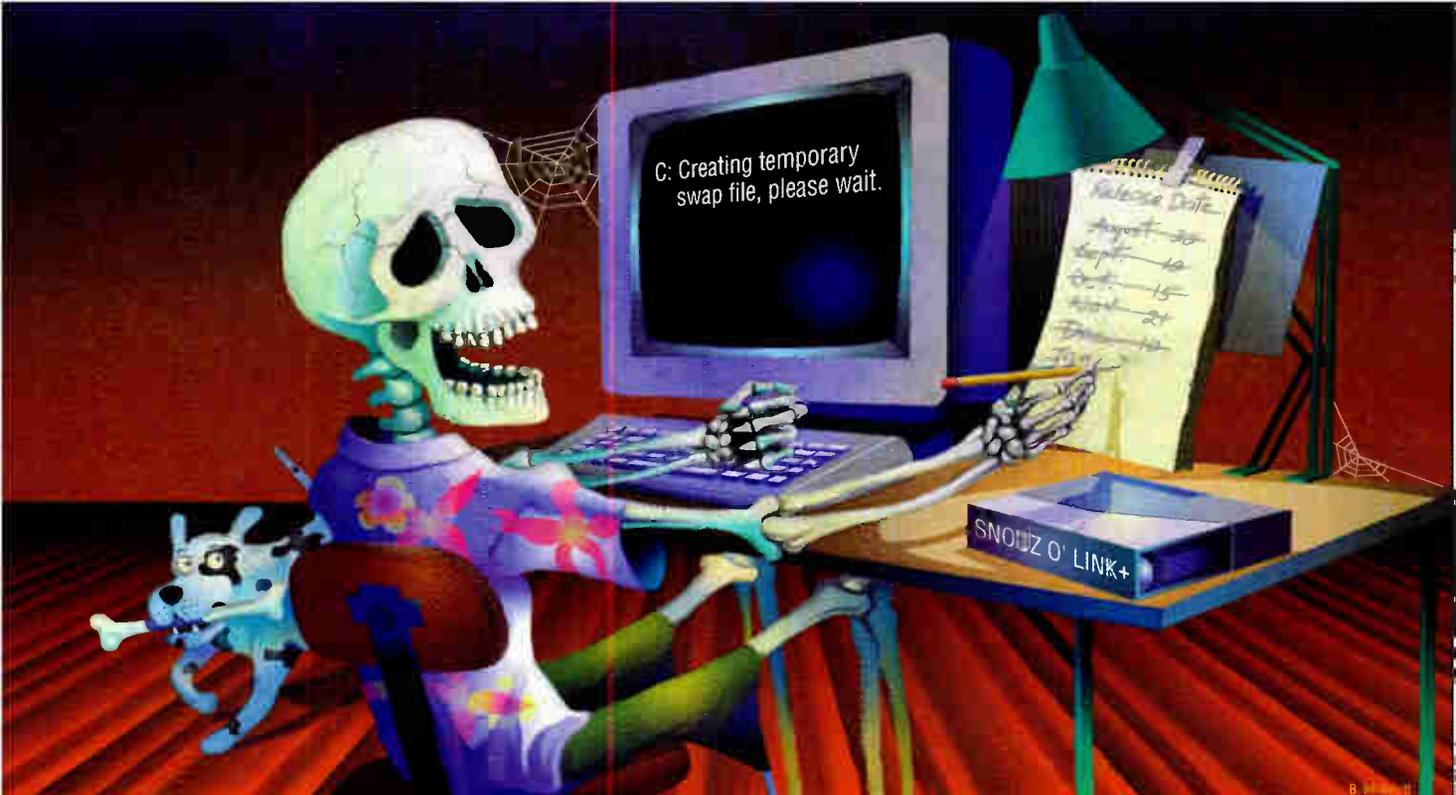


UNIX



- AcerFrame 1000
- Compaq Systempro/LT
- Everex Step 486DX2/50 EISA Tower
- NCR 3447
- ALR PowerPro
- DECpc 450ST
- Gateway 50-MHz 486DX2 EISA
- Northgate 486 EISA DX2
- AST Premium SE 4/50
- Dell 450SE/2
- IBM PS/2 Model 95 XP 486
- Tangent MultiServer

NetWare benchmark results show very similar performance among servers, regardless of price or configuration. Many of these servers remain unsaturated even with 12-client loads. UNIX benchmark results show that saturation occurs for most servers at less than 12 clients. On these tests, Compaq's Systempro/LT and NCR's 3447 turned in the best performance results.



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World Radio History

FAST 486 FILE SERVERS

had been completely corrupted and had to be rebuilt. We re-created it as a smaller (less than 300-MB) partition, and then all tests ran smoothly.

IBM PS/2 Model 95 XP 486

This server is compact and well designed. Modular construction of the major parts makes installation and removal of individual components quite easy.

DOS and NetWare came preinstalled on the system, as did two 3Com Micro

Channel 32-bit Ethernet cards. We easily completed all the NetWare benchmarks. Unfortunately, after completing the tests, the server started behaving erratically. Upon booting, we would receive the message "Processor card changed—00169." Sometimes, additional "Not OK—Call IBM" icons would also appear. In spite of repeated execution of the configuration utilities (including complete system tests), we couldn't completely eliminate this intermittent problem.

NCR 3447

At 29 inches, the 3447 doesn't fit under every table, but it is sturdily constructed, and it has ample room for additional devices, and wheels for easy transport. Our only real complaint about the chassis is its power interlock switch; you can't turn the system on with the case open. Although it's a nice safety feature, it effectively prevents debugging and testing of new hardware without jamming the switch open.

We installed and ran NetWare using two Cogent E/Master III 32-bit Micro Channel Ethernet interface cards. However, the actual tests proved more difficult to run on the 3447 than on any other server. Many of the benchmarks froze one or more clients, and we were unable to get the message-passing tests to run at all.

Northgate 486 EISA DX2

Northgate's machine presented problems running both NetWare and Unix. After we ran the EISA configuration utility and installed NetWare, the system failed to come up due to a "failed initialization of firmware." The system was particular about reconfiguration and occasionally lost configuration information when we attempted to modify other parts of the system.

Northgate didn't ship Unix drivers for the SCSI controller, so we called technical support. Ciprico, the host adapter's manufacturer, ended up shipping these drivers. After we completed the Unix installation, the Unix benchmarks crashed the operating system, destroying our data partition. This created a completely unrecoverable file system, and we needed to rebuild the entire Unix partition. After a few tries, we were able to run the benchmarks successfully.

Tangent MultiServer

Like Northgate's system, the MultiServer was finicky about the EISA slots used for the adapter cards, and we had to juggle them a bit to get the system running. However, once we got NetWare installed, the system ran without notable problems.

Drivers for the Mylex SCSI adapter for SCO Unix 3.2.4 have not been released, so we ran our Unix tests under SCO 3.2.2. We had no problems installing the operating system or device drivers, and, after installation, the tests ran quite smoothly.

The Best Servers

If you're running Unix, the Systempro/LT is an obvious top performer, followed by the NCR 3447. If you're running NetWare, performance choices are not that clear-cut, and you'll have to make a selection based on other criteria.

After working extensively with each of these servers, we'd select five systems as

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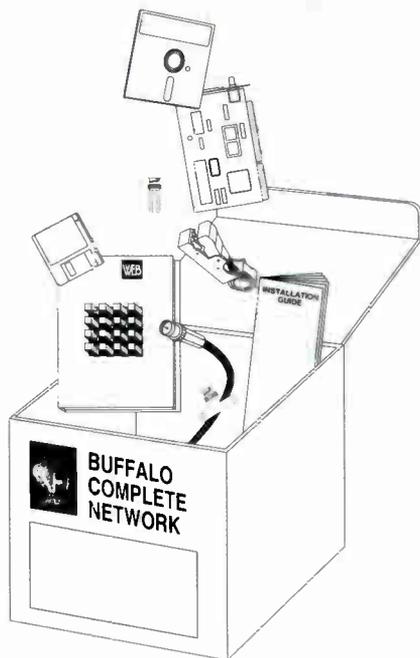


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World Radio History

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the most flexible, the most stable, and the easiest to install and maintain. Exclusive of performance, the Compaq Systempro/LT is the best, followed by the DECpc, the Dell 450SE/2, the Everex Step system, and the IBM PS/2 Model 95. Of course, price needs to enter into the process as well. DEC (yes, DEC), Dell, Northgate,

Tangent, and Gateway win on that basis.

Overall, we prefer the DEC, Dell, and Everex systems as NetWare servers. For Unix, we recommend the Compaq Systempro/LT and the NCR 3447 if they fit within your budget. If you need a less costly Unix server, check out the Tangent MultiServer. ■

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APPLICATION

CorelDraw 3.0: A Swiss Army Knife for Illustrators

G. ARMOUR VAN HORN

When I opened the CorelDraw 3.0 box, I almost expected a kitchen sink to fall out. The new release of one of the premier Windows illustration packages includes more than just a few new features. Corel has put together a bounty of fonts, clip art, and even complete stand-alone applications. In addition to the upgrade of the original illustration program, the visual catalog program Mosaic, and CorelTrace (see screen 1), CorelDraw 3.0 comes with an image-editing program (CorelPhoto-Paint), a charting module (CorelChart), and a slide-show application (CorelShow).

This release is an extremely powerful offering, marred occasionally by interface quirks and an insistence on doing things its own way. But, in the end, you get a remarkable value for \$595.

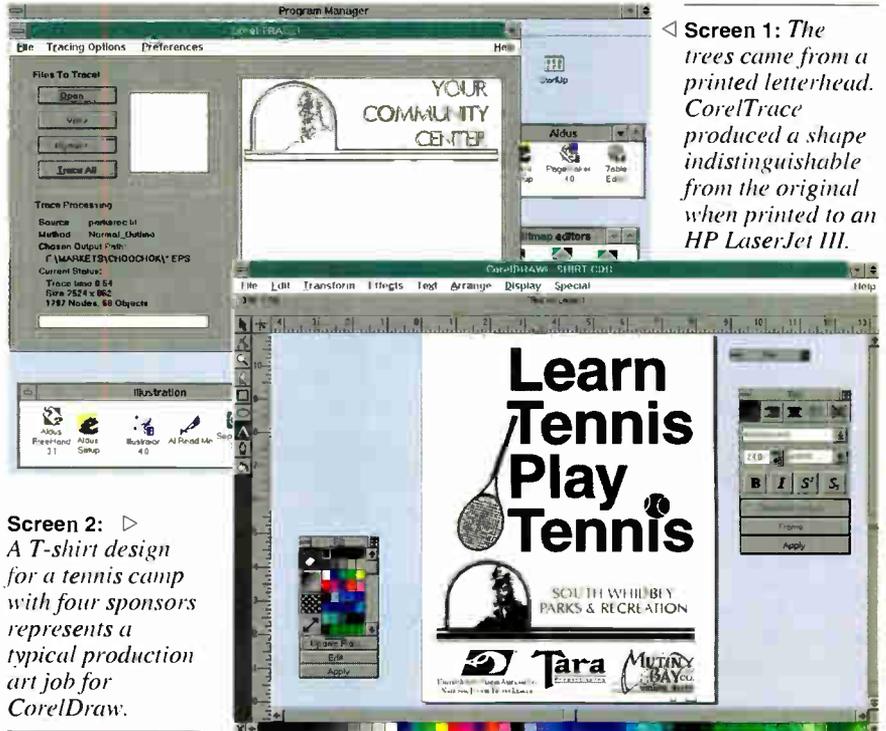
Look and Feel

I expect that the users of CorelDraw 3.0 will be businesspeople who want to use one of the high-end word processors now available under Windows and only one additional product. This version of CorelDraw adds enough features to support this audience.

The screen layout is comfortable for Windows users; the menu bar is across the top of the screen, the toolbox down the left, and a color palette across the bottom. A status bar immediately below the menu bar indicates most attributes of the current selection: its size, location, outline and fill, font, and what layer it is on. Optional rulers display across the top and left of the drawing area, and visible guidelines can be drawn out from the rulers.

The toolbox displays nine tools in a vertical array, but several of these have "fly-outs" with alternatives. For example, selecting the Freehand Pencil tool brings up options for both polyline and Bézier drawing, unless a bit map has been placed in the drawing and is currently selected, in which case the only option is the auto-trace tool. This approach keeps the screen free of clutter.

Corel introduces roll-up menus in this version, which brings additional power to the screen without taking up too much space. Each of the seven different roll-ups includes a variety of functions, such as line thickness, start and end arrows, line



Screen 1: The trees came from a printed letterhead. CorelTrace produced a shape indistinguishable from the original when printed to an HP LaserJet III.

Screen 2: A T-shirt design for a tennis camp with four sponsors represents a typical production art job for CorelDraw.

type, and colors on the Outline roll-up. A single click will reduce the floating palette to nothing more than the title bar and control box, making this probably the least intrusive use of floating palettes available.

Tools of the Trade

Corel continues to use two pointer tools. The Pick tool allows a selected object to be moved, stretched, or scaled; double-selected objects can be rotated or skewed. The Shape tool allows for manipulating points within objects, Bézier control handles, and the spacing within text blocks. Points are modified, joined, or deleted by double-selecting a point or points. Double-clicking on any of the points will call up the point-editing palette as close as possible to the mouse location.

The Zoom tool allows you to move in to inspect details by selecting the magnifier tool and dragging a marquee around the area of interest. This can be repeated indefinitely. My system—a National Designs Volante TIGA board and an NEC MultiSync 3 monitor—let me zoom to fill my screen with about 3/8 inch by 1 inch of my drawing. The Show All Objects option draws the screen at the highest magnification that fits all objects on-screen,

helping you find those intermediate or temporary objects that seem to end up around the perimeter of any drawing.

In previous versions of the program, you had to work in wireframe mode and switch to preview mode to view a drawing. CorelDraw 3.0 lets you edit directly from preview mode, although working in wireframe mode is much faster.

Fun with Fonts

The text tool has options for entering text or symbols. Text can be entered directly on-screen or through a dialog box; the trade-off is feedback versus speed. In general, 3.0 feels much snappier than earlier versions of the program, but sluggish performance is still a major problem when it comes to text redraws.

The symbol entry allows you to select from a wide variety of symbols that have been created by Corel: arrows, bullets, an artichoke from the food font, or a conference room table from the floorplan font. Corel recognizes the standard Windows Symbol character set in this dialog, as well as the Lucida Bright Math extensions from the Microsoft TrueType Font Pack. Procedures for creating additional symbol sets, as well as complete alphabets in either

TrueType or Adobe Type 1 formats, are clearly spelled out in the documentation.

Font support represents a major enhancement to the program. Previous versions required a proprietary font format. If you needed Garamond in illustrations and page layouts, you would require a complete set of fonts in WFN format for use in Corel and the same fonts in Adobe Type 1 or other format for use in other applications. Corel now recognizes Adobe format and TrueType as well as the WFN format.

Text-handling options include a spelling checker and thesaurus.

Features and Fillers

A clever feature for an illustration program is the Print Merge function, which allows merged data to assume all the text attributes of the field names placed in the original. Anyone responsible for issuing

certificates for corporate training programs is going to love this, except that the data file uses pairs of backslashes as separators instead of the more common comma-delimited format.

The Fill menu includes checkerboard fills, solid colors, fountain fills, and custom PostScript fills. Several PostScript fills are included with the program, with appropriate warnings that their use may slow or disable printing. The tool for positioning offset radial fills will be a major help to those who don't need such features every day, being much more intuitive than the clipping path or paste-inside process that other software demands.

The distortion options that Corel was known for in earlier versions remain essentially unchanged. The Perspective command allows you to generate 2-D art in a straightforward manner and distort it to simulate viewing from an angle other than directly in front of the art. I have used this feature to simulate the appearance of a sign on a building from the perspective of approaching vehicles.

Illustrations are automatically saved periodically, about every 10 minutes. I have come to depend on automatic saves in Microsoft Word for Windows, and I have lost enough illustration work over the years to appreciate the feature.

The Turn-Around Test

I used Corel to work on a typical production art job, in this case a T-shirt design for a tennis camp with four sponsors (see screen 2). As is typical in real-world illustration work, the art assignment came in with a couple of pieces of good clean art, several verbal suggestions, and a sketch on the back of an envelope.

The large text, racquet, and ball were submitted as a very clean stat (i.e., well-defined lines and no smudges or marks). I scanned the image and used CorelTrace to generate vector information. In the interest of speed, I replaced the text with Helvetica Bold, but I used the tracing output for the racquet and ball. Tracing the 312-KB TIFF file caused CorelTrace to crash with a General Protection failure. Corel technical support suggested that 5.8 MB of temporary file area might not be sufficient. It worked when 7 MB were available. The documentation claims that files up to 3000 by 3000 pixels can be processed by CorelTrace, but my experience suggests that this would take as much as 30 MB of temporary file space. The file was traced in a reasonable 50 seconds on a 20-MHz 386 with 8 MB of RAM.

The windswept trees came from a printed letterhead, and the black image was anything but solid. In this case, I used

CorelPhoto-Paint to eliminate voids in the black of the logo. Tracing with the auto-trace tool in CorelDraw was very disappointing, but a CorelTrace conversion of the file provided a shape that was indistinguishable from the original when printed to a Hewlett-Packard LaserJet III. After tracing, the lines were replaced by vector elements in CorelDraw.

The tennis logo in the lower left was supplied in very clean form, and the interior of the logo and the type both traced cleanly. The outside of the logo shape traced jaggedly, and I could discover no explanation. I drew a rectangle, round-cornered it, skewed it to the right, and then combined it with the internal elements from the trace. This gave me a perfectly shaped logo.

The Tara Properties logo I had previously done in Aldus FreeHand. I opened the original file, copied the logo, and pasted it into the SHIRT.CDR file easily.

Finally, the Mutiny Bay Co. logo was an EPS file on the Macintosh. CorelDraw imported the logo but displayed nothing. Switching to wireframe mode showed that the entire image had been imported successfully, but all fills and lines had been changed to white.

In the real world, artists don't give hours of careful attention to a single image. It just doesn't work that way. Most of us get a handful of scraps and a demand for a proof in a day's time. Corel's tools acquitted themselves very well in this situation, demonstrating quality images, ease of use, and good connections to other software.

Working Together

The other elements of the program are not particularly integrated with the main drawing program, a discovery that left me with mixed feelings. I would welcome anything that could make the separate elements work together more readily, but additional integration might make it more difficult to use other applications, such as PhotoStyler instead of CorelPhoto-Paint, for those who need the extra power. Each module works well enough with the others through the Clipboard, OLE facilities of Windows, and common file formats.

The other program elements don't share all of CorelDraw's interface features, but enough commonality is maintained that you won't get lost moving from one to another. The zoom tools in CorelChart and CorelPhoto-Paint are limited to preset magnifications, for example.

CorelChart includes the vast majority of charting tools that anyone could want, and it also imports data from ASCII text files, dBase data files, Lotus or Excel

BYTE ACTION SUMMARY

■ WHAT CORELDRAW 3.0 IS

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■ LIKES

It delivers advanced graphics tools at a price far below those of competing solutions, and it does a good job integrating with Windows and other graphics software.

■ DISLIKES

Text handling is slow; cannot open multiple files.

■ RECOMMENDATIONS

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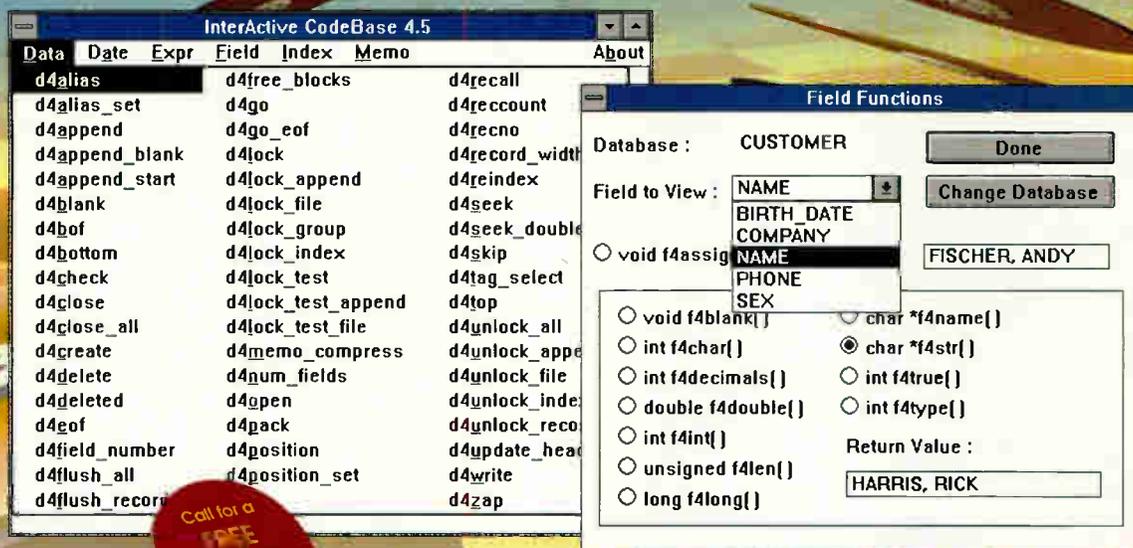
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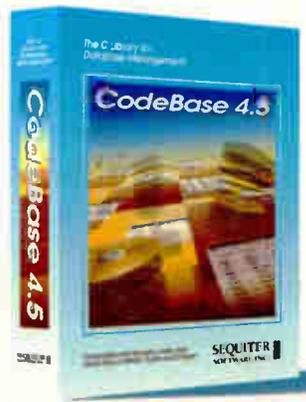
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spreadsheet files, and Harvard Graphics chart format. Eighty chart types are listed in the manual, including a vertical and horizontal bar, line and area charts, 3-D charts, pie charts, scatter charts, high-low-open-close, and histograms.

CorelPhoto-Paint is a repackaged version of ZSoft's PhotoFinish. It accepted all the bit maps I offered it, of both PC and Macintosh origin. CorelPhoto-Paint does the expected painting tasks with somewhat more grace than Windows Paint, offers useful photo-retouching tools, and easily did the bit-map touch-up, cropping, and resizing that I needed while working with CorelDraw and CorelTrace. There is no direct support for scanning.

CorelShow is an OLE client application that functions as an on-screen slide projector. It lets you use objects from any OLE server application, including CorelDraw, CorelChart, and CorelPhoto-Paint, as well as other programs such as Excel and Word. The only image-editing options are positioning and resizing; all other editing is done in the source application. CorelShow offers 22 transition effects, including cell dissolves, wipes, zooms, blinds, and curtain transitions. Corel is offering a run-

time module that will allow you to distribute slide shows without requiring CorelShow on the destination machine.

Mosaic is a catalog utility for graphics files and maintains thumbnail images of your illustrations, bit maps, and clip art. A little time storing your files will eliminate much time wasted opening several similarly named files when you're seeking one particular image.

Corel has taken a leading position in the use of CD-ROM drives on the PC, so it is no surprise that it has one of the first interfaces to Kodak's Photo CD product. Mosaic will display the images on the CD-ROM, and CorelPhoto-Paint will open them.

The All-in-One Alternative

Corel's installation procedure was smooth, filling about 30 MB of disk space from 10 high-density 3 1/2-inch disks. The installation instructions in the manual would be more helpful if the space requirements for various options were spelled out. A CD-ROM disk is included in all packages that includes the contents of the floppy disks as well as an additional 100 fonts and substantially more clip art.

Documentation consists of a single volume of about 800 pages, on-line help from all programs, a 54-minute VHS video tour of the software's features, and a poster that shows the included type faces.

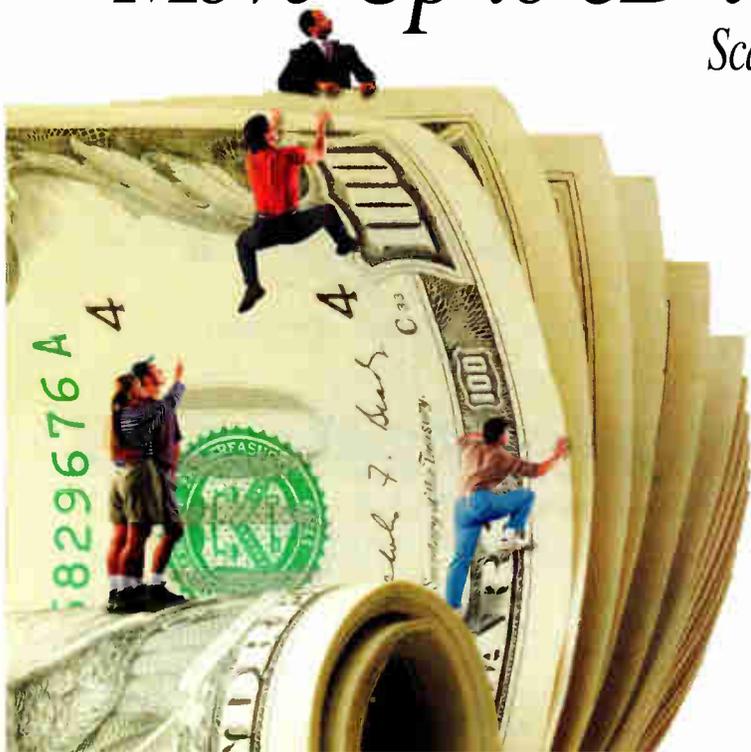
The largest remaining shortcoming for CorelDraw is its inability to open multiple files. While generating the sample artwork, I created three or four separate files, all of which would have been open at the same time if I had been working in either Adobe Illustrator or Aldus FreeHand.

Graphic arts professionals will probably continue to choose individual programs rather than the Corel collage. Experienced illustrators, in particular, will probably find no reason to switch from Illustrator or FreeHand. But corporate users will appreciate the ability to perform virtually all their graphics operations (other than page composition) in the Corel suite. A single purchase can cover a lot of needs. The total value is exceptional; no other single illustration package on the market today can match it. ■

G. Armour Van Horn is a writer and a graphics consultant. He can be reached on BIX as "vanhorn."

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HARDWARE

Compaq's Newest Notebooks

HOWARD EGLOWSTEIN

You could always count on Compaq for two things: high quality and high prices. It seems that nothing's sacred these days. Two new Compaq notebooks, the LTE Lite/25c and Contura 3/25, may change your expectations of Compaq products.

The LTE Lite/25c is a 6.5-pound notebook with a 25-MHz 386SL processor, an active-matrix color LCD, and a tiny trackball built into the display bezel; models start at \$4999. The Contura 3/25 is one of a redesigned family of portables with many of the same internals as LTE Lite notebooks, packed into a new case and bundled with a clamp-on trackball. The 25-MHz models start at \$2099. While the competition is largely lowering prices on existing models, Compaq is introducing new, lower-cost models—without sacrificing quality or performance.



The LTE Lite/25c (left) and Contura 3/25 offer very different styles and prices, but both provide solid performance and good quality.

LTE Lite/25c

With the power off, the 25-MHz 386SL-based LTE Lite/25c looks like any other member of the LTE Lite family: a short-throw keyboard, an off-white 8½- by 11-inch case, and a full complement of ports for external connections, including an external expansion bus. A more careful examination shows a tiny trackball nestled into the lower right corner of the display bezel.

Switching the system on starts the fun. After a short delay, the 256-color active-matrix LCD kicks in with breathtaking color. The 25c's display is so good, you might not want to plug in an external monitor when you get back to your desk. The 25c is inexpensive by active-matrix color standards (similar systems from Toshiba and NEC sell closer to \$6000), but it's still much more expensive than passive-color systems. However, compared to the 25c's screen, the displays of passive-color notebooks seem dull and lifeless.

The 25c also sets an impressive precedent in battery life for active-matrix systems. A color LCD's backlighting must be much brighter than that of monochrome LCDs, and it has three times as many elements to drive per pixel. The battery life of the 25c should be shorter than that of the monochrome LTE Lite; it was, but not by much. In the BYTE Lab's battery test, the LTE Lite/25c lasted 3 hours, 4 minutes.

The new Compaq notebooks include a save-to-disk feature called *hibernation*. When the batteries begin to get low or after a fixed interval, the Compaq machines take themselves out of standby, write all the relevant memory and state information to disk, and then kill the power.

My review unit came with 4 MB of RAM and an 84-MB hard drive for \$4999 (the 120-MB model is \$5399). The 25c also comes complete with Microsoft Windows installed in several languages.

When you're running Windows, you use a thumb-driven trackball near the screen hinge on the right side of the display to position the cursor. The mouse buttons are on the outside of the case, right under your fingertips as you grip the case to move the ball. Compaq's pointing-device solution is elegant and effective, as long as you're right-handed (which I'm not). I took the machine with me on a trip to New York, and it drew a lot of interest. After they finished lusting over the screen, most folks commented that the trackball was very usable, but a bit too small and too light. I'd have the trackball closer to the keyboard; it was distracting to have to remove my hand completely from the keyboard to position the cursor.

Contura 3/25

The Compaq Contura doesn't share the clean, stark lines of the LTE family. It is,

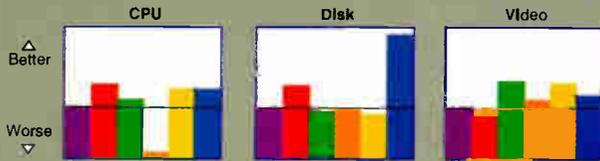
BYTE ACTION SUMMARY

- **WHAT COMPAQ NOTEBOOKS ARE**
The LTE Lite/25c is an active-matrix color notebook. The Contura is an inexpensive unit with a clamp-on trackball.
- **LIKES**
The LTE Lite/25c's excellent active-matrix color LCD; the Contura's competitive price.
- **DISLIKES**
The 25c's trackball is for right-handers; the Contura's trackball doesn't work left-handed.
- **RECOMMENDATIONS**
Both units are excellent choices.
- **PRICES (AS TESTED)**
LTE Lite/25c, \$4999
Contura 3/25, \$2099
- **FOR MORE INFORMATION**
Compaq Computer Corp.
P.O. Box 692000
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(800) 345-1518
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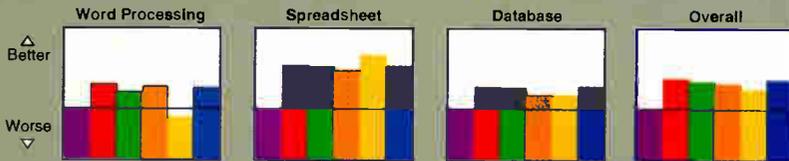
BYTE BENCHMARK RESULTS

Toshiba T2200SX Zenith Z-Note Compaq LTE/Lite Dell NL25 Compaq Contura Compaq LTE/Lite 25C

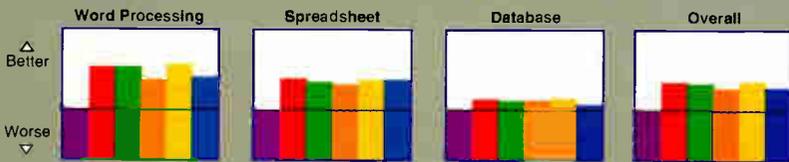
DOS LOW-LEVEL



DOS APPLICATIONS



WINDOWS APPLICATIONS



All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Toshiba T2200SX running DOS 5.0 and Windows 3.0 = 1.

The BYTE Lab's low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE Lab's low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

The BYTE Lab's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.0. We test three application categories for each environment, running test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 2.3 and Microsoft Excel 3.0a; and Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV. The data files and test scripts are available from the BYTE Lab.

BATTERY TEST

Zenith Z-Note Compaq LTE/Lite Dell NL25 Compaq Contura Compaq LTE/Lite 25C



The LTE Lite/25c and Contura 3/25 performed about the same, on the high end of the performance scale among 25-MHz 386SL machines. The battery-life test results of just over 3 hours are very solid and consistent with Compaq's claims.

instead, styled in dark gray with mauve accents, rounded edges, and strangely contoured keys. The Contura is a bit easier to cradle under your arm than an LTE. When you pick up an LTE Lite, you spend a second or two making sure you have a firm grip on it; not so with the Contura. The hinged side has a slight indentation where

your fingers land as you grab it.

The Contura is as solid as any Compaq I've ever seen. It comes in several models, starting with the 20-MHz Contura 3/20 Model 40, with a 40-MB hard drive, for \$1699. (My \$2099 review unit ran at 25 MHz and included a 60-MB drive.) The keyboard on each model has the same lay-

out as that of the LTE Lite family.

The Contura's cursor control is a Logitech Portable Trackman dressed in Contura gray. It mounts on either the right or left side of the case with a simple spring clip. If you mount it on the right, it partially blocks the floppy drive access slot. It will mount on the left, but the software refuses to remember that you've reversed button functions from Windows session to Windows session. It insists that the ball is right-handed unless you reset it each time you start up Windows. I ended up putting the Trackman back in the Contura's box and testing the machine with a Microsoft Ballpoint instead.

Compaq thoughtfully put unshifted PageUp and PageDown keys on the Contura, which makes text editing much easier. The keyboard action, layout, and excellent display proved to be an effective combination.

Powerful Portables

Both machines are powered by 25-MHz 386SL processors, and they turned in similar performances on the BYTE benchmarks. Neither machine had the optional 387SL math coprocessor installed. The benchmark figure tells the story, but suffice it to say that you won't be disappointed by these machines running Windows or any other task.

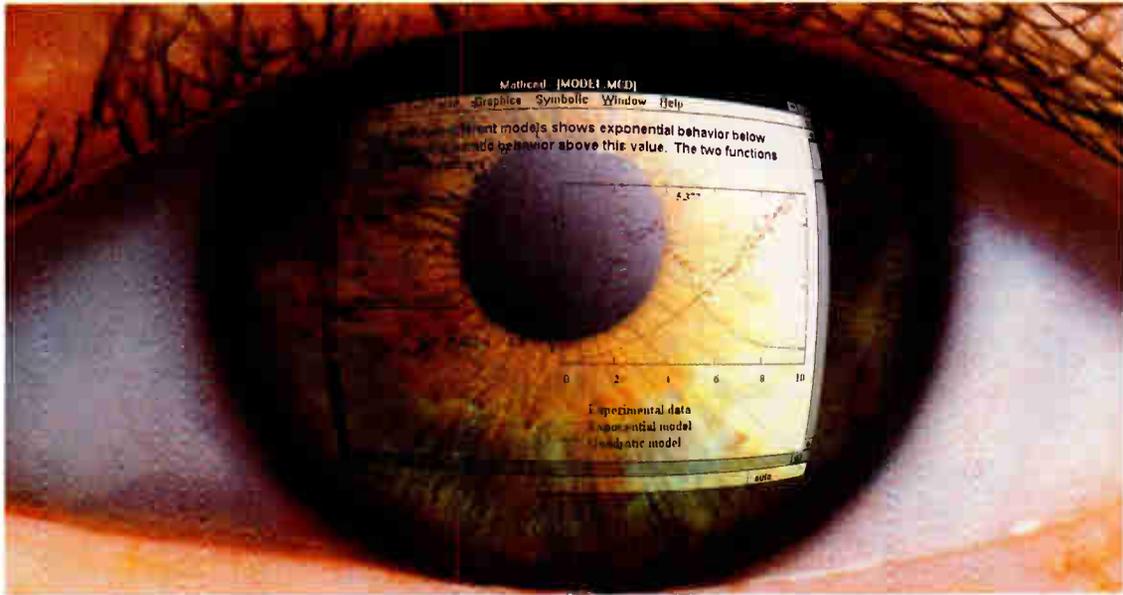
The Contura is almost a dead match in performance for Dell's NL25 notebook. In our battery tests, the NL25 beat out the Contura's 3 hours, 18 minutes by only 1 minute. Dell recently lowered the price of its NL25 to \$1798 for a configuration similar to that of the \$2099 Contura I tested. For just \$300 more, the Contura gives you a better keyboard and a sharper display.

These Compaqs are well built and compare favorably to their competition in performance, price, and features. I also applaud Compaq's new aggressive pricing strategy; the "old" Compaq would have priced the color unit out of reach of most buyers.

One criticism: If Compaq is going to continue to bundle in Windows, I wish it would think of us left-handers when building pointing devices. The LTE Lite/25c's trackball is excellent, but it's impossible to use left-handed. The Contura's trackball software simply does not work in left-handed mode. When it comes to the new pointing devices, Compaq may have dropped the ball, but it has finally learned how to make and price notebooks. These two are definitely winners. ■

Howard Eglowstein is a testing editor for the BYTE Lab. You can reach him on BIX as "heglowstein."

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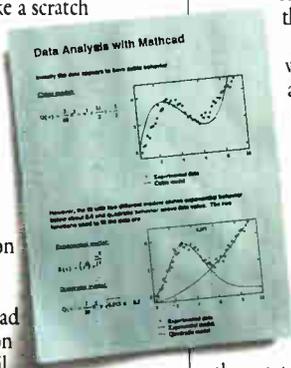
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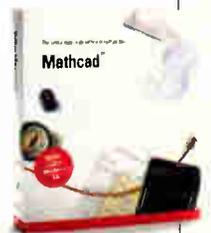
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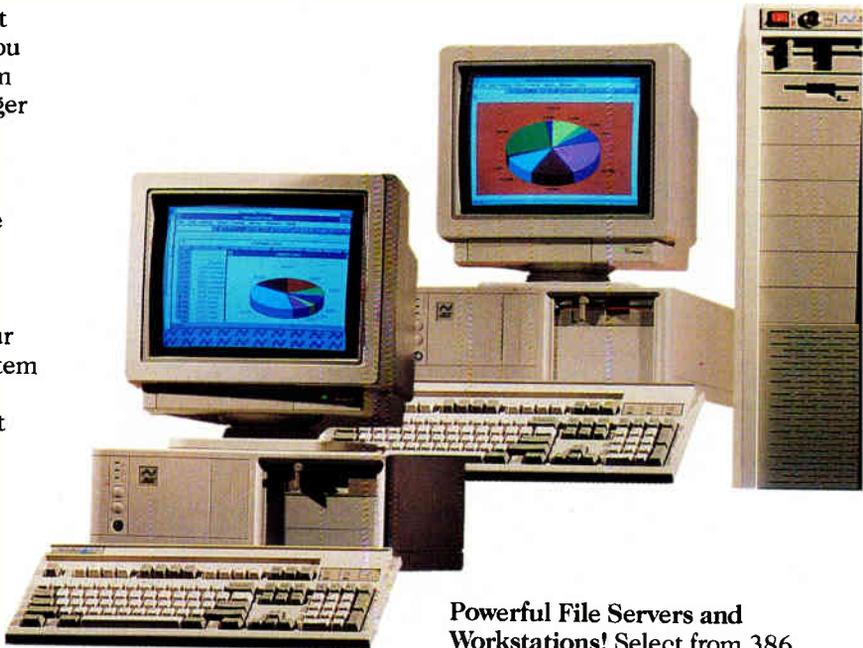
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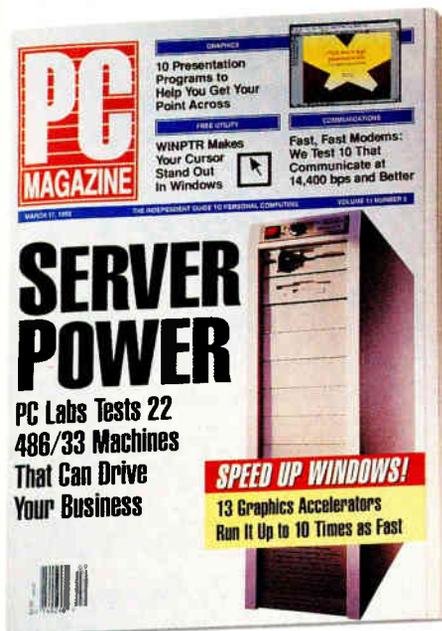
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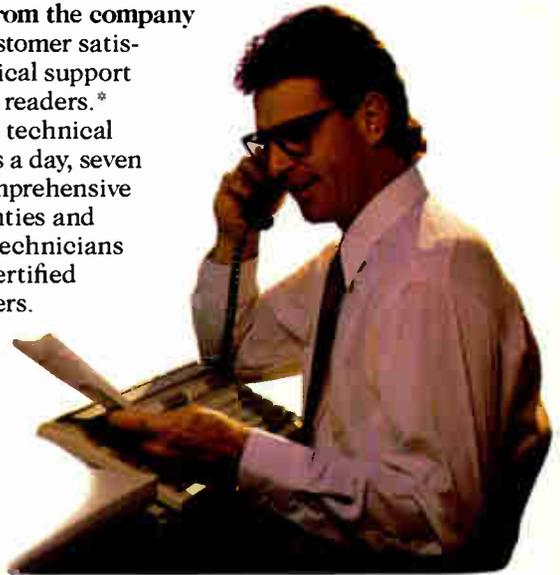
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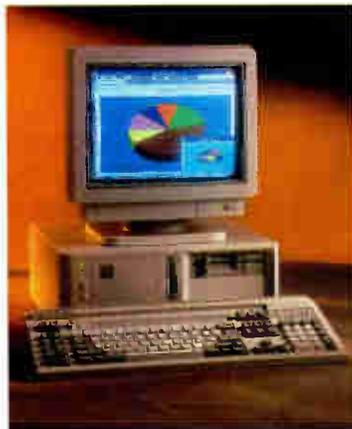
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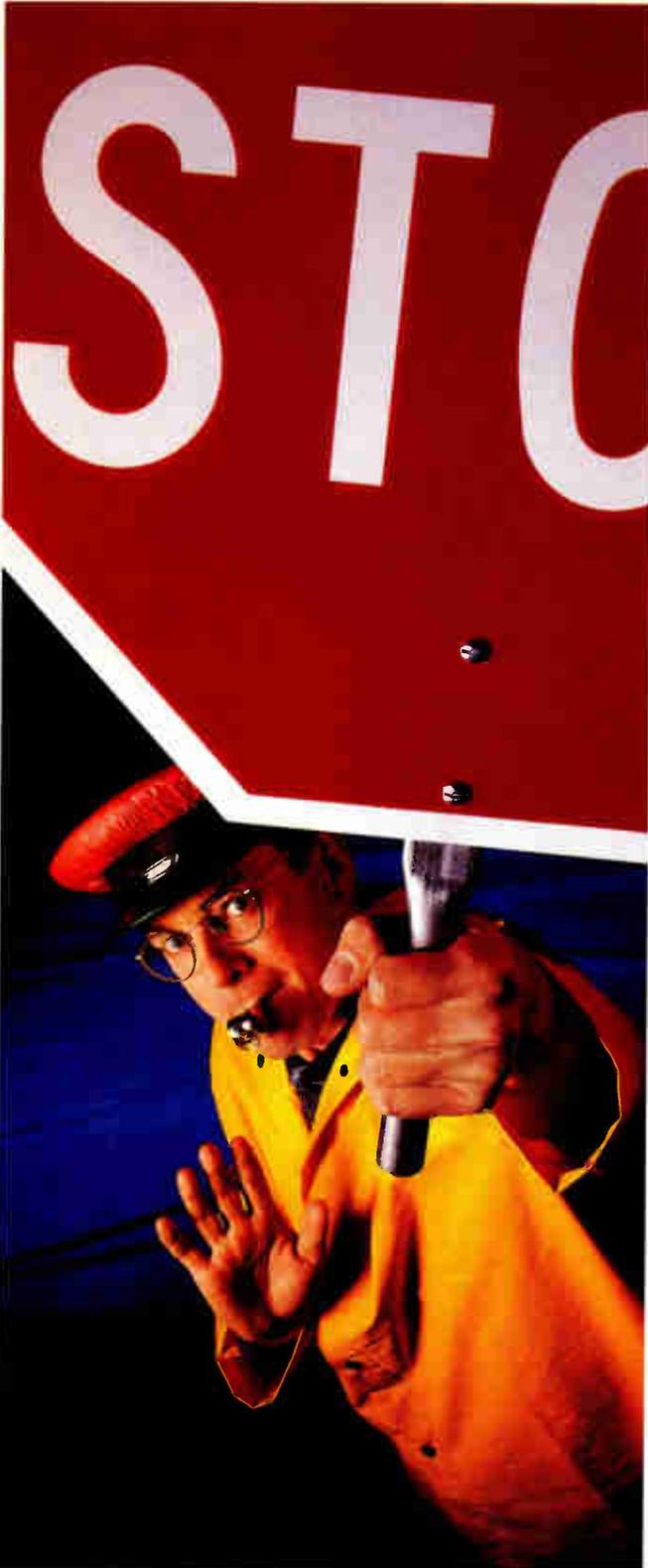
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HARDWARE

Color Ink-Jet Printers Take Whacks at Wax

HOWARD EGLOWSTEIN

You're looking for a color printer. Quality printing and good solid colors require a laser printer, right? The only technology available for a reasonable price is wax transfer, right? Not necessarily. The Canon CJ10 and Hewlett-Packard PaintJet XL300 color ink-jet printers are ready and willing to make your desk a brighter place to work.

Canon CJ10

If the CJ10 were simply a 400-dot-per-inch color ink-jet printer, that would be reason enough to take a look at it. The CJ10 incorporates both a four-color printer using Canon's color Bubble-Jet technology and a letter-size color 24-bit scanner into a single, compact desktop unit. The base price of \$6995 gives you a color copier; add another \$2700 for the optional IPU (image processing unit) and you get a complete graphics workstation. The IPU connects to your DOS/Windows machine or your Mac and provides both color output and scanner services for most applications.

The scanner portion of the CJ10 is an interesting variation on the conventional flatbed scanner. A single optical head picks up 256 bits each of red, green, and blue as it makes horizontal swipes across the width of the page. After each swipe, it moves down the page and repeats the process. Although it picks up all three colors in a single swipe, it's not really a single-pass scanner in the conventional sense. Scanning a full page takes about a minute and a half—about average for color scanners these days. The CJ10's printer uses Canon's BC-40 400-dpi print head and specially coated paper. The paper has a surface that enhances the brilliance of the ink—short grain to prevent wicking (or smearing) and a coated back to keep the ink from soaking through the paper. It's quiet, too: I tested the CJ10 on a large 486 system, and the printer made less noise than the computer's cooling fan.

You connect the CJ10 and IPU to your PC or Mac with one of two installation kits. The PC kit comes with an Adaptec SCSI board, Windows drivers, and a special edition of Aldus's PhotoStyler. The drivers allow any Windows application to access the CJ10 as a native Windows printer. It's not PostScript, so to get beautiful-



Two new offerings from the biggest names in ink-jet technology. The HP PaintJet XL300 (left) is the latest in the PaintJet family and replaces several other PaintJet models for Mac, PC, and Unix platforms. The Canon CJ10 (right) combines a color copier, a 400-dpi color printer, and a color scanner into a single desktop unit.

BYTE ACTION SUMMARY

WHAT THESE PRINTERS ARE

The Hewlett-Packard PaintJet XL300 is a 300-dpi color ink-jet printer. The Canon CJ10 combines a color copier, a 400-dpi color printer, and a color scanner into a single desktop unit.

LIKES

Both printers produce crisp, bright color output. The CJ10 multifunction solution is incredibly convenient.

DISLIKES

Neither is suitable as a color proofing device.

RECOMMENDATIONS

The XL300 is a good choice for network applications to complement existing laser printers. The CJ10 is a superb bit-map printer.

PRICE

Canon CJ10 copier, \$6995; IPU interface with 2 MB of RAM, \$2700; IPU interface with 16 MB of RAM, \$5500
 HP PaintJet XL300: with 2 MB of RAM, \$3495; with PostScript Level 2 and 6 MB of RAM, \$4995; 4-MB memory upgrade, \$599

FOR MORE INFORMATION

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ly formed characters on the page, you will want Adobe Type Manager or something similar. The Mac drivers install as a Quick-Draw printer; you'll need ATM on the Mac as well for text output. A CJ10 networking utility lets you share the CJ10 with other AppleTalk users.

HP PaintJet XL300

Imagine a 300-dpi LaserJet that prints in full 24-bit color, uses ink-jet cartridges, prints 11- by 17-inch pages (with an optional paper cartridge), and takes up a lot of desk space. The HP PaintJet XL300 is the latest in the PaintJet family and



The Canon CJ10 output (left) is sharp and clear; the special Canon paper makes the colors virtually leap off the page. The HP XL300 output (right) doesn't have the banding problem of the CJ10, but its colors tend to be a bit murky compared to those of the Canon output.

replaces several other PaintJet models for Mac, PC, and Unix platforms.

The PaintJet thinks it's a LaserJet in many ways. It handles the color version of HP's PCL 5 printer control language, it uses the same memory and network interface cards as the HP LaserJet III, it offers built-in PostScript Level 2, and it can use the same drivers as the LaserJet for monochrome applications.

The innards are very similar to the older PaintJet models. A scanning head with four colored print heads scans back and forth over the page. On both sides of the paper, heating elements dry the ink before the page leaves the printer. The XL300 will take standard copier paper, specially coated PaintJet paper, transparencies, or "glossy paper," which is a lot like plastic transparency sheets, only opaque.

PCL 5 automatically includes a variety of scalable outline fonts and HP plotter emulation using HPGL/2. The included drivers support Windows, Macintosh, and selected DOS applications. If your application isn't supported, the XL300 will take output from any application that can talk to a LaserJet III or PaintJet printer or an HPGL/2 plotter.

Color, Color Everywhere

HP is positioning its printer as a natural addition to offices that already use laser printers. Canon is targeting businesses that

could not previously afford color output. I immediately positioned both on my desk, connected them to my 486 machine, and tried them out with a variety of software packages. On both printers, I ran some samples from CorelDraw 3.0 to see how the printers handled graphics and spreadsheet-type applications. The CJ10 couldn't reproduce some of the subtle shading the XL300 could, and the XL300 did a better job of matching the screen colors.

I used Canon's Windows drivers to link the CJ10's scanner to PhotoStyler and made several test scans. The images were very consistent, although a bit contrasty and heavy in the red-orange area. I expected the horizontal scanning technique to show some banding in the scan, but it didn't. As you might expect, printing something scanned on the CJ10 worked well. The printer tends to print with the opposite color skew of the scanner, resulting in near-perfect output. The special Canon paper makes the colors virtually leap off the page. The printer prints in bands, and the bands overlap slightly, leaving subtle lines across the page.

To test the XL300, I scanned the same images with an Epson ES-300C and printed them using PhotoStyler. The XL300 doesn't have the banding problem of the CJ10, and its colors tend to be a bit dark and murky compared to the CJ10 (see the print samples). Its output looks fine—no,

better than that—but not quite as stunning as the CJ10 output. The only problem was memory. Printing a full 8½- by 11-inch image requires a 4-MB upgrade to the base 2-MB model. I had only enough to print an area about 3½ by 5 inches. To print a full 11- by 17-inch page requires an 8-MB upgrade.

You wouldn't have to ask me twice to put either printer on my desk. The XL300 is an easy fit for network applications to complement existing laser printers or to replace pen plotters in some applications. I wouldn't want one as a color proofing device for color bit-map work, though.

The XL300 does the best job of printing area graphics of any printer the BYTE Lab has tested. I'd opt for extra memory and the PostScript option, though. The CJ10 is a superb bit-map printer, and having the scanner integrated into a single unit is incredibly convenient. While the color isn't perfect, it's less dithery than with wax-transfer printers, and the overall effect is more breathtaking than anything I've seen from other printers in the same price range.

Either way, you can have my LaserJet Series II. After working with these two printers for a few weeks, I find black-and-white output to be quite boring. ■

Howard Eglowstein is a testing editor for the BYTE Lab. You can reach him on BIX as "heglowstein."

HARDWARE

DGX Takes the Direct Approach to Graphics Performance

JAKE RICHTER

Back at last fall's Comdex, Dell gave everyone a taste of what local-bus technology could accomplish. The project was code-named JAWS, and it made an impressive demonstration. This summer, JAWS grew into a real product—the Dell PowerLine 450DE/2 DGX (for Direct-Coupled Graphics Xccelerator).

The PowerLine DGX is similar to the PowerLine 450DE/2 that BYTE reviewed in July ("Dueling DX/2s: The First 486 Clock Doublers"); both are desktop systems based on Intel's 50-MHz 486DX2. The PowerLine DGX sells for \$4399 and comes in a configuration similar to that of the standard PowerLines: 8 MB of RAM, a 120-MB hard drive, and a 16-inch monitor. Like other PowerLine systems, the PowerLine DGX also includes a Tseng ET-4000-based Super VGA on the motherboard. But the DGX version includes a completely redesigned CPU card that speeds graphics processing by adding a second complete graphics system wired directly to the CPU bus.

Heart of DGX

The DGX controller card includes both the system's 486DX2 CPU and the local-bus graphics controller. By integrating these onto the same board, Dell was able to directly connect the display frame buffer to the CPU, thereby achieving data transfer rates close to those of regular system memory. This is the basic design of a local-bus system.

The DGX graphics system, with its 2 MB of video RAM, sports two modes: a pass-through mode, in which the display data generated by the built-in VGA is displayed on the monitor connected to the DGX controller; and a native mode, in which software that knows how to directly control the DGX graphics device can take over the display for improved performance.

The DGX controller supports an impressive range of resolutions and color depths in native mode, including 1024- by 768-pixel and 1152- by 900-pixel displays with 16-bit color, and 1280 by 1024 pixels with 256 colors. DGX also supports high vertical-refresh frequency modes (70 Hz at



The PowerLine 450DE/2 DGX delivers fast, high-resolution, 16-bit graphics, but it requires driver support for each application or environment.

BYTE ACTION SUMMARY

- **WHAT THE DELL POWERLINE 450DE/2 DGX IS**
A 486DX2/50 with a proprietary local-bus scheme for fast graphics.
- **LIKES**
Windows and AutoCAD graphics performance is outstanding; there is a wide variety of drivers for many environments.
- **DISLIKES**
DGX-specific drivers are required for local-bus operation.
- **RECOMMENDATIONS**
DGX is a good choice for supported environments.
- **PRICE**
\$4399
- **FOR MORE INFORMATION**
Dell Computer Corp.
9505 Arboretum Blvd.
Austin, TX 78759
(800) 426-5150
(512) 338-4400
fax: (512) 338-8421
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1024 by 768 pixels and 72 Hz at lower resolutions).

While DGX is touted as a graphics accelerator, it's really just a better frame-buffer controller. DGX doesn't have the special hardware commonly associated

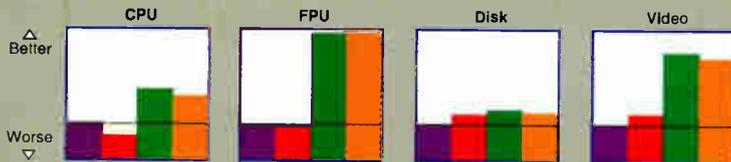
with graphics accelerators; it just delivers greater data transfer bandwidth. However, DGX includes a hardware cursor. This is extremely useful in windowing environments, since software doesn't have to continually disable and enable the cursor while

DGX TAKES THE DIRECT APPROACH TO GRAPHICS PERFORMANCE

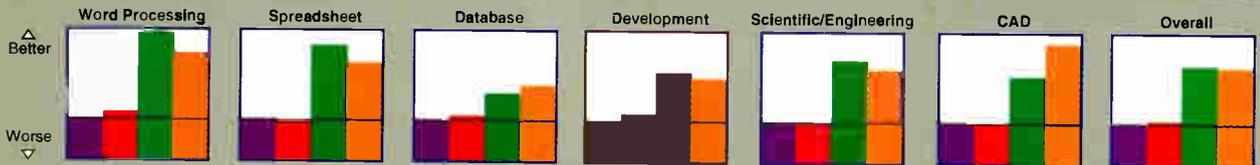
BYTE BENCHMARK RESULTS

■ Compaq Deskpro 386/33L
 ■ NEC PowerMate 386/33i
 ■ Compaq Deskpro 486/50L
 ■ Dell PowerLine 450DE/2 DGX
 ■ Sun Sparcstation IPC

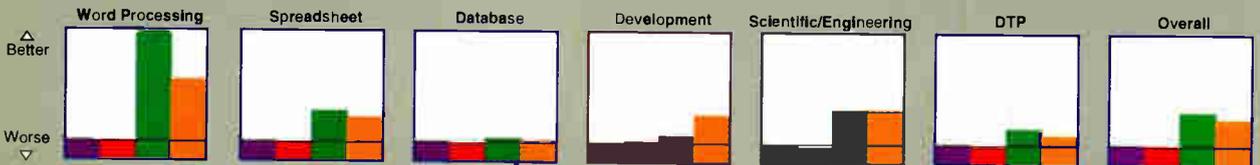
DOS LOW-LEVEL



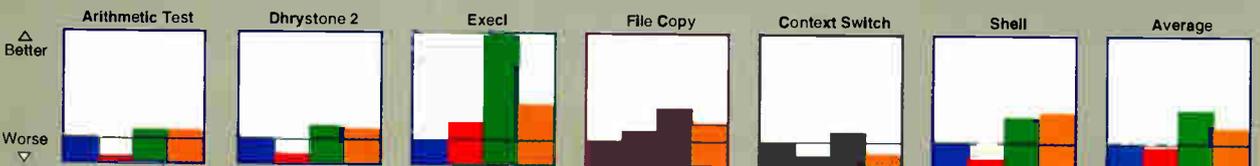
DOS APPLICATIONS



WINDOWS APPLICATIONS



UNIX



All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 = 1. For each index in the Unix tests, a Sun Sparcstation IPC = 1. The overall index is the average index of the individual tests.

The BYTE Lab's low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE Lab's low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

The BYTE Lab's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test un-

der two environments: DOS 5.0 and Windows 3.0. We test six application categories for each environment, running test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 3.1+ and Microsoft Excel 3.0a; Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV; Development: Borland Turbo Pascal for Windows and Microsoft C 6.0; Scientific/Engineering: MathSoft Mathcad for Windows 3.0, The MathWorks MatLab 3.5k, and Computing Resource Center Biturbo Stata 2.1; CAD: Autodesk AutoCAD release 11; and Desktop Publishing: Aldus PageMaker 4.0. The data files and test scripts are available from BYTE.

Our Unix tests show relative performance for double-precision arithmetic, the Dhystone 2 benchmark, spawning a process (execl()), file copy throughput, pipe-based context switching, and running a shell script with eight concurrent scripts running. Unix benchmarks are available on Usenet, from Demolink, in the listings area on BIX, or on disk.

The benchmarks show best performance under Windows and AutoCAD, two environments supported by DGX drivers; other benchmarks are run on the PowerLine's standard VGA hardware. Note that the Windows benchmarks are run in 256-color mode on the PowerLine and 16-color mode on the baseline Deskpro 386/33L and other comparison systems.

drawing near it. A hardware cursor is also more pleasing aesthetically, since it doesn't flicker.

From a programming perspective, the DGX graphics subsystem is designed primarily for protected-mode access. While

it's technically possible to access the DGX frame buffer from a real-mode program, it's probably more of a hassle than it's worth. The DGX frame buffer can be mapped into one of three locations in the PC's address space as one contiguous 4-

MB block. This simplifies graphics programming, since there is no tedious bank switching involved—a process that dominates all real-mode Super VGA graphics programming and applications. This DMA, combined with well-written driver

software, can give DGX native-mode graphics a really substantial performance boost.

Some Drawbacks

There are two drawbacks to DGX's architecture. First and foremost, you won't see any acceleration with DGX unless you're using an environment or application supported by a DGX driver; this is a restriction not imposed on most local-bus designs. Without a DGX driver, the system will

run from the Super VGA on the motherboard at normal VGA speeds. The PowerLine DGX ships with drivers for Windows, AutoCAD, X Window System, AutoShade, 3D Studio, Animator Pro, CAD-Key, and Intergraph MicroStation. Dell also plans drivers for NextStep, Windows NT, Open Desktop, and Solaris.

The other drawback (of limited concern to most users, but of real concern to developers) is that the technical documentation for DGX is difficult to obtain; and

when you finally get it, you'll find it disappointingly sparse.

How Much Faster?

The BYTE Lab's standard benchmark suite (see the figure) gives a good measure of overall performance, but the Windows application results may be misleading. The Lab tested the baseline system, which provides the basis for the performance indexes, with Windows in 640- by 480-pixel by 16-color mode. At a minimum, Dell's DGX drivers support 256 colors at that resolution. Thus, the benchmark results compare the DGX system with 8-bit color against the baseline and comparison machines with 4-bit color. That the DGX system compares closely, at twice the color depth, with a full 50-MHz Deskpro indicates its speed under Windows.

I wanted to determine more precisely the speed of graphics operations with and without DGX. I compared the memory-to-screen performance of the DGX under Windows to that of an optimized Windows driver running on the built-in Super VGA at the same resolution. The DGX achieved a data transfer rate of 15.4 million pixels per second, compared to 4.5 million pixels per second for the Super VGA. Overall, DGX performed about three times as fast as the built-in Super VGA.

In a few areas, though, the Windows performance of the built-in Super VGA exceeded that of the DGX. This can probably be attributed to the (still beta, at this writing) DGX Windows driver not being quite as optimized as it could be.

Benchmarks aside, the Dell DGX system simply flies when running AutoCAD and Windows. The performance difference between non-DGX and DGX operation is extremely noticeable, which is great if you use graphics applications supported by DGX drivers.

If all you use are text applications, or graphics applications not supported by DGX-specific drivers, then getting a DGX-based system would be wasteful. Also, to upgrade the DGX to a faster graphics solution, should one come along, you'll need to swap entire processor cards.

On the other hand, if you are simply interested in speed and you're looking for an extremely fast Windows or AutoCAD system right now, take a serious look at the PowerLine 450DE/2 DGX. ■

Jake Richter is the chief technologist at Panacea, Inc., a graphics driver development and publishing company. You can reach him on BIX as "jrichter," on CompuServe at 75130.2705, on MCI Mail at 351-5206, and on America On-Line as PanacJake.

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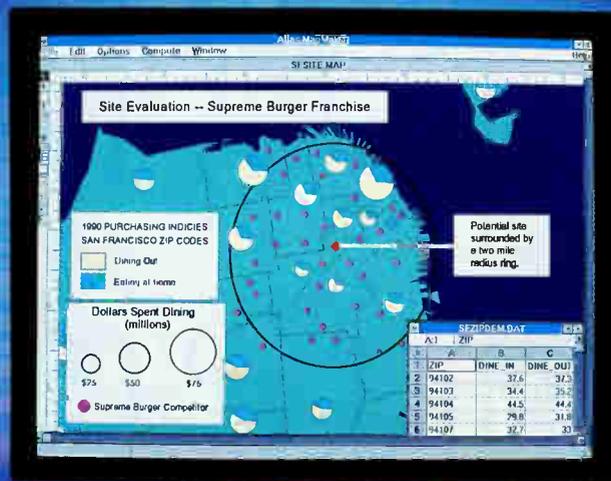
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World Radio History

SYSTEM AND HARDWARE

Racing at 33 MHz: Quadra 950 and Radius Rocket 33

TOM THOMPSON

The Mac community hardly had a chance to catch its breath after Apple redefined high-performance late last year with its Quadra line. This summer, Apple unveiled its Quadra 950. Like the Quadra 900, the new machine is a tower design, but the 950's 68040 processor runs at 33 MHz, and the new system comes standard with 8 MB of RAM. The result is a claimed 30 percent boost in CPU processing power over the 900.

But there's more than one way to put together a 33-MHz 68040-based Mac. The Radius Rocket 33 is a 33-MHz, 68040-based accelerator board that brings this new level of performance to the Mac II, IIx, IIcx, and IICI.

A New Hot Rod

The Quadra 950 is essentially a Quadra 900 chassis with a new main logic board. This design strategy let Apple turn out the Quadra 950 in a short time, and it also provides an upgrade path for Quadra 900 owners. Until the end of the year, Quadra 900 owners can upgrade to a Quadra 950 for \$1499 and a board swap.

There are significant additions to the new logic board besides the faster CPU. First, Apple boosted the I/O bus clock speed from 15.67 MHz to 24.28 MHz. This reduces I/O latency to all I/O devices (e.g., serial, video, and SCSI) connected to the bus. Also, the 950's faster 25-MHz Ethernet controller chip provides faster network throughput.

The Quadra 950's built-in video circuitry uses a different DAC (D/A converter) and video controller ASIC (application-specific IC) than the Quadra 900's. These changes supply two new features: First, the built-in video now supports a 16-bit pixel depth, which displays 32,768 colors (32-Bit QuickDraw uses 1 bit as an alpha channel, so only 15 bits in the pixel contain actual color information).

Second, the 950 handles a new display size of 1024 by 768 pixels. The 950 includes modified ROM code to support the



Two alternatives for Mac computing at the highest level: Apple's new Quadra 950 sets the standard, while Radius's Rocket 33 accelerator board can give Quadra-class performance to older Macs.

new pixel depth and display size. With 2 MB of VRAM (video RAM), the Quadra 950 can provide 16-bit-deep screens on all monitors up to 21 inches (1152 by 870 pixels) in size. Because of the faster processor bus, VRAM SIMMs rated with an 80-nanosecond access time are required; you can't get away with using 100-ns VRAM like you could on the Quadra 700 and 900.

The Rocket 33 Remedy

If you own an older modular Mac, Radius has a plug-in accelerator board that supplies roughly the same processing power as a Quadra 950 without requiring that you junk your hardware investment.

The Radius Rocket 33 (\$2499) is a 33-MHz, 68040-based accelerator board that manages up to 128 MB of RAM. The Rocket 33's design is elegant: a NuBus

board and some software, with no scary hacking of logic board traces or yanking of chips required for installation. Just transfer the SIMM RAM (80-ns or better required) from the main logic board to the Rocket's eight SIMM sockets, and plug the board into an unoccupied NuBus slot. Note that you must leave 2 MB of RAM on the main logic board so that the computer can boot, although that RAM isn't used in subsequent operations.

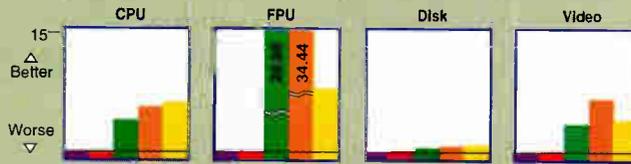
When the Mac first boots, Radius's software performs some intricate initialization maneuvers and restarts the system. The second time the Mac starts, the Rocket board assumes control, and the Mac's main logic board operates as a smart I/O processor for the Rocket.

The RadiusWare Control Panel software automatically recognizes applications (e.g., Microsoft Word 4.0) that are

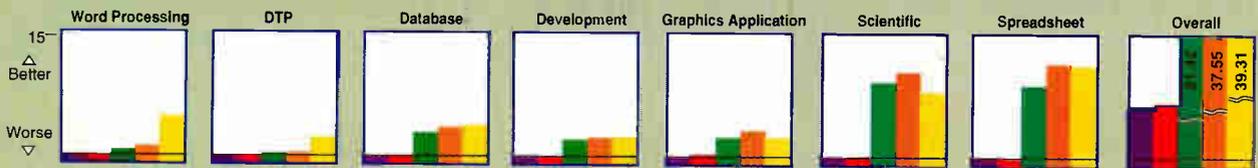
MACINTOSH BENCHMARK INDEXES

■ Mac Classic II
 ■ Mac LC II
 ■ Quadra 900
 ■ Quadra 950
 ■ Radius Rocket 33

LOW-LEVEL PERFORMANCE



APPLICATION-LEVEL PERFORMANCE



The Quadra 950 is 28 percent faster than the Quadra 900. The Rocket 33 provides nearly equivalent performance. The Rocket 33's processor caches were disabled during the word processing and desktop publishing tests, which degrades performance and gives the Quadra 950 a deceptively low overall index. Note that the Rocket 33 doesn't fare as well on the floating-point tests.

All machines were tested using System 7.0.1. Except for the Dhrystone test, all results are indexed. For each test, a Mac Classic II = 1, and higher numbers indicate faster performance. The floating-point benchmarks use the SANE library. Comprehensive test results and detailed configurations are available for all machines on request.

Dhrystones

Mac Quadra 950	25,000
Radius Rocket	25,000
Mac Quadra 900	16,666
Mac LC II	2000
Mac Classic II	2000

BYTE ACTION SUMMARY

■ WHAT THE QUADRA 950 AND ROCKET 33 ARE

The Quadra 950 is Apple's 33-MHz 68040-based computer. The Rocket 33 is a 33-MHz 68040-based NuBus accelerator board.

■ LIKES

The Quadra 950 offers more processing power than its predecessors and supports a new display size and pixel depth. The Rocket 33 revitalizes older Macs.

■ DISLIKES

The Rocket 33 has some compatibility problems with Mac sound, QuickTime, and virtual memory. It also doesn't work in a Mac IIsi or IIfx.

■ RECOMMENDATIONS

If you don't own a Mac or you need the ultimate in processing

power, get the Quadra 950. If you already own a NuBus Mac, consider the Rocket 33.

■ PRICE

Quadra 950 (includes a 13-inch RGB monitor, a 230-MB hard drive, and a standard keyboard), \$9517
 Radius Rocket 33 (no RAM), \$2499

■ FOR MORE INFORMATION

Apple Computer, Inc.
 20525 Mariani Ave.
 Cupertino, CA 95014
 (408) 996-1010
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Radius, Inc.
 1710 Fortune Dr.
 San Jose, CA 95131
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incompatible with the 68040's copyback cache mode and compensates by setting the 68040 cache to write-through mode. If you have a Radius monitor, there's a QuickColor Control Panel that provides QuickDraw acceleration so that video runs a tad faster.

I put the Rocket 33 in a Mac II with 8 MB of RAM, a 100-MB hard drive, a Radius DirectColor/24 display board, and a 19-inch Radius monitor. The Rocket ran System 7.0.1, with a few limitations: Radius's software (version 1.3) garbles sound playback and breaks both virtual memory and QuickTime. Photoshop 2.0.1 worked fine, even when capturing images from a color scanner (an Epson 300C) connected through the SCSI port.

Unfortunately, the Rocket 33 has some failings. In addition to the software incompatibilities (which Radius should fix in later releases), it limits your choice of Mac hosts. The Rocket 33 is incompatible with the Mac IIfx, and, with 8 MB of RAM, the board draws a hefty 16 watts, which puts it outside the Mac IIsi's power budget.

Comparing Performance

The BYTE Lab's low-level benchmark results show that the Quadra 950 is the most powerful Mac to date, with noticeable

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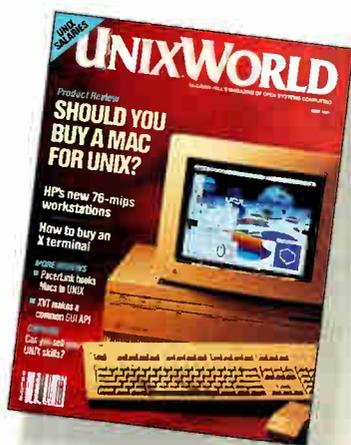
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BYTE Reprints

increases in processor, floating-point, and I/O throughput over earlier Macs (see the

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APPLICATION

FrameMaker: Power Publishing for Windows

TOM YAGER

Fulfilling the needs of exacting document creators is Frame Technology's stock-in-trade. The company's latest effort brings its well-respected workstation-based document publishing system to a new platform: Microsoft Windows. FrameMaker for Windows is everything that version 3.0 is on the Unix and Macintosh platforms: a program that can be used to write, design, and print any kind of document. FrameMaker is uniquely scalable, applying its professional touch to everything from memos to books.

What FrameMaker brings—though perhaps not uniquely—to Windows-based publishing is an effective combination of ease of use and tremendous power. Preparing simple documents like business letters or reports is as easy in FrameMaker as in just about any GUI-based word processing package. You can choose from a broad set of templates that roughly match the type of document you plan to create. These are more than mere demonstration files; they are well-designed, professional-looking style guides for written communication. Frame Technology even provides an attractive letterhead template for business correspondence.

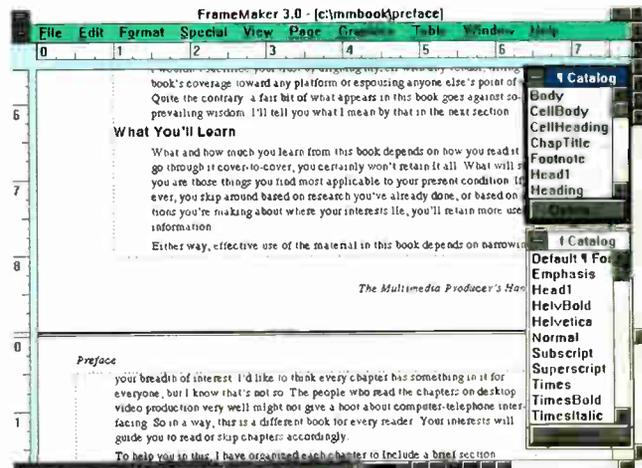
You use all the templates in the same manner: Delete the "filler" text and pour in your own. (The program has import filters to handle text from just about any word processor.) The templates cover every aspect of a document's appearance, from margins to font family to type size. They also include default paragraph- and character-format catalogs, similar to the style sheets in other publishing packages.

When you start pouring text into a template, FrameMaker does what a lot of other high-end publishing systems would like to do: collect text as effectively as a word processor does. Too often, capable document publishing systems are so poor at text entry that you're moved to use some other program for that. FrameMaker doesn't just do a bang-up job of formatting your text; it feels good and responsive as a text-entry system.

Framed

If your work doesn't fit neatly within the constraints of the program's built-in templates (*constraints* is actually too strong a word, since you can change anything in

FrameMaker's document-editing window, showing the floating character- and paragraph-tag catalogs. The floating catalogs are handy for quickly applying fonts, type styles, and other attributes. But on a 640- by 480-pixel display, they crowd the screen's real estate.



any template), you need to venture into the more creative side of FrameMaker's personality. FrameMaker's name comes from its universal use of stretchable rectangular frames as objects for holding text or graphics.

A FrameMaker document can start either as a template that you customize to your needs or as a blank sheet of paper—whichever you prefer. Either way, shaping the document starts with drawing frames on the page to contain the information that you intend to add later. (You stretch a frame by clicking on one of its lines and then dragging the line until the box is the size that you want.) Frames are drawn on *master pages*, and you can have up to 25 of them within a document.

The best way to think of master pages is as backgrounds for documents. For a business letter, for example, you'd draw (using the program's built-in drawing tools) or import your company logo and other constant information to a master page and then stretch out a frame where you'd like the text of the letter's body to go. When you switch to the *body pages* to add your text, the elements you created on the master page appear, and the cursor jumps directly to the top of the text-entry frame you created.

If you want to change one of the master-page items, you can do so by switching back to master-page-editing mode at any time. This scheme makes it easy for a resident FrameMaker expert to create custom master pages—actually document templates—and place them in the hands of inexperienced users. These users can't accidentally change anything that was cre-

ated in the master page, but they can see it and get a feel, as they type, for how the finished document will look.

Tagging Text

In addition to frames, FrameMaker depends on *tags*. These are names that get attached to groups of attributes that apply to either characters or paragraphs. You create a paragraph or character format tag by filling in a dialog box that includes a space for a unique name. Once you make the changes in that dialog box, the new format's tag name gets added to the appropriate character or paragraph catalog. FrameMaker lets you see these catalogs on-screen as floating windows containing scrolling lists (see the screen above). These catalogs are exquisitely simple to use: Just click on the name of the tag you wish to apply. If you select some text, the tag will be applied to what you've selected. Otherwise, the new tag will be applied at the insertion point, covering text you add from that point until you select the next tag.

This brings out one of the first things that makes FrameMaker a little harder to use than less capable tools. Because there's no easy way to trigger a new tag selection from the keyboard, you'll probably want to have the paragraph- and character-tag catalogs on-screen all the time, where they're easily accessible. FrameMaker lets you do that, but it takes up screen space. It's primarily for this reason that you're better off not running FrameMaker on a standard 640- by 480-pixel display. Even though there are buttons on the window border for popping up the catalogs, the tedium of reaching up there, calling up the catalog,

wide grins. *Get List.* **MADNESS.**

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MicroStation

selecting the tag, and closing the catalog window proved more than I'm willing to suffer.

FrameMaker clearly shows its workstation roots here, running far more effectively on a 1024- by 768-pixel display that affords the space to keep the catalog windows visible all the time. Still, I consider it an oversight that FrameMaker doesn't allow you to create macros for common operations such as switching to and from italics. There are keyboard shortcuts, but they're awkward, multicharacter sequences fashioned after the EMACS editor, and they don't cover everything.

Good with Long Documents

If you're writing a book or a lengthy technical document, FrameMaker is loaded with features made just for you. Many of the things that are optional in other packages are standard in FrameMaker. You can feed it volumes of text, and if you mark up the text properly, FrameMaker will generate tables of contents, indexes, and figures.

Instead of being stuck with a fixed mechanism, you can use FrameMaker's general-purpose list generator to create lists of any kind. This method works for glossaries, bibliographies, and reports. You can format these lists any way you like. When you generate a list, it's automatically placed in a separate document file so you can apply master pages, change tags around, and otherwise manipulate the file as you would any other document. FrameMaker's automatic list generation is one of its highlights.

Another highlight is FrameMaker's versatility in dealing with nontraditional types of documents. If, for example, you had to create a catalog in which certain items (e.g., prices and ordering information) changed depending on whether the reader was a retail or wholesale customer, other tools might force you to create two documents to cover the differences. FrameMaker covers you with *conditional text*, a special kind of tag that makes text invisible if a certain variable isn't set. Using this feature, you could have a single catalog document with conditional text that would let you choose whether the retail or wholesale version was to be printed. Similarly, conditional text will let you produce different versions of a document that vary according to language or regional custom. "Conditional text" is a bit of a misnomer, because almost any printable object, including bit-mapped graphics and tables, can be marked for conditional inclusion.

Another powerful aspect of FrameMaker is its handling of tabular material. The program can import text from any

source as a table. FrameMaker's table formatting capability provides almost limitless variety in layout. As with the rest of the package's features, if you're an experienced user, you can take the reins directly and do your own formatting. If you're less experienced, or just pressed for time, FrameMaker's defaults make sense and look great on paper. You can import table text from any delimited ASCII source, which makes it possible to pull in data from spreadsheets, database managers, or any application that lets you save

BYTE ACTION SUMMARY

■ WHAT FRAMEMAKER FOR WINDOWS IS

A professional, cross-platform document publishing program that handles everything from memos to books.

■ LIKES

Templates provide quick access and ease of use for less demanding users, but FrameMaker scales itself remarkably well to tasks of any size; files are compatible with those from the Unix and Mac versions.

■ DISLIKES

The program doesn't always conform to Windows customs, and there should be some kind of keyboard macro facility; the interface is buggy in places.

■ REQUIREMENTS

A Windows-ready 386-based PC with at least 4 MB of RAM.

■ RECOMMENDATIONS

It's an excellent choice as a companywide document publishing system. It's quick and easy enough for creating memos, and its power makes even weighty documents a breeze.

■ PRICE

\$795

■ FOR MORE INFORMATION

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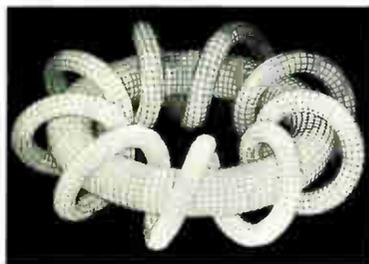
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FRAMEMAKER

in ASCII. You can also include graphics (drawn or imported) in tables. Manipulating a table is almost as easy as working with a graphical spreadsheet.

FrameMaker's designers have chosen not to limit its number of potential users. Even the program's spelling checker is loaded with options, such as checking for double words, looking for bad hyphenation, and writing unrecognized words to a file for you to handle later. FrameMaker also has a component called FrameMath, a good set of tools for building WYSIWYG equations; this should appeal to anyone who has to compose mathematical or scientific manuscripts. The program is endowed with a capable markup language; unfortunately, the documentation for it is not included in the standard package.

It's impossible to cover all of FrameMaker's positive attributes in one short review, so I won't even try. I'll summarize it thus: I'm convinced that FrameMaker can do *anything*; it's just a matter of knowing how to ask.

It Doesn't Feel Like Windows

Because FrameMaker is so packed with capabilities, it includes a help facility based on its own built-in hypertext engine. But FrameMaker's help isn't based on the familiar Windows help system, and therein lies the rub: While FrameMaker *looks* like a Windows application, it doesn't *feel* entirely like one. The proprietary help engine is only one example.

A non-Windows feel runs throughout FrameMaker for Windows. You press Alt-Arrow instead of Control-Arrow to move between words. Text fields in dialog boxes look like those in Windows, but they don't act the same. You often can't, for instance, sweep the cursor over a text field to select the text in it.

Sometimes the interface just plain behaves badly. For example, in the dialog boxes that you use to set up running headers and footers to create printed page-border data that changes according to the page's contents, the insertion point jumps around. You can click on the mouse to set it, and the blinking-line cursor appears, but when you start typing, the text gets added elsewhere. The same is true of deletions, which makes things dicey. In main-body text, the PageUp and PageDown keys navigate according to a printed page, not a display page, and the keys for moving to the beginning or end of a document are nonstandard.

The argument put forth by experienced FrameMaker users—and I am one of them—is that FrameMaker offers a predictable interface regardless of the platform it's running on. There's certainly an

advantage to that: If you make your company an all-FrameMaker shop, you can buy whatever hardware you like to run it, and even mix and match systems, and the program will be uniform across all of them. FrameMaker files are compatible across platforms, and all implementations can import graphics created elsewhere. The "FrameMaker feel" means you can sit down in front of anything that's running FrameMaker and immediately know how to use it.

While that's great if you're already a FrameMaker fan, it makes the package a little harder to fall for if you're a Windows user and you've grown accustomed to Windows programs. In many cases, there is simply no reason for Frame Technology not to add the Windows feel: Key combinations like Control-Arrow, Control-Home, and Control-End aren't mapped to anything. At least the developers could have double-mapped these keys to make moving between Windows applications easier.

In the long run, I find it unusual that FrameMaker, for its do-everything spirit, lacks the one thing that would make it a true cross-platform player: keyboard-mapping capability. The manual suggests using Windows' Macro Recorder (bleh) or a third-party macro facility to alter the keyboard map. But it also points out, rightly, that these macros aren't portable. Frame Technology should take on the responsibility of building a facility for redefining elements of the program's interface.

Still the Best

Landing on Windows opens FrameMaker up to its broadest potential audience. The program is an ideal solution for Windows users looking for an extremely powerful document-creation program. More important, the software now runs on all major platforms, so people in mixed-hardware offices can use it on their machine of choice and share files with coworkers who use other types of systems. While PageMaker can share files between its Windows and Mac versions, FrameMaker spans Windows, Unix, and the Mac.

It's impossible to work, as I have, with FrameMaker on four different platforms (Sun, Next, and Mac systems, and now Windows) without feeling a tremendous respect for it. ■

Tom Yager is a BYTE technical editor and director of the BYTE Multimedia Lab. He is working on his second book, The Multimedia Producer's Handbook (Academic Press, forthcoming). He can be reached on BIX as "tyager" and on the Internet at tyager@bytepb.byte.com.

SYSTEM

Cyrix Cx486SLCs Hit the Desktop

ROGER C. ALFORD

Cyrix is the latest of a growing list of companies to provide microprocessors for the lucrative, high-volume PC marketplace. Over past years, Cyrix has become well known for its high-performance math coprocessors, which are now available for every speed and flavor of Intel's and AMD's 386 CPU offerings: DX, SX, and SL. In March, Cyrix announced its move into the CPU arena with the introduction of its Cx486SLC processor.

Tandon and Zeos are two of the first companies to incorporate the new 25-MHz Cyrix processor into their desktop machines. In this review, I'll take a look at the Tandon Option 386SLC/50 and the Zeos 486SLC-25 with an eye toward how the Cx486SLC contributes to the performance, compatibility, and pricing of these two systems.

On the Inside

Tandon's Option system has been on the market for nearly a year. It's an upgradable design featuring a modular processor cartridge that slides in through the system's front panel. Option owners upgrade their systems by purchasing new cartridges as new processors become available. This architecture obviously played an important role in Tandon's ability to deliver one of the first Cx486SLC-based systems.

Tandon calls its 25-MHz Cx486SLC processor cartridge a 386SLC/50—an unfortunate choice, in my opinion. The company claims the name, which implies that the system includes a 50-MHz version of a 386SLC (i.e., a cached 386SX built by IBM), reflects the system's performance most accurately and will simplify choices for less informed purchasers. I think it will only further confuse the many consumers who are already bewildered by the large variety of processor offerings.

The Tandon Option system comes standard with 4 MB of DRAM, two floppy drives (one of each standard type), two serial ports, a parallel port, an integrated 512-KB Super VGA video controller, and a fax/modem board, all for a base price of \$994; this price does not include a processor cartridge. The system also comes with DOS 5.0, Windows 3.1, Microsoft Works for Windows, a mouse, and a 30-day Prodigy start-up kit. My review system had an additional 4 MB of DRAM, a



Tandon's Option 386SLC/50 (left) and Zeos's 486SLC-25 are the first desktop systems to include Cyrix's 486-compatible Cx486SLC.

BYTE ACTION SUMMARY

- **WHAT CX486SLC SYSTEMS ARE**
486-compatible systems built around Cyrix's Cx486SLC processor.
- **LIKES**
Very attractive prices; solid compatibility.
- **DISLIKES**
Performance could be improved with an external cache.
- **RECOMMENDATIONS**
Tandon's Option 386SLC/50 offers the best combination of price, performance, and features.
- **PRICE (AS TESTED)**
Tandon Option 386SLC/50, \$2770
Zeos 486SLC-25, \$2174
- **FOR MORE INFORMATION**
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movable 200-MB hard drive, a 14-inch color monitor, and a 386SLC/50 processor cartridge with a Cyrix math coprocessor. My system's price was \$2770.

Oddly, the Tandon Option lacks DRAM parity checking. Therefore, the system can't verify memory integrity during normal operation. Tandon maintains that the

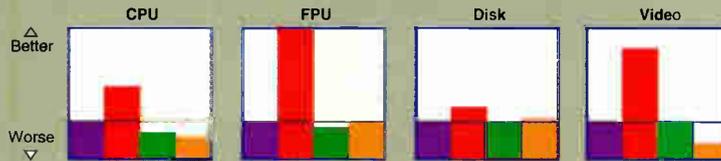
BIOS does a complete memory test at power-up, so parity checking is unnecessary. But with the amount of memory being used in today's systems steadily increasing, the absence of parity checking seems to be a notable drawback.

The Zeos 486SLC-25, with its large seven-drive-bay desktop case, is a more

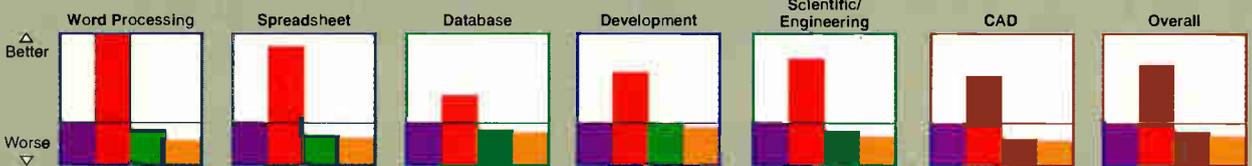
BYTE BENCHMARK INDEXES

■ Compaq Deskpro
 ■ Compaq Deskpro 486/50L
 ■ Tandon Option 386SLC/50
 ■ Zeos 486SLC-25

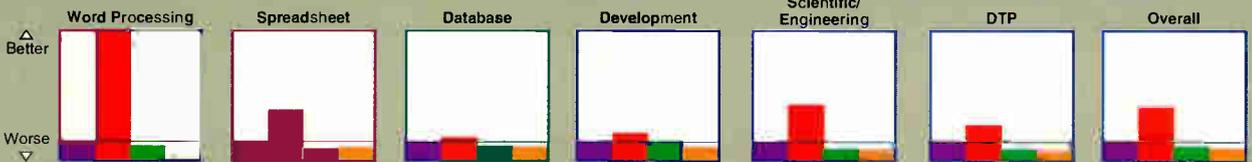
DOS LOW-LEVEL



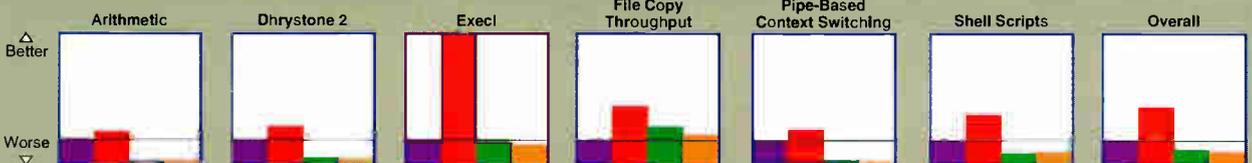
DOS APPLICATIONS



WINDOWS APPLICATIONS



UNIX



All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 = 1. For each index in the Unix tests, a Sun Sparcstation IPC = 1. The overall index is the average index of the individual tests.

The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you to identify the relative performance of a given subsystem and to determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

BYTE's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two en-

vironments: DOS 5.0 and Windows 3.0. We test six application categories for each environment, running test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 3.1+ and Microsoft Excel 3.0a; Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV; Development: Borland Turbo Pascal for Windows and Microsoft C 6.0; Scientific/Engineering: MathSoft MathCAD for Windows 3.0, The MathWorks MatLab 3.5k, and Computing Resource Center Biturbo Stata 2.1; CAD: Autodesk AutoCAD release 11; and Desktop Publishing: Aldus PageMaker 4.0. The data files and test scripts are available from BYTE.

Our Unix tests show relative performance for double-precision arithmetic, the Dhrystone 2 benchmark, spawning a process (execl()), file copy throughput, pipe-based context switching, and running a shell script with eight concurrent scripts running. Unix benchmarks are available on Usenet, from Demolink, in the listings area on BIX, or on disk.

The benchmark results show that the performance of 25-MHz Cx486SLC systems lies somewhere between that of 25- and 33-MHz 386 systems. Of the two Cx486SLC machines, the Option 386SLC/50 is clearly faster.

traditional box. My review unit came with 4 MB of DRAM, a 107-MB hard drive, a Diamond Stealth 1-MB Super VGA adapter, a 14-inch color monitor, a game port, and the same basic I/O ports and floppy drives as the Tandon Option. The Zeos 486SLC-25 also comes with DOS 5.0,

Windows 3.1, a choice of two Lotus application programs, a mouse, and a Cyrix math coprocessor, for a total cost of \$2174. Upgrading to a 240-MB hard drive and 8 MB of RAM, a configuration that more closely matches that of the Tandon Option, brings the total system cost to \$2583.

To challenge the compatibility of the Cx486SLC processor, I put the two machines through rigorous software testing beyond that of BYTE's already-comprehensive DOS, Windows, and Unix benchmarks. First I tried numerous DOS and Windows applications with no problems.

CYRIX CX486SLCS HIT THE DESKTOP

Even with Windows operating in 386 enhanced mode and while running multiple applications simultaneously, both systems worked flawlessly. Multiple DOS boxes under Windows were no problem, and even my sometimes-fickle Battle Chess program had no problems running in a Windows 3.1 DOS box.

I next installed OS/2 2.0 to give the systems a try in a true multitasking environment. OS/2 ran smoothly, with both OS/2 and DOS applications running well.

As a final test, I enlisted the help of an associate who is intimately familiar with QNX, a real-time Unix-like operating system from Quantum Software Systems. After repartitioning the hard drives, we installed QNX on both systems; both ran fine. We compiled QNX applications and ran them, and then we ran DOS applications using QNX's *rundosp* utility.

Benchmarks Say...

The results of the BYTE benchmarks are shown in the figure. I also compared the low-level benchmark results of the machines reviewed with those of a Compaq 386/25e and a Tandon 486/25 (which uses a 25-MHz Intel 486DX processor) to see where the Cyrix-based systems fit in (not shown). From a pure CPU-horsepower standpoint, the Cyrix processor clearly outpaces the 25-MHz Intel 386DX. It is also apparent that the 25-MHz Cx486SLC is somewhat slower than the 33-MHz i386DX (used in the Compaq 386/33L) and the 25-MHz 486 (used in the Tandon 486/25). Thus, Cyrix appears to have carved out a niche between the 386/25 and 386/33 processors with its initial CPU offering.

Interestingly, the fast 25-MHz Cyrix math coprocessor in the reviewed systems competes very favorably with the 33-MHz Intel 387 in the Compaq 386/33L. The Zeos 486SLC-25, with an FPU index of 0.99, shows essentially equivalent performance, while the Tandon Option 386SLC/50's is slightly slower at 0.85.

Of the two Cx486SLC-based systems, Tandon's Option was clearly the overall performance leader. It outshone the Zeos 486SLC-25 in the low-level CPU and video benchmarks and in virtually all the application-level benchmarks. However, Zeos's system eked out slightly better low-level FPU and disk benchmark results, allowing it to show a small performance advantage in the Windows spreadsheet index.

It looks like Cyrix's engineers did their homework in developing the Cx486SLC. After my rigorous applications testing with multiple operating systems, not the least hint of a compatibility problem revealed itself. And while it may maintain the foot-

print of a 386SX, the Cx486SLC definitely outruns the 386SX/DX processors (operating at the same clock rate) according to the BYTE tests.

The Tandon Option 386SLC/50 and Zeos 486SLC-25 are both solidly built machines. They rely exclusively on the Cx486SLC to provide improved performance; perhaps an additional external cache would make for better-optimized designs.

Of the two, the Tandon Option 386SLC/

50 stands out as the better performer. And despite its misleading name, it offers a very attractive price for the total package, especially factoring in its easily upgradeable CPU module and removable hard drive. ■

Roger C. Alford, a BYTE consulting editor, is president of Programmable Designs, a Michigan-based consulting firm specializing in electronics design. He can be contacted on BIX as "rogera."

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PANASONIC LF-9000 REWRITABLE	650MB	1024	6144	1024
PANASONIC LF-7000 MULT.	1GB	1024	0132	1024
PIONEER WORM	650MB	512	5120	NONE
PIONEER MULTIFUNCTION	650MB	512	6144	NONE
↑ COCA REWRITABLE	650MB	512	4128	NONE
↓ RICOH REWRITABLE	650MB	1024	6144	1024
RICOH REMOVABLE	50MB	512	1024	NONE
MAXTOR/RICOH 800 WORM	000MB	2040	6144	2040
SHARP REWRITABLE	600MB	512	5120	NONE
SHARP REWRITABLE	650MB	1024	6144	1024
↓ SONY 3.5 REWRITABLE	120MB	512	2040	NONE

CorelSCSI supports an impressive array of SCSI devices, including all current ASPI controllers. The devices are selectable from the software pick list shown here.

On our way to testing removable storage products for this month's Solutions Focus (see page 198), we sought our own solution: how to test drive mechanisms independently, apart from the influence of adapters and software drivers. This raised the more general problem of how to deal with SCSI on the PC.

Although the Macintosh provides a standard hardware and software interface for SCSI devices, PC-class systems are faced with a wealth of confusing options. Most of the removable-media devices we reviewed provided their own SCSI boards and drivers. Few provided a standard interface that would allow other devices to share the same SCSI platform. Aside from presenting a configuration nightmare, special-purpose drivers no longer respond to real-world needs. SCSI, after years of quiet growth, is catching on as a useful PC interface for CD-ROMs, tapes, and optical scanners, as well as the various types of removable media.

A Level Playing Field

To provide a level testing environment, we connected all our test media to a single SCSI board. The environment we chose for the project was an Adaptec 1542B interface board and the CorelSCSI software drivers. The SCSI board was configured not to load any of the attached SCSI devices at boot time. The ASPI (advanced SCSI programming interface) driver was loaded for communication with the SCSI board. ASPI is an interface to the SCSI hardware that allows multiple device drivers to communicate through the same hardware. Developed by Adaptec, it is now available through other manufacturers.

The CorelSCSI device drivers load on top of the ASPI driver. CorelSCSI can then control any device driven by ASPI software. If you are only going to use some plain-vanilla SCSI devices, you probably don't require the CorelSCSI software, since the drivers provided by Adaptec work quite well. The difference is the Corel goal of universal hardware support.

The stated goal of the CorelSCSI software is to create drivers for every conceivable SCSI device to ensure that they can all work together without conflict. Currently, this support extends to magneto-optical media, CD-ROMs, write-once optical drives, jukeboxes, and tape drives. CorelSCSI also supports Kodak Photo CDs, allowing any Extended Architecture-compliant CD-ROM drive to read Photo CDs directly. Drivers are provided for DOS, Windows, OS/2, and Novell NetWare (although not all drives are supported in all environments). You can call Corel and receive a list of all currently supported drives and environments. A partial list is displayed in the screen.

Some Surprises

In our test setup, we disabled the on-board Adaptec SCSI BIOS and managed all device communications using just the Corel drivers. We were pleased to discover we could quickly configure a setup with widely varying drives. We strung magneto-optical, CD-ROM, and removable-media drives together, and the installation software recognized them all and provided the proper driver. A reboot after installation provided immediate access to the drives that contained preformatted media. The CFormat command quickly formatted the

remaining devices. It was a simple, and elegant, solution.

What did surprise us was the lack of setup support for standard SCSI hard drives. The Corel installation consistently came back with a "drive not found" error when we attempted to add a Quantum drive to the SCSI chain. In fact, it finds it; it simply cannot recognize it. Further exploration revealed that CorelSCSI does not recognize any standard SCSI hard drives. Performing a manual configuration (we told it the drive was a removable SyDOS) solves the problem. This, however, is a queer oversight for a system purporting to support "all available SCSI devices." According to Corel technical support, you are expected to use the drivers provided with your SCSI card to support the standard drives. This can get rather confusing, not to mention the added waste of yet another driver crowding into your cramped memory space.

We ran into another problem when communicating with a Procom floptical drive. Although the CorelSCSI software automatically recognized the drive, we couldn't format standard 720-KB and 1.44-MB floppy drives. Since this is one of the strengths of the optical technology, it was a great disappointment not to be able to take advantage of it.

Corel plans to bundle the CorelSCSI software with Adaptec adapters. It looks like a good combination to us. There are still some kinks to work out, but the strategy is a solid one. Aside from the omissions mentioned, the CorelSCSI software let us quickly and painlessly swap drives on and off our test systems without hindrance. In fact, it became rather transparent, just as good tools should be. ■

—The BYTE Lab

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BOOK AND CD-ROM REVIEWS

HUGH KENNER

To humiliate a world-class chess-playing machine, try proposing a round of tic-tac-toe. Expert at one "fragment of high human competence," Belle or Deep Thought proves nonetheless "very brittle," unable to expand the concept of "game," incapable even of *looking* at the chessboard on which we pretend it's expert. That's been a recurrent complaint about AI projects: dependence on rule systems so special-case it's stretching things to mention "intelligence."

Contrast the approach of a man named Stewart Wilson, who writes, "By stimulating and understanding complete animal-like systems at a simple level, we can build up gradually to the human." (Then perhaps further upward to chess, thence to the chess whiz, a special case of "the human"?) Thus, "We hope to reach human intelligence from below instead of piecemeal through high-level competences." Equipped with the right mix of simpler aptitudes, our gadget will *learn* the advanced ones (or learn to learn them).

Wilson is speaking on behalf of what's been miscalled "artificial life": miscalled, because of the myriad irrelevancies in which that phrase can entangle thought; notably, "Is life thinkable without protoplasm?"

Come in from another direction. In a computer run of many hundred generations, artifacts can grow and learn, can even manifest skills no programmer ever taught them. Life? Yes, but (some cry) doesn't that program merely *simulate* life, which requires a medium other than silicon? No, cry others; as long as that program is running, what's inside the computer *is* alive: *is* life.

Such wranglings are dreary, and I could wish that Steven Levy had laid out his *Artificial Life: The Quest for a New Creation* so they'd not bedevil his opening pages. Readers may prefer to start with chapter 6, "The Genetic Algorithm," proceed to the end, and loop back to chapter 1, rather than read Levy's book straight through.



IS ARTIFICIAL LIFE POSSIBLE?

**Artificial Life: The Quest
for a New Creation**

Steven Levy
Pantheon, \$25,
ISBN 0-679-40774-X

The genetic algorithm in effect uses evolution to optimize something naive. "One of the first used GA's to seek strategies in an extremely simplified version of chess." Contrast that with AI's papa-knows-best procedure of just writing in the best strategies available. The AI program can never know more than papa does. But there's no reason a GA mightn't happen on maneuvers no Grand Master has hitherto glimpsed.

Evolution is learning conducted over many generations. Millions of years? Well, computer generations can flicker by quickly; it's even feasible to recommence, as it were from the Day of Creation, again and again. Why? Well, to satisfy yourself that chance, judiciously applied, didn't just happen to solve the problem once but will *always* solve the problem, if not always in the same way.

A sample: Here's a "trail" of 89 squares, twisting and turning, with gaps increasingly frequent and increasingly long. A creature that can see only one step ahead must rely a good deal on chance to reach the trail's end. We next turn loose 65,536 such creatures and offer them 200 moves each. While most accomplish nothing of note, a few will stay on track for as many as four squares. We discard all but the top 10 percent, pair those at random, interbreed them....

And lo, after but 20 generations, the average "ant" can navigate some 30 squares. By 70 generations, "the population is loaded with smart ants," a surprising number of whom have managed the entire 89-square trail. One organism that myriad trials produced was "Champ 100," with "devilishly efficient" logic exquisitely tailored to the problem. "An impressive creature," Levy remarks, "even more so because no one programmed it": only "the incremental wisdom of natural selection." ■

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."

VISUAL ATTRACTION

In the short time since its release, I've developed into something of a fan of Microsoft's Visual Basic (VB). I was fortunate enough to receive four books on the subject. The first of these, *Visual Basic for Windows Inside & Out*, is a beginner's book that suffers from a chronic lack of direction, jumping from subject to subject. It claims to cover the full range of VB's capabilities, but the chapter on DDE shows VB only as a client, and there are only three pages on interfacing with DLLs. And even though this is the only book with content specific to the Professional Toolkit, that chapter is only a laundry list with no examples.

The better beginner's book is *Visual Basic by Example*. While the overly loud layout gave me a headache, the book's

organization and presentation are superb. It gives beginners just what they need: a tour, with brief examples, of all VB's major features. This book has a fun, nonintimidating style clearly aimed at nonprogrammers. There is a chapter on more advanced topics at the end, but it's short and confusing. Still, this book, with the available floppy disk, is the best way I've seen yet to learn VB from scratch.

The other two books target an audience that's programmed before, if not already in Visual Basic. I was both pleased and disappointed with *Visual Basic Power Programming*. I was impressed with the sections on data structures like lists, sparse arrays, and hash tables. What turned me off was that much of the book seemed to be rehashed QuickBasic code. One example had a delay subroutine that used a tight loop (a Windows and event-driven programming no-no) instead of the VB Timer control. Another example cross-referenced

source code listings by line numbers—not very useful in a visual, highly modular system like VB. On the plus side, the book includes several useful routines and forms on a floppy disk.

For me, the most impressive piece of work came directly from Microsoft Press in the form of *The Microsoft Visual Basic Workshop*. This book turns a moderately skilled programmer into a VB expert. It has a terse, no-nonsense style that lets it cover a lot of ground in a little space, and it's loaded with useful examples. The advanced topics are covered well, including examples of VB DLL client and server programs and interfacing to both Windows and custom DLLs. The floppy disk makes the package complete.

Visual Basic by Example and *The Microsoft Visual Basic Workshop*, combined with the documentation and on-line help included with VB, will put you on the fast track to creating your own Windows applications.

—Tom Yager

Visual Basic for Windows Inside & Out, Gary Cornell, Osborne/McGraw-Hill, \$27.95, ISBN 0-07-881764-1.

Visual Basic by Example, D. F. Scott, Que, \$21.95, ISBN 0-88022-904-7.

Visual Basic Power Programming, Namir C. Shamas, Windcrest, \$29.95, ISBN 0-8306-3963-2.

The Microsoft Visual Basic Workshop, Hohn Clark Craig, Microsoft Press, \$34.95, ISBN 1-55615-386-4.

QUALITY BY DESIGN

Turn Signals Are the Facial Expressions of Automobiles, Donald Norman, Addison-Wesley, \$28.95, ISBN 0-201-58124-8.

Turn signals? Facial expressions? What do these have to do with computers? Nothing, at first glance.

On the other hand, this sequel to *The Design of Everyday Things* continues Donald Norman's crusade to make the world around us more suitable. He is a champion of the appropriate uses of technology and design.

This book immediately struck a responsive chord. Ever attend a school play? Ever become frustrated with all those clicking, whirring, beeping, and whining cameras? I managed to encounter this just before discovering that Donald Norman's opening chapter is a recounting of just such an experience. This is technological rudeness, a benign technology transformed into an unstoppable annoyance, leading you to lose the enjoyment, the fun, the wonder of the moment.

When design breaks down, signs show up. Signs mean something is wrong—the task to be completed is either too complicated or inappropriately designed. The example of a door with a large, flat push handle and the accompanying "Pull" sign is exquisite. Everyone has experienced this beast. Everyone wonders why the silly door doesn't open the way it "should." (And some of us continue to push, even after seeing the sign.) When the real world does not match our internal-world model, we need time to adjust. The world would be much simpler if the model were consistent.

The messages are clear and thought-provoking: Be consistent, be appropriate, don't intrude, be polite.

—Raymond GA Côté

CORPORATE SNAPSHOTS



Corporate Snapshots, Disclosure's \$995 annual CD-ROM release, contains key facts and figures for over 11,000 public companies. Disclosure (5161 River Rd., Bethesda, MD 20816, (301) 951-1427) culls data directly from original SEC filings and other public sources. The financial information provided includes a few key ratios, but it isn't as complete as the information you'll find in an annual report. You won't find a breakdown of assets and liabilities, for example, nor a detailed balance sheet. Corporate Snapshots functions mainly as a directory of corporate America.

Each record contains general information, such as company name, address, telephone number, SIC (Standard Industrial Classification) codes, and a description of the markets the company pursues. It also lists shareholder information: current outstanding shares, shares held by officers and directors, and the total number of shareholders.

Financial overviews include a five-year summary of sales, net income, and earnings per share, with two years' worth of selected financials (i.e., total assets, shareholder equity, net sales, net income, total liabilities, and net worth) and seven financial ratios (e.g., quick ratio, current ratio, net sales/assets, debt/equity, and net income/net sales). Do you want to know what your local CEO is raking in? You can find that here, too, along with the salaries of other corporate officers.

A simple, effective menu interface makes the data accessible. You open the database from the main menu and can search by almost any data field. Once you've selected a record, you can display the entire record or just a subset (e.g., the annual financials or list of directors). You can also create your own format for displaying records, sending records to a printer or file, and generating mailing labels.

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You can export selected records for use in a spreadsheet. You won't find enough financial data here to make informed investment decisions, nor does Corporate Snapshots offer investment guidelines. (For investors, Disclosure offers Compact D/SEC, a monthly subscription service on CD-ROM, with detailed financial information on 12,000 public companies). As a resource for quick facts, Corporate Snapshots works well.

—Stanford Diehl

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DISK ARRAYS EXPLAINED



Traditional I/O subsystems can't keep up with today's microprocessors. As 486s and 586s push the clock rates of PCs to 66 MHz and fast 68040s accelerate high-end Macs, hard disk subsystems bottleneck severely. Since the IBM XT first appeared on the market with its then-vast internal 10-MB hard disk, processor performance has increased five or more times faster than that of hard disks—and the disparity continues to widen.

As computers grow in power and as the demands on LANs increase, the storage crunch worsens. Bigger single disk drives were the first line of defense. But 3 1/2-inch drives are now reaching capacities of 1 GB, and 5 1/4-inch drives exceed 3 GB. But many users need even more space, particularly those downsizing from large and midrange computers to LANs.

A disk array, which groups multiple drives into what appears to be a single logical volume, can narrow the performance gap between processors and hard disks by working the component drives in parallel. A disk array also substantially boosts total subsystem capacity. The mission-critical nature of LANs highlights another key benefit of disk arrays: reliability. Disk drives are inherently the most failure-prone component of a computer system. Tape backup is a common minimum level of protection against drive failure, but many companies are willing to pay a premium to avoid costly—if not catastrophic—system downtime.

In disk array terminology, the terms *data availability*

and *fault tolerance* are used instead of *reliability*. Putting multiple drives together in an array is actually less reliable than using an individual drive, since there's an increased chance that one of the drives will fail sooner than others. But data redundancy enables many disk arrays to tolerate the failure of one drive.

Fundamental Concepts

The seminal work on modern disk array architectures appeared in a late-1987 paper by Patterson, Gibson, and Katz of the University of California–Berkeley. Entitled “A Case for Redundant Arrays of Inexpensive Disks (RAID),” the paper compared RAID to its alternative, the SLED (single large expensive disk), and established five competing RAID levels, or architectures, each with its own unique combination of trade-offs. Disk arrays generally increase performance by sustaining multiple simultaneous read and/or write operations. How effectively a disk array increases performance depends on the RAID architecture used and how the manufacturer implements it.

The *host adapter* (i.e., system drive controller) that is used to control the drives in a disk array crucially affects performance and fault tolerance. While disk arrays are often implemented with a single host adapter, this

Harnessing gangs of hard disks boosts capacity, performance, and reliability

arrangement constitutes a single point of failure: If the host adapter fails, the entire disk subsystem is unusable. To circumvent this, two or more host adapters can be used in a disk array implementation, allowing continued operation of the disk subsystem in the event of a single controller's failure. There's another advantage: Multiple controllers provide additional data paths to the drives to increase the data transfer rate of the disk array.

SCSI host adapters (including the newer SCSI-2 adapters) are used almost exclusively in disk array designs because the intelligent SCSI connection lends itself well to this application. One particularly valuable feature of SCSI is its disconnect/reconnect capability. A host adapter can send a command to an individual drive (i.e., "write a sector" or "seek to a particular sector") and then disconnect from that drive before the command is completed in order to send a command to another drive for simultaneous execution. The host adapter then reconnects with each drive in turn as it completes its work. Some disk arrays use ESDI or IDE drives, but even these disk arrays typically use a SCSI host adapter that can control the array's ESDI

or IDE drives through appropriate secondary controllers.

Redundancy and the associated fault tolerance are key to the operation of nearly all modern disk arrays. The disk array driver software or intelligent host adapter must be able to detect a drive failure and notify the system operator while continuing to process disk reads and writes.

To eliminate downtime, many disk array implementations allow "hot swapping" of failed drives. A failed drive can be replaced with a new drive while the power is on and the system is operating normally. The disk array driver software then rebuilds the appropriate data onto the new drive as a background task while the system continues to operate normally—albeit with a noticeable performance decrease. With some array drivers, you can specify the amount of system processing time to be dedicated to the rebuild: You can choose a fast rebuild with a substantial performance penalty or a slower rebuild that is less taxing on the system.

How Disk Arrays Work

Most disk arrays use some form of *striping*, or distribution of data across multi-

ple drives. Striping may occur on a bit level or on a sector (i.e., block) level. Bit-level striping typically occurs in multiples of 8 bits to and from each drive. The first chunk of data is stored on the first drive, the second chunk on the second drive, and so on for all the drives. For example, each drive in a four-drive array may have an 8-bit SCSI connection capable of a 2-MBps data transfer rate. By byte-striping the data across the four drives in 32-bit (i.e., 4-byte) chunks, 1 byte to each drive, the effective data transfer rate becomes 8 MBps for both write and read operations.

A disk array that implements striping without any drive redundancy is often referred to as RAID 0, although it is not a true RAID implementation as defined in the Berkeley paper. Since such a disk array offers no fault tolerance, it is less reliable than a single-drive implementation; its only virtue is speed. Such a disk array would be suitable only for certain special applications—perhaps in scientific analysis or imaging—that can tolerate compromised system reliability.

The use of *mirroring* for fault tolerance in microcomputer networks is now well established and was in use even before it

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received its RAID 1 designation. Novell NetWare, in particular, incorporates support for disk mirroring. With mirroring, two drives store identical information so that one is a "mirror" of the other. Thus, for every disk write operation, the system must write to both disks. In the event of a disk failure, the other drive keeps working until the failed unit is replaced, with no lost data and no system downtime.

Since dual-write operations can actually degrade system performance, many im-

plementations employ *duplexing*, where each mirrored drive has its own host adapter. The dual-adapter approach allows read and write operations to take place in parallel, enhancing the performance of the disk subsystem. The redundant host adapters also beef up system fault tolerance, since disk operation will continue even if one of the adapters fails.

Duplexing is often further enhanced by incorporating striping, which creates a RAID 0/1 disk array. Several drives at-

tached to one host adapter are striped, while the same number of drives attached to a second host adapter are also striped in a fashion that mirrors that of the drives on the first host adapter. While the mirrored/duplexed disk array approach provides good fault tolerance, it is relatively expensive to implement, because only half the available disk space can be used for data storage.

Less Expensive Redundancy

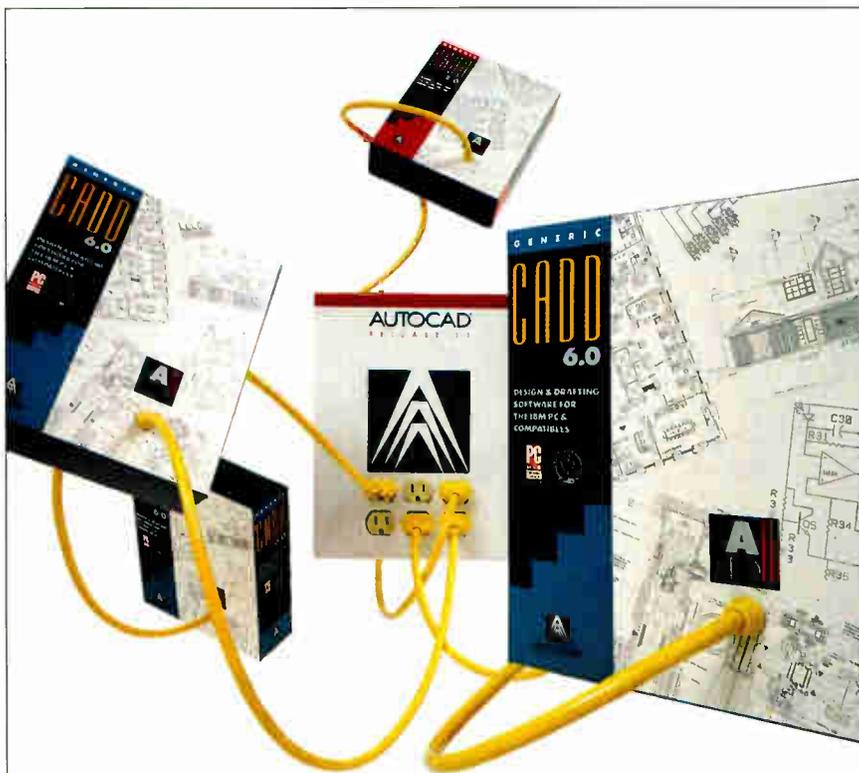
There's something inherently distasteful about having 5 GB of on-line disk storage but only being able to use 2.5 GB of it for data storage because the remainder is used for data redundancy. Other RAID architectures were therefore developed to improve both performance and storage efficiency while retaining an acceptable level of data availability.

RAID 2 is one approach that has succeeded in improving the reduction of data storage overhead. It uses extra check disks, with data bit-stripped across the data and check disks. The data includes an interleaved Hamming code, which can be used to detect and correct single-bit errors as well as detect double-bit errors. Because of the amount of information required for the check bits, several check disks are required to implement RAID 2. In an array with 10 data disks, for example, four check disks would be required, resulting in about 71 percent of the disk storage space being available for actual data storage. An array with fewer than 10 data disks becomes impractical, because the amount of storage available for data drops off quickly and can drop well below 50 percent.

Because of its interleaved Hamming code, RAID 2 is relatively complex to implement. It's optimal for reading and writing large data blocks at high data transfer rates, but smaller block reads are inefficient, and the read-modify-write operations required for small block-write operations result in poor performance. While mainframe RAID 2 implementations have been developed, RAID 2 is generally impractical for smaller systems.

The RAID 3 approach is now used widely in workstations and is seeing increased use in microcomputer LANs. However, standard microcomputer drives already incorporate ECCs (error-correction codes) with every sector written to every disk; thus, the RAID 2 bit-level approach to data recovery is unnecessarily redundant. Only enough redundant information to recover data from the failed drive, should any single drive fail, needs to be stored in the disk array.

RAID 3 uses a single redundant check disk (sometimes called a *parity disk*) for



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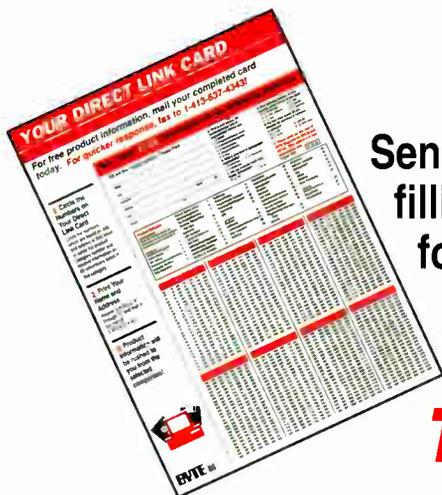
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each group of drives. A computer may have multiple drive groups to further enhance capacity, performance, or fault tolerance. Data written to the RAID 3 disk array is bit-stripped across the data disks. The check disk receives the XOR (exclusive-OR) of all the data values written to the data drives. Since data transfers to and from individual drives occur only in unit-sector multiples, the minimum amount of data that can be written to or read from a RAID 3 disk array is the number of data drives multiplied by the number of bytes per sector; this is known as a *transfer unit*. A typical five-drive array, for example, would have four data disks and one check disk and might have a 512-byte sector size on each disk. The transfer unit in this case is 2048 bytes (4×512).

Since the multiple drives in the disk array are written or read simultaneously, extremely fast data transfer rates can be achieved. This is particularly true when the size of the data being written or read is at least the size of the transfer unit. The performance of a RAID 3 implementation slows down considerably when many smaller data transfers are taking place, such as might occur in a transaction-pro-

cessing application. For data reads smaller than the transfer unit, all the data in an entire transfer unit must be read anyway. This makes the read operation longer than would otherwise be necessary, thereby reducing the efficiency of the operation.

Write penalties are worse. For data writes that are smaller than a transfer unit, only a portion of a sector of each data disk needs to be modified. But, again, the disk array must deal with complete transfer units. In this case, a complete transfer unit must be read from the combined data disks; then, the new write data must modify the read data where appropriate; finally, the modified read data must be written back to the data disks, with the check disk being updated appropriately.

This arrangement clearly results in slower write operations when small amounts of data are being written. Because of this, RAID 3 implementations are preferable for applications that process large chunks of data.

Rotational latency—the time it takes a drive's platters to rotate to the position where the sector being accessed is under the drive's read/write heads—can vary among the various disks in an array, re-

sulting in added delays during data transfer operations. To alleviate this problem, most RAID 3 implementations incorporate spindle synchronization to keep the rotation of all drives in a group synchronized for maximum performance.

The clear advantage of the RAID 3 approach over RAID 0/1 is the reduced overhead for the redundant check disk. In a five-drive array, for example, four of the five drives, or 80 percent, are used for data storage. This provides 4 GB of data storage in a 5-GB disk array.

Better Transaction Processing

RAID 4 offers a disk array architecture that's better optimized for transaction-processing applications than RAID 3's architecture. One notable difference between RAID 3 and RAID 4 is that the latter performs block striping or sector striping on the data on the drives, while the former performs bit striping. Thus, with RAID 4, one entire sector is written to one drive, the next sector is written to the next drive, and so on. This technique allows multiple unrelated sectors to be read simultaneously, and it is particularly valuable for small reads that need to access

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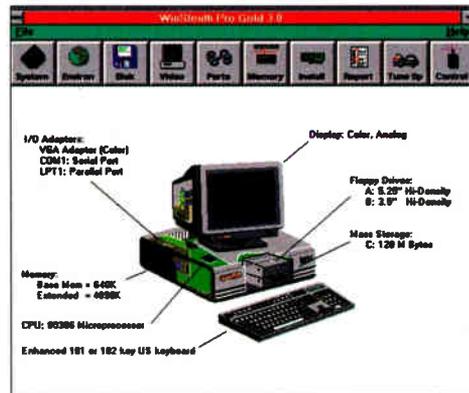
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only a single drive in the array.

Like RAID 3, RAID 4 dedicates one entire disk for storing check data, allowing data from a failed drive to be easily recovered. While this approach allows multiple reads to occur simultaneously—different sectors from different drives—write operations are a bottleneck. Since the single check disk must be written to during every write operation, only one write operation can take place at a time.

RAID 5 overcomes RAID 4's single-write bottleneck, and it is becoming the dominant disk array architecture for microcomputer LANs and systems that go beyond the ubiquitous but inefficient mirroring approach. Unlike RAID 4, which dedicates a single physical disk for check data, RAID 5 dedicates the equivalent of one entire disk for storing check data but distributes the check data over all the drives in the group. For example, sector 1 of disk 5 may be assigned to hold the check data for sector 1 of the remaining data drives, while sector 2 of disk 4 may hold the check data for sector 2 of the remaining data drives, and so on.

Because the check data is simply the XOR of all the write-data values for the corresponding sector on each of the data disks, the new check data for a single-sector write can be calculated without having to read the corresponding sectors from the other data disks as long as the old sector data and the old check-data values are known. Thus, only two disks are involved in a single-sector write operation: the target data disk and the corresponding disk that holds the check data for that sector. This is in contrast to the RAID 3 implementation, which requires all drives in a group to be read and written when a single-sector-size write occurs.

The primary benefit of the RAID 5 distributed check-data approach is that it permits multiple write operations to take place simultaneously. It also allows multiple reads to take place simultaneously and is efficient in handling small amounts of information.

Recovering and Rebuilding

The figure illustrates how data recovery works in RAID 3, RAID 4, and RAID 5 disk array designs. When data is written to multiple data disks, the XOR of all the data values is written to the check disk. If any one disk fails, the missing data from that disk can be determined (i.e., recovered) by taking the XOR of the data values from the remaining data drives and the check disk. This is a simple operation that can be implemented in either the system software or the host adapter.

When a failed drive—whether it's a

data or check disk—is replaced, the data on the replaced drive must be rebuilt so that it contains all the information from the original drive. Until the replaced disk is completely rebuilt, the disk array is vulnerable to another drive failure, which would be catastrophic. Once rebuilding is complete, however, the disk array returns to a fault-tolerant state, allowing any single disk to fail without disrupting system operation.

The operating system's disk array driv-

er is responsible for overseeing the rebuilding of a replaced drive. Interleaved with normal system activity, the data from the good drives in the array must be systematically read by the driver, which must then recover the missing data (using the XOR procedure described above) and store the recovered data on the replacement drive. Since the server system's CPU and disk resources are used for this process, a system performance degradation results until the rebuilding process is complete.

continued

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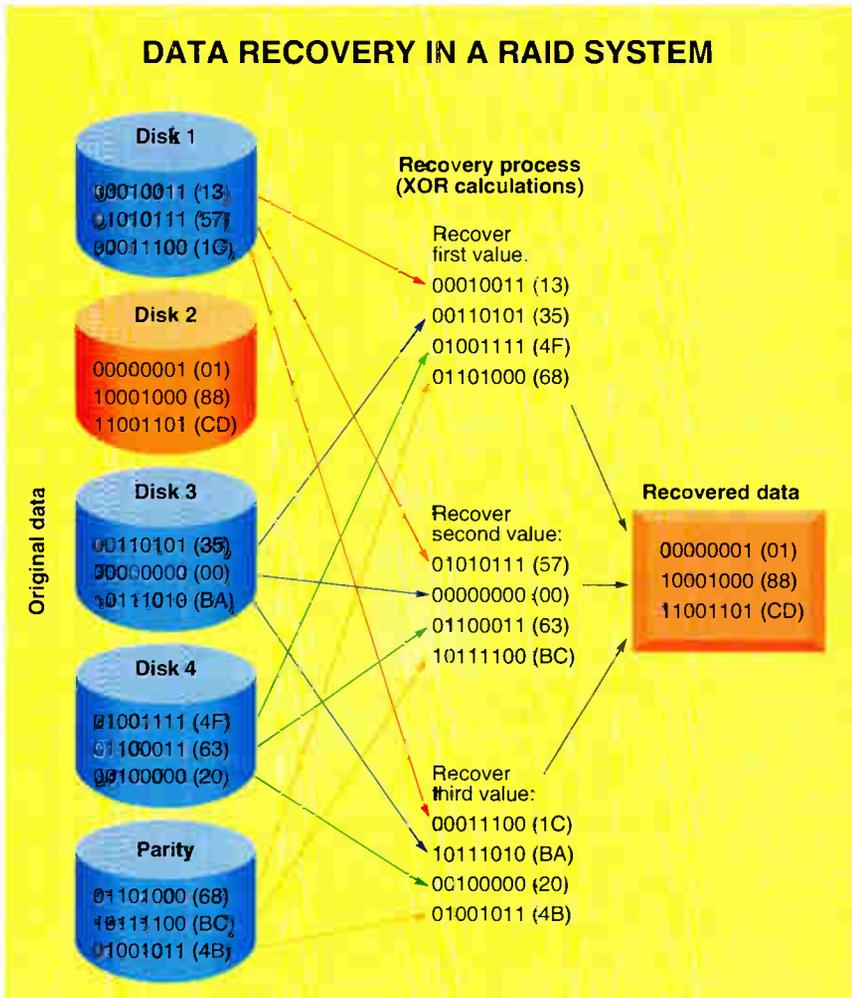
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In this example, disk 2 (shaded in red) has failed. The system recovers the data one value at a time. To recover the first value, the system reads the first value from each of the remaining disks and calculates an XOR on them, producing the first lost data value from disk 2. The process then repeats until the system has recovered all values. The process is the same for RAID 3, 4, or 5.

Real-World Disk Arrays

Disk array implementations, while generally based on the designs described here, vary considerably among manufacturers. Some companies combine features of different array architectures to create a hybrid. Others take the concept of redundancy beyond the drive, incorporating redundant controllers and/or power supplies (see "No More Data Loss: The BYTE Lab Tests Six Disk-Array Subsystems," August BYTE).

Compaq was an early supplier of microcomputer disk arrays with its Systempro. This is essentially a RAID 4 implementation that gives you the ability to add a second controller that mirrors/duplexes two RAID 4 groups. Dell supplies its Dell Drive Array, another RAID 4 implementation, but it lacks hot-swap capabilities.

Despite these offerings, the general industry trend in disk arrays heavily favors RAID 5 over RAID 4. Since the same hardware can generally be used for either architecture, the primary difference is in the more complex software drivers required to implement RAID 5. It seems likely that existing RAID 4 implementations will eventually move up to the higher performance offered by RAID 5.

Another example of a modern disk array implementation is Legacy Storage Systems' Mass HFD NetSpan disk array for NetWare systems, which offers duplexed RAID 0/1 functionality with redundant SCSI controllers and redundant power supplies, one for each of the duplexed channels. The system, which can also operate as a RAID 5 disk array using optional software, features hot-swappable drives and

auto-sensing power supplies. If one supply senses that the other has failed, it provides power for both channels instead of just its own. Core International's CPR-400 disk array is a RAID 3 implementation that can operate with NetWare systems. It incorporates redundant controllers and power supplies and allows hot-swapping of failed drives, power supplies, and controllers.

Some companies, such as Chantal Systems and Integra Technologies, offer software-only RAID 5 solutions that support hot-swapping of failed drives and on-the-fly data rebuilding when a new drive is installed. Others offer specialized controllers that off-load some of the data-manipulation duties (e.g., check-data calculation) from the LAN processor to reduce system overhead and increase performance, such as Ciprico's RimFire 6600/10 series. NCR also has developed a special drive controller for optimizing disk array operations, and it now offers a disk array that can accommodate a combination of array architectures simultaneously, including RAID 0/1, RAID 3, and RAID 5.

In the Unix workstation arena, Storage Concepts offers SCSI-based RAID 3 disk arrays designed to operate optimally with the specific I/O structures used in Unix and Unix-like operating systems, which do not readily accommodate the concurrent-I/O operations of RAID 5.

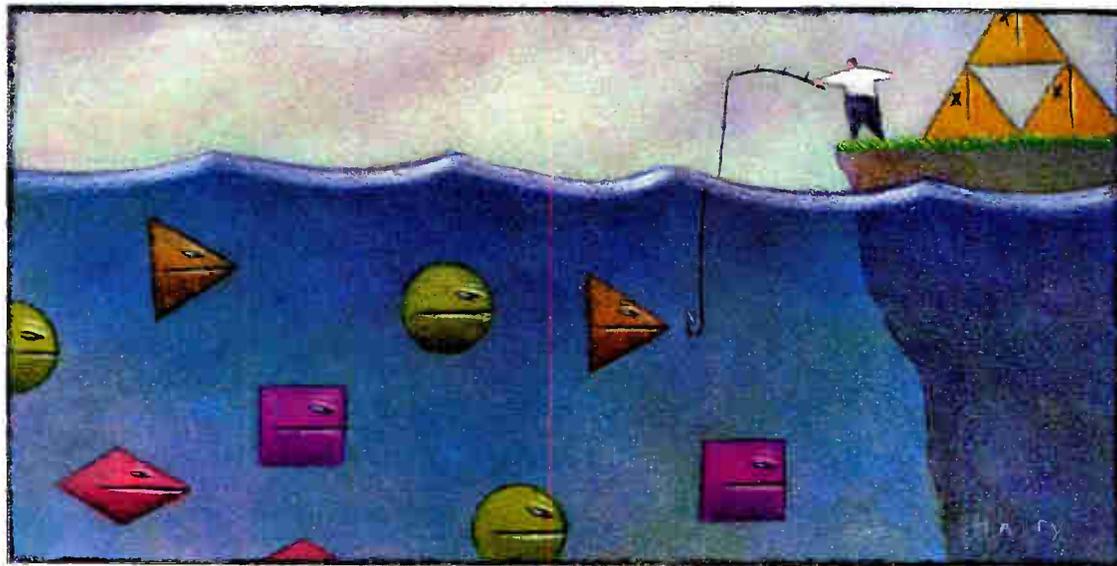
Beyond simple mirroring, disk arrays are establishing themselves as a reliable, fast, high-capacity, and economical way to implement disk subsystems for personal computer LANs. Mirroring and duplexing are still appropriate for smaller installations that require fault tolerance and modest disk capacity, but RAID 3 and RAID 5 disk arrays, with similar fault-tolerance and performance characteristics and better disk-space utilization, are proving their worth in larger installations. While users with mission-critical applications will make the move to disk arrays out of necessity, many with less-critical applications will choose disk arrays because the increased performance and data availability make good economic sense for their companies. ■

ACKNOWLEDGMENTS

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MAC OOP EXPLAINED



OOP (object-oriented programming) has become increasingly popular over the past several years, and for good reason. Once you've overcome a few hurdles, this programming method can dramatically shorten the amount of time needed to construct an application, compared to traditional procedural programming. The reason is simple: With OOP, you create modular objects to build applications. Once you've created these objects, you can easily integrate them into subsequent applications.

You won't realize the benefits of OOP until you've created a series of classes. And it may take as long (if not longer) to construct the needed classes for your first OOP application as it would to construct standard procedural code. As you go on to develop further applications, however, you can reduce development time by using classes you developed in previous applications.

Object-compiler vendors help you get started by including *class libraries*—a group of classes structured to assist you in developing applications. Within those classes are the methods and instance variables that are required to perform actions such as controlling menus, drawing, handling mouse-clicks and key presses, printing, and saving files. Two popular class libraries for the Macintosh are MacApp for MPW and the Think Class Library for Think C.

To help you better understand how OOP programming works, I've built a sample program using the TCL. My program implements a tool palette similar to those

used in draw and paint programs. It has three buttons: an arrow tool, a text tool, and a rectangle tool. Each specifies a different cursor shape when it's selected. The arrow tool shows the arrow cursor, the text tool displays the I-beam cursor, and the rectangle tool shows the cross-hairs cursor. The rectangle button changes its icon whenever the user double-clicks on it. This feature might allow the user to choose an outline-only or filled-drawing mode for rectangles. Listing 1 includes code fragments from the tool palette program.

Inheritance Issues

As a programmer, you're probably familiar with OOP's inheritance hierarchy of classes. Figure 1 shows a portion of the TCL inheritance hierarchy, or *class hierarchy*.

The class hierarchy defines the library classes as they relate to object-oriented concepts. This is the structure that defines the inheritance path, the instance variables, and the methods of each class. The relationships between the classes in this structure are based solely on subclasses and superclasses.

Many classes in libraries are abstract. You use them not to create objects directly, but to provide methods and instance variables that subclasses inherit. In the sample program, I created subclasses for the abstract TCL

Object-oriented programming can cut your development time on the Mac

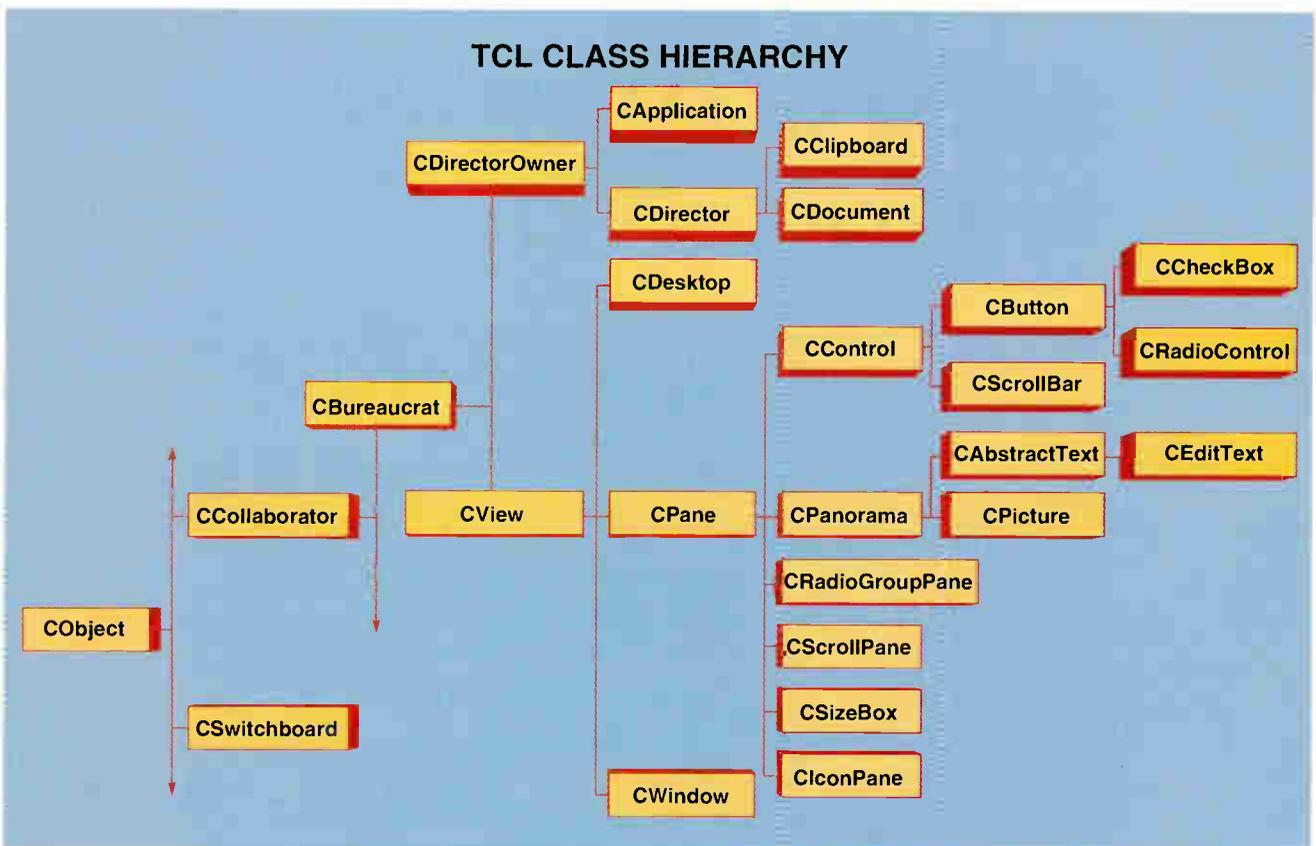


Figure 1: A portion of the TCL class hierarchy. This structure defines the inheritance path, the instance variables, and the methods for each class.

classes CApplication, CDocument, and CPane. I call these subclasses CDemoApp, CDemoDoc, and CDemoPane, respectively.

CDemoApp contains no special instance variables or new methods. It is similar to the Application subclass in any of the examples included with Think C. CDemoDoc is similar to the Document subclass in any of the examples included with Think C, but I have modified the BuildWindow() method to create the tool palette. CDemoPane contains three methods that control the cursor shape. These change depending on the palette tool chosen.

For the sample program, I created two other subclasses: CIconButton and CPalettePane. CIconButton is a subclass of CIconPane. CIconPane is part of the standard TCL and is a subclass of CPane. CIconPane can draw an Icon or cicon resource, and it can behave as a button. The sample program requires the subclass CIconButton to perform functions that CIconPane does not support, such as highlighting only one icon button at a time, handling the swapping of icons whenever a user double-clicks on a control, and displaying a specific cursor whenever the

icon button is active.

CPalettePane is a subclass of CPane, but it's nearly identical to the TCL class CRadioGroupPane, which simply supervises a set of radio buttons. CPalettePane behaves similarly by controlling the on and off states of the palette buttons. My sample program requires CPalettePane because CRadioGroupPane assumes it is using objects of type CRadioControl, not CIconButton. And unlike CRadioGroupPane, CPalettePane also handles different cursors for the different icon buttons it controls.

Even though inheritance is an important part of OOP, it is good only for describing what methods and instance variables are shared between classes. It does not explain how the classes interact with each other. For example, while most applications have windows, the Window class is not a descendant of the Application class.

As another example, you might think from looking at figure 1 that the Desktop class directly interacts with the View class, because CDesktop is a subclass of CView. This is not true, because these are only inheritance relationships. Each class inherits

all its methods and instance variables from its superclass. Therefore, a Desktop is a View, a Desktop acts as a View, and a Desktop responds to messages as a View would.

The question now is how library classes interact with each other. How do objects receive messages to draw windows and their contents? How does an application know what to do when a user clicks? The answers to these questions lie in the interaction relationships defined in other class organization structures. These other structures control two types of operations that occur in all Macintosh applications: displaying information and executing commands. Any Macintosh class library must handle these two operations. The TCL implements displaying information and executing commands in two distinct structures. But before I begin explaining these other structures, you must understand the starting gate of all TCL messages.

The Switchboard

The key to displaying information and executing commands is in how the TCL interacts with the Macintosh Event Manager. Any Macintosh programmer knows that

SOME ASSEMBLY REQUIRED

the Event Manager is the application's connection to the real world. The Event Manager intercepts any mouse-clicks, key presses, disk insertions, or network activity and dispatches them to the application. Therefore, to construct Macintosh applications properly, class libraries must have a connection to the Event Manager. The CSwitchboard class is the TCL's connection to the Event Manager.

CSwitchboard is not an abstract class. In fact, it is robust enough that you should never have to create a subclass for developing applications. The tool palette example uses an unmodified CSwitchboard.

A method within CSwitchboard calls `WaitNextEvent()`. After getting an event record, the switchboard determines the type of event and dispatches it appropriately. This dispatch starts the actions needed to display information or execute commands.

Displaying Information

Macintosh class libraries usually have a structure that supports displaying information. The classes in the TCL that do this are part of the visual hierarchy and are descendants of the View class. The

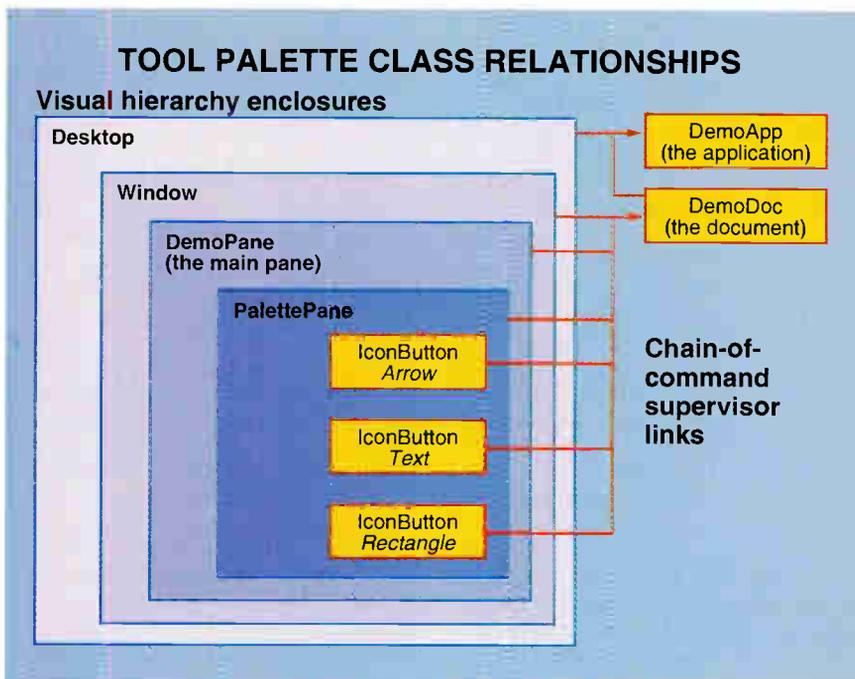


Figure 2: The class relationships for the visual hierarchy and chain of command in the tool palette example. Note that the views are also in the chain of command.

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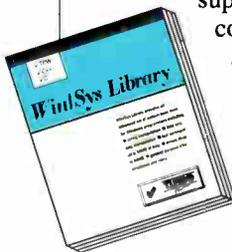
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visual objects that a user sees are known as *views* because of their ancestral relationship with the View class. These visual objects include the Mac Desktop, windows, and panes within windows. In figure 1, the Desktop, Window, and Pane classes are all Views.

While inheritance relationships link classes in the class hierarchy, *enclosures* link CView, CDesktop, CWindow, CPane, and the other classes in the visual hierarchy. The all-encompassing enclosure is the Mac Desktop, which is at the top of the visual hierarchy. Enclosed within the Mac Desktop are windows, and within windows are panes. A pane within a window is an example of a *subview*—a view enclosed by another view.

Glance at your Mac's screen, and you will see the general relationships between the classes associated with the visual hierarchy. The view that fills the screen is the Mac Desktop, and on the Desktop are windows. A subview of a window is typically a pane. Panes present text, graphics, and even controls to the user.

As a Macintosh Toolbox programmer, you know that all drawing on a Mac occurs in windows, not directly on the Mac screen.

You must now understand that all drawing using the TCL occurs in panes and that panes can be nested. Each pane has its own QuickDraw drawing environment, so you can draw in a pane without worrying about its location.

In my sample program, the Mac Desktop encloses the window, and the window encloses several panes. The IconButtons and the PalettePane are all Panes and are therefore part of the visual hierarchy. The IconButtons are subviews of the PalettePane, and the PalettePane is a subview of the Window object.

Even though views may have subviews, be careful not to think of views as having inheritance relationships. While the Mac Desktop encloses a window, a CWindow is not a CDesktop. Enclosures form the relationship link in the view hierarchy.

I have discussed how enclosures link visual objects. These visual objects communicate with each other and to the application by way of *visual events*. The visual hierarchy can accept and act on these events, which consist of actions from the user or messages from other objects. Visual events from a user include mouse-clicks and cursor adjustments. Visual events from

other objects include toolbox activate and update events.

Activate or update visual events always have a window associated with them, so the calling object sends these messages directly to the window object. For example, if the Switchboard discovers an update event, it sends an `Update()` message to the window requiring the update. The window then sends `Draw()` messages to each of its subviews (generally panes), instructing each of them to perform their required drawing updates. Each view only needs to know how to draw itself through its `Draw()` method. This feature shows a definite advantage of using OOP and class libraries.

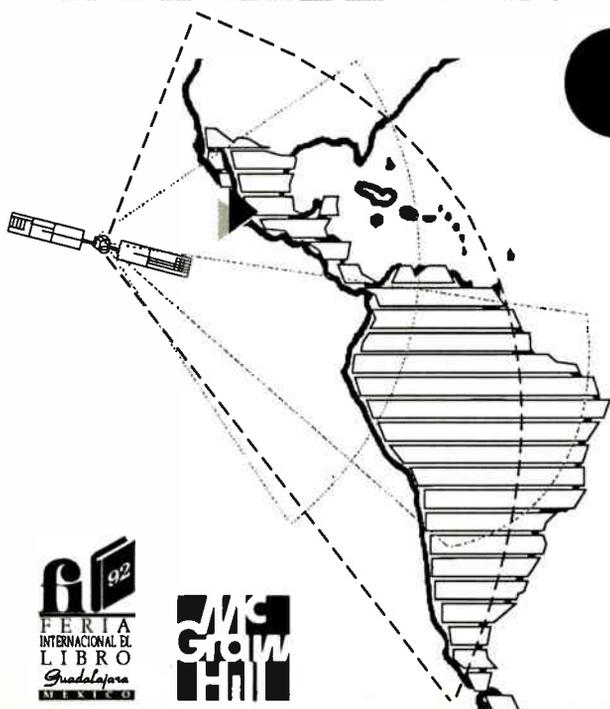
All mouse-click and cursor-adjustment visual events start at the top of the visual hierarchy. If the Switchboard receives a mouse-down event, the Desktop object is first to receive a visual event, since it is the view that encloses all others. The Desktop object then determines whether the cursor is within the menu bar, a desk accessory, or a window. If the cursor is in the drag, go-away, zoom, or grow region of a window, the Desktop object sends the appropriate message to that window.

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Listing 1: The `DoClick()` method in `CIconButton`. This method runs when a user clicks on an icon button.

```
void CIconButton::DoClick(Point hitPt, short
    modifierKeys, long when)
{
    short          iconSwap;
    if ( gClicks == 1) {          // Only a single-click
        if ( GetValue() != BUTTON_ON) {
            SetValue( BUTTON_ON);
            if ( clickCmd != cmdNull)
                itsSupervisor->DoCommand( clickCmd);
        }
    } else if ( gClicks == 2) {  // User dbl-clicked
        if ( secondIconID != (short)0) {
            iconSwap = iconID;    // Swap icon IDs
            iconID = secondIconID;
            secondIconID = iconSwap;
            // Load new icon
            CIconPane::IIconPaneX( fPreferColor);
            SetValue( BUTTON_ON); // Draw new icon
        }
        if ( dblClickCmd != cmdNull)
            // Send dbl-click cmd
            itsSupervisor->DoCommand( dblClickCmd);
    }
    // Set cursor to appropriate symbol
    BroadcastChange( cursorChanged, &cursorID);
}
/* CIconButton::DoClick */

END
```

If the cursor is within the content region of a window, then the Desktop object sends a `DispatchClick()` message to that window. The window then determines the subview within which the cursor appears and sends a `DoClick()` message to that subview. The subview will probably consist of a pane enclosed by the window.

The sample program consists of a Mac Desktop with a window, a `PalettePane`, and a series of `IconButtons`. The `DemoPane` sits within the window. If a user clicks on an `IconButton`, the `Switchboard` sends a `DispatchClick()` message to the `Window` object. The `Window` object then locates the subview where the mouse-down occurred (the `IconButton` object) and sends it a `DoClick()` message.

Another advantage of using class libraries should now be evident: Classes that have already been created handle all the visual event dispatching, including calling the TCL methods `DispatchClick()` and `DoClick()`. The only thing that needs to be done in the tool palette example is to define what the `IconButtons` will do when the user clicks on them. To define these actions, you must override the `DoClick()` method from the `CIconPane` class, as shown in listing 1.

`DoClick()` first checks for a single- or double-click by reading the TCL global variable `gClicks`. (The `Switchboard`

object sets `gClicks` to the number of mouse-clicks.) If the user initiates a single-click, the program calls `GetValue()` to ensure that the button is not already on before making a call to `SetValue()` to turn on the button.

If the user initiates a double-click, the program checks for a non-null value in the instance variable `secondIconID` to determine whether a second icon is available. If so, `DoClick()` loads the second icon. It does this by swapping icon resource IDs with `iconID`, an inherited instance variable from `CIconPane`, and then calling the inherited method `IconPaneX()`. `IconPaneX()` already handles the actual loading of an icon resource. The example simply takes advantage of the features of an inherited method.

There are no `Draw()` methods in the subclasses created in this example. The superclass to `CIconButton`, `CIconPane`, has a `Draw()` method, and since `CIconButton` is a subclass of `CIconPane`, it inherits `CIconPane`'s `Draw()` method. The `Draw()` method in `CIconPane` calls another `CIconPane` method, `DrawIcon()`. `SetValue()` in `CIconButton` calls the same method. Here again, I am taking advantage of an inherited method.

Although `CPalettePane` is a pane, it is not visible to the user. It exists simply to enclose the icon buttons for control

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OCTOBER 1992 • B Y T E 271

possible commands that can be handled in each case condition. If the command number does not equal one of the case conditions, the bureaucrat cannot handle the command, which is then automatically sent to the bureaucrat's supervisor through the default condition of the following switch statement:

```
default:
    itsSupervisor->
        DoCommand(aCommand);
    break;
```

Since it is at the top of the chain of command, the Application class does not have a supervisor. If the Application object can't handle a command, no object can.

The top of the chain of command in the sample program is the Application object CDemoApp. CDemoDoc is one of its subordinates. CDemoDoc supervises all other objects, including the window, CDemoPane, CPalettePane, and CIconButton. Figure 2 shows the general relationships that exist between the classes associated with the chain of command and the visual hierarchy.

The tool palette example has code that

could associate command numbers with each palette control. If a click command is defined, a DoCommand() message is sent to the document—the button's supervisor—when the user clicks on an icon button. Listing 1 shows this action. Sending the message SetClickCmd(command-Number) to an icon button sets the command number for that object.

There is also a separate set of command numbers for double-clicks on a control. If a double-click command is defined, the program sends it to the button's supervisor when the user double-clicks. Sending the message SetDoubleClickCmd(command-Number) to an icon button sets the double-click command number for that object.

To simplify the example, command numbers have not been defined, so the overridden method DoClick() does not send DoCommand() messages. The example does use standard TCL commands, such as New, Close, and Quit. You can add a command to change the drawing mode if the user double-clicks on the rectangle tool button. If the user double-clicks, then the program sends the defined double-click command to the button's supervisor,

CDemoDoc. CDemoDoc then takes whatever action is necessary to change between outline-only and filled-drawing modes.

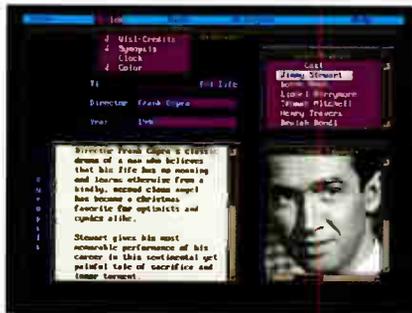
Direct commands use supervisors to form a hierarchy in the chain of command. However, communication can also occur between objects without a supervisory relationship. This is called *collaboration*.

Collaboration

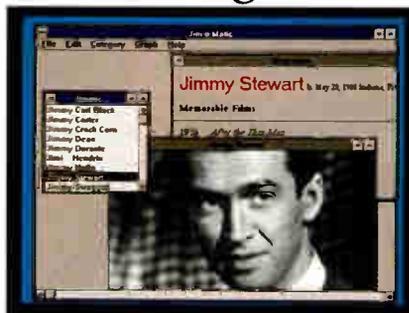
Every bureaucrat is a descendant of the class CCollaborator. A collaborator allows peer-to-peer communication between objects through dependencies. When you set up a dependency, one collaborator becomes the provider, and the other becomes the dependent. To set up a dependency, you simply send the dependent object a DependUpon(aProviderObject) message.

When a critical property has changed or an action has occurred, an object notifies its dependents through the method BroadcastChange(reason, info). To receive broadcasts of changed providers, dependent objects must include the method ProviderChanged(aProvider, reason, info). The reason and info parameters pass directly from the provider

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SOME ASSEMBLY REQUIRED

to the dependent. The `aProvider` parameter tells the dependent which provider sent the broadcast.

The tool palette example uses two types of collaboration: The `CDemoPane` class is dependent on `CPalettePane`, and each of the `CIconButtons` are dependent on the `CPalettePane`. When the user chooses a new tool, the `SetValue()` method in the `CIconButton` class sends a broadcast. The `CPalettePane` object intercepts the broadcast through its `ProviderChanged()` method, which has been overridden from the `CBureaucrat` class.

The overridden `ProviderChanged()` method turns off the previously selected tool since it has an instance variable, `currentStation`, that points to the selected tool object. The `ProviderChanged()` method in `CPalettePane` is identical to the method in `CRadioGroupPane`, except that references are made to `CIconButton` instead of to `CRadioControl`.

The `DoClick()` method in `CIconButton` sends another broadcast when a tool is changed to indicate a change in the cursor shape. The `info` parameter is `CURSORID`, an instance variable in `CIconButton` that contains the cursor resource ID

for that tool. The `CPalettePane` class also intercepts this second broadcast, but immediately rebroadcasts it. The `CDemoPane` class receives this second broadcast (since it is dependent on `CPalettePane`) and adjusts the cursor accordingly.

Like the `ProviderChanged()` method in `CPalettePane`, `ProviderChanged()` in `CDemoPane` is overridden from `CBureaucrat`. `ProviderChanged()` simply sets the `CDemoPane` instance variable `cursor` equal to the `info` parameter. When the `Switchboard` sends an `AdjustCursor()` message, the `CDemoPane` instance variable `cursor` is used to specify a cursor resource.

Starting Point

My toolbox example serves as a starting point for a drawing or painting application. In addition, it shows how you can use a tool palette to control any general application. Adding commands for single- or double-clicks and specifying color icons (instead of black and white) are a couple of easy ways to extend the capabilities of this program.

Classes within libraries have other relationships besides inheritance. Completely

different structures form when information is displayed or commands are executed. If you thoroughly review the `TCL` or any other class library, you will find a complex, yet robust, set of program code. The expanse of a class library is intimidating, and it may well take months for you to become familiar with the majority of classes. However, the time you invest will pay off in faster development times in the long run.

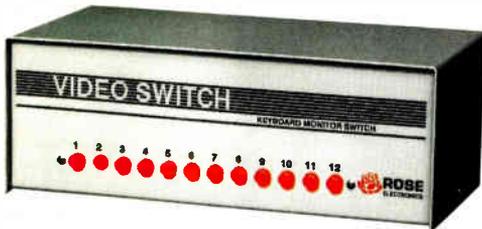
Class-library reference manuals usually describe the individual classes very well. But only by studying sample code will you understand how the various classes interact. ■

Editor's note: *Complete class listings for the sample program are available on BIX. Look for "tools.sit" in the "frombyte92" listings subarea.*

James H. Parshall is a computer systems consultant and graduate student at Purdue University's school of electrical engineering. He uses the TCL for developing client-server applications. You can reach him on BIX c/o "editors" or on the Internet at parshall@ecn.purdue.edu.

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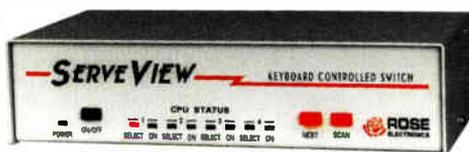
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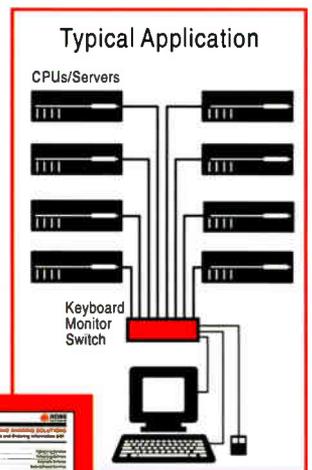
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CREATING BIT-MAPPED BUTTONS

If you're using standard buttons in your Windows programs, you can liven up the interface and make it easier to use by programming bit-mapped buttons. Imagine, for example, a delete icon shaped like a trashcan that opens and closes when you click on it.

To the user, bit-mapped buttons work like standard buttons. However, they're quite different from the programmer's standpoint. To use them, you must draw and load two 16-color bit maps, register a window class, and create a window using `CreateWindow`. DirManager, this month's Software Corner selection, uses five bit-mapped button icons that enhance clarity by using pictures instead of words. If implemented properly, bit-mapped buttons can do this for any program.

Standard Windows buttons exhibit common behaviors. When you click on a button in an application, it appears to push down. If you hold down the mouse button while moving the mouse cursor off the button, it pops up again. Move the mouse cursor back onto the button, and the button pushes down. Release the mouse button, and the program initiates an action.

Bit-mapped window buttons add color and style to your Windows programs

Behind the scenes, the button call-back procedure calls `SetCapture` to capture all mouse input. The button is still receiving mouse messages when the mouse cursor moves outside the button's window.

Beyond Bit-Mapped Buttons

DirManager is more than an exercise in programming bit-mapped 16-color buttons: It's a full-blown public domain File Manager replacement program for Windows. DirManager uses bit-mapped icons to perform several functions. Each bit map brings up a corresponding dialog box.

Like File Manager, DirManager divides its main window into two sections: A directory appears on the left and files on the right. DirManager lets you select one file or multiple files. You can view or execute

selected files, change their attributes, or copy, delete, rename, or move them. Note that DirManager launches your viewer or text editor; it does not include its own. To view a file, select it and double-click on the left mouse button. Double-clicking on the right mouse button executes the file.

DirManager can rename, create, and delete subdirectories, and it can sort files by name, date, size, or extension in ascending or descending order. Most commands have shortcut keys.

If an error occurs during a file operation, DirManager displays a dialog box that lists the error and the files that created it. DirManager does not stop a file operation on the first error, but it attempts the specified operation on each selected file. DirManager doesn't reread the directory after an error occurs, so the file remains selected. As a result, files shown in the file window may not actually exist in the selected directory. ■

James Stading is a software developer for Windows in Rockford, Illinois. You can reach him on BIX c/o "editors" or on CompuServe at 71035,3150.

MAC/Tom Thompson

NCSA Telnet for Macs

Oddly enough, there are occasions where I use Unix. Now, thanks to NCSA Telnet 2.5, I can use Unix from a Mac. NCSA Telnet is a public domain Mac application that establishes one or more interactive terminal sessions with Unix workstations via the TCP/IP telnet protocol.

NCSA Telnet runs on top of several flavors of TCP, but I recommend using the MacTCP version so you can work on remote Unix hosts while maintaining normal Mac file-sharing and printing services. NCSA Telnet supports graphics terminal emulation, and it includes ftp for file transfer. I've used NCSA Telnet from my Mac IIci running System 7.0 and MacTCP 1.1 to read mail on the Internet and to work remotely on the Silicon Graphics and Next workstations here at BYTE. NCSA stands for the National Center for Supercomputing Applications (at the University of Illinois), which developed NCSA Telnet 2.5 in coordination with Brigham Young University.

UNIX/Ben Smith

Stand-Alone Dired

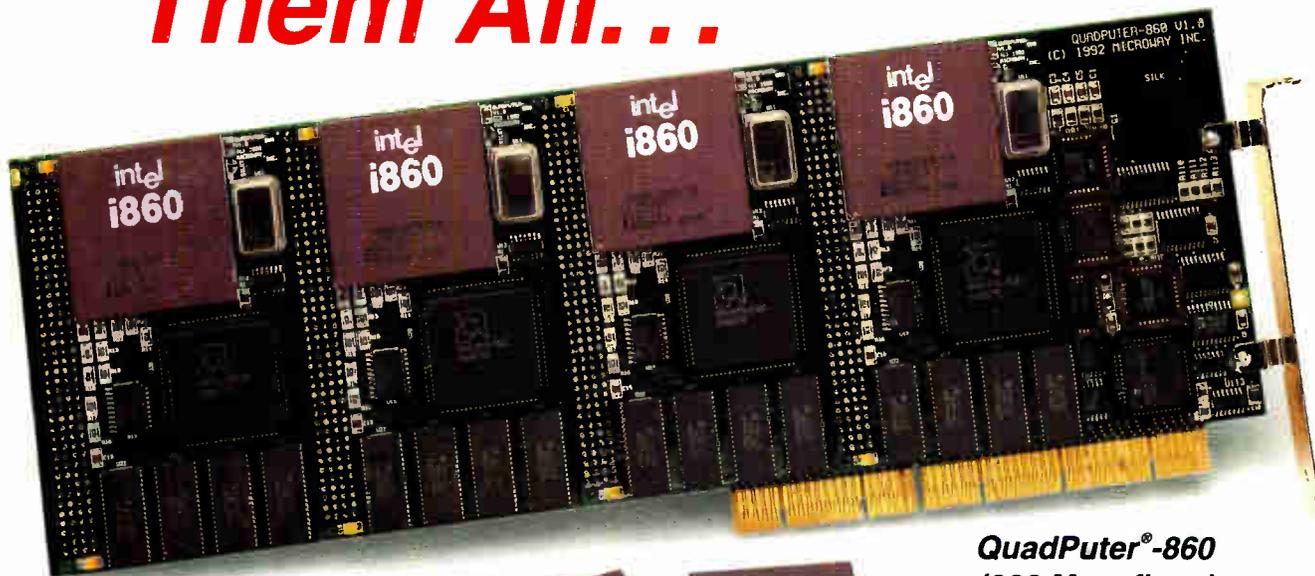
If you use an emacs editor, you're familiar with its `dired` command, which is a visual method of applying commands to files and directories. Thanks to Mike Lijewski, who is the author of a stand-alone public domain Dired utility, you can now have the ease of the `dired` command without the overhead of emacs.

Dired presents a screen that looks like the output from `ls -l`. If you press the `e` or `f` key when the cursor is on a file, Dired loads the file into your editor. If the cursor is on a directory, you move to that directory. In this way, you can navigate a directory tree. Dired also has commands for deleting, renaming, changing ownership and permissions, page-at-a-time viewing, printing, and searching for strings within the directory list.

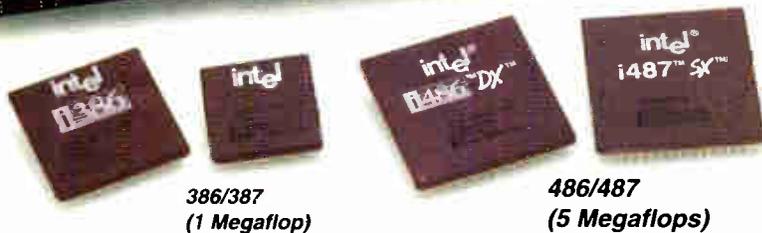
Dired is written in C++ and is somewhat tricky to port. It's been tested on many Hewlett-Packard systems, as well as on SunOS, GNU C++, and AT&T C++ systems and compilers.

Editor's note: Software Corner highlights public domain, freeware, and shareware programs. The programs are available in electronic format. 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.

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OS/2 2.0 PROGRAMMING TOOLS ARRIVE—FINALLY

Now that IBM has released OS/2 2.0, development tools are beginning to emerge. The 32-bit version 2.0 runs almost every program available for DOS, Windows, and OS/2. Except for a few installation bugs, OS/2 2.0 works well. It's fast and easy to use, and it offers a wide range of configuration options never before supported. Best of all, developers have all the tools they need.

Early Beta Versions

IBM realized early on that it had to provide development tools for OS/2 2.0. Only 16-bit tools were available, and IBM's only C compiler, C/2, was based on an obsolete version of the Microsoft C compiler. While the IBM C compiler was being developed, IBM released beta versions of it, along with a debugger and development environment called WorkFrame/2.

For professional developers, the OS/2 2.0 beta program was a nightmare. The toolkit releases lagged behind the operating-system releases, so developing software with the latest beta release of the tools meant using an obsolete version of the operating system. The documentation with the beta toolkits was full of errors and omissions, and some manuals had references to obsolete OS/2 1.x functions. IBM was beating the 32-bit drum, but it was incapable of providing developers with timely releases of the tools necessary to develop new 32-bit applications.

IBM kept everyone informed through mailings and CompuServe's OS2DEV and IBMOS2 conferences. The company made no attempt to disguise or hide problems with the beta version and required no confidential disclosures to obtain the code. This was a refreshing change that went a long way toward reestablishing IBM's credibility with developers.

The First Steps

A few months after IBM released the OS/2 2.0 General Availability (GA) code, it be-

gan shipping version 1.0 of its 32-bit C compiler, C Set/2, as part of the IBM C Developer's WorkSet/2. Included in WorkSet/2 are the Presentation Manager debugger (IPMD), the WorkFrame/2 development environment, the kernel debugger (KDB), sample DLLs, the PMSpy program, the resource compiler, include files, migration tools, and many well-written source code examples.

WorkFrame/2 is a plug-in environment that lets you specify the compiler, assembler, debugger, and linker you will use. It lets you set the compile, link, or debug options to any value you want. It can generate make files and libraries. You can configure it through a simple user window. WorkFrame/2 works with projects rather

than individual files and directories.

You establish a project by entering the project parameters in the Project Control window. You can enter information such as the project name, project description, name of the make files, and compile/link/run options. Once you've entered the information about the project, you can build a new version of the target code by clicking on the "new" button in the Project Control window.

C Set/2 is a full 32-bit ANSI 1989 optimizing compiler that generates code for OS/2 2.0. The compiler supports 16- and 32-bit run-time coexistence, static and dynamic run-time libraries, HPFS (High Performance File System), and memory-mapped file I/O. It provides migration support for converting programs from OS/2 1.x to OS/2 2.0. C Set/2 produces tight, fast, and consistent code. It can't be used to develop virtual or physical device drivers, but C Set/2 is perfect for developing 32-bit applications.

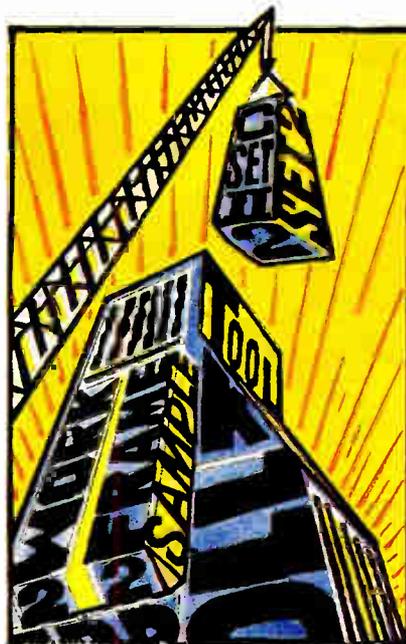
The WorkSet/2's IPMD makes debugging 32-bit applications a breeze. However, the WorkSet/2's initial price of \$895 turned off developers. Developers complained loudly, and IBM dropped the price to \$295 until September 1. It wasn't clear at press time if IBM would extend this policy.

Support Your Local ISV

IBM has also taken steps to do a better job of supporting ISVs (independent software vendors), who are critical to OS/2 2.0's success. IBM technical-support personnel have appeared on all major BBSes and conferencing systems, including CompuServe, BIX, Usenet, and Fidonet.

Several other OS/2 2.0 support programs are in place as well. The Developer Assistance Program ((407) 982-6408) helps commercial developers. IBM has a toll-free order line ((800) 342-6672) for OS/2 software and support material, and the IBM I.V. League supports authors and publishers. IBM is sponsoring several OS/2

**Numerous OS/2 2.0
development tools are
finally starting to appear**



2.0 tools conferences, where developers can get the most up-to-date information on OS/2 2.0 and associated development tools, and OS/2 migration workshops, where developers can get technical assistance in converting their applications to run under OS/2 2.0.

The Coming Onslaught

Some vendors began developing OS/2 2.0 tools before the GA code was released. Other vendors, noting the overwhelming response to OS/2 2.0, have announced products or plan to release products for OS/2 2.0 later this year. Current offerings include languages, CASE tools, debuggers, and other tools.

In the language area, C and C++ compilers for OS/2 2.0 have been announced by Borland International, Clarion Software, MicroWay, Symantec, and Watcom.

Watcom also has a 32-bit FORTRAN compiler, and Clarion has announced OS/2 2.0 versions of its Pascal and Modula-2 compilers. IBM is rumored to be working on its own C++ compiler, while Arity is shipping a 32-bit Prolog compiler for OS/2 2.0. Digitalk has released an OS/2 2.0 version of Smalltalk/V PM. Micro Focus and Liant Software have announced COBOL compilers for OS/2 2.0.

New CASE tools for OS/2 2.0 PM development have been announced by Caseworks, the Stirling Group, Guild Products, Guidance Technologies, Gpf Systems, VZ, Vleermuis Software Research, Software Engineering International, Enfin Software, ImageSoft, and Intelligent Environments. If you're migrating Windows applications to OS/2, check out Micrografx's Software Migration Kit.

I doubt that you'll need more debug-

ging tools than the ones IBM provides. However, you might want to consider Periscope's OS/2 2.0 version of the Periscope debugger and Soft & GUI's Error Manager debugging tool. SourceLine Software is shipping a hypertext source code browser for OS/2 2.0. Personal Systems Software sells a C-callable toolkit for writing OS/2 2.0 device drivers. Intersolv has announced OS/2 2.0 versions of PVCS, PolyMake, PolyAwk, and the Sage Professional Editor. Hamilton Laboratories has a 32-bit version of its C shell. GammaTech has a 32-bit version of its HPFS utilities. And Parallel PC's is shipping an OS/2 2.0 version of the Synectics SDK (Software Development Kit).

For those on a budget, several good public domain and shareware tools are available for OS/2 2.0. The public domain GNU C/C++ compiler for OS/2 2.0 is available

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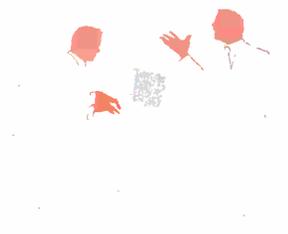
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24	Getty Oil	48	Coca-Cola	72	Colgate-Palmolive

27 million Americans can't read. And guess who pays the price.

While American business is trying to stay competitive with foreign companies, it's paying an added penalty. The penalty of double-digit illiteracy.

Believe it or not, 27 million American adults can't read and write. Another 47 million are literate on only the most minimal level. That adds up to almost one third of our entire population... and probably a disturbing number of *your* employees.

What does illiteracy cost you? Get out your calculator. Illiterate adults make up 50%-75% of our unemployed. Every year they cost us an estimated \$237 billion in lost earnings. They swell our welfare costs by \$6 billion annually and diminish our tax revenues by \$8 billion.

Illiteracy costs you through your community, too. It robs the place where you work and live of its resources. It undermines the potential of the people who make your products and the people who buy them. No dollar figure can be assigned to this. But over the years, this may be the costliest loss of all.

What can your company do about this? It can join in local efforts to fight illiteracy. It can volunteer company dollars and facilities for better school and tutorial programs. It can invest in a more literate community.

The first step is to call the Coalition for Literacy at **1-800-228-8813** or fill out the coupon below. Do it today. You may find it's the greatest cost-saving measure your company has ever taken.

A literate America is a good investment.



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HANDS ON/BEYOND DOS

on BIX, CompuServe, and other BBSes. You can also download several GNU utilities (e.g., rcs, make, awk, grep, and diff) and the GNU emacs editor.

The Written Word

IBM has announced the OS/2 Technical Library, a set of manuals for OS/2 developers that's priced at \$295. The manuals are a necessity for anyone programming for OS/2 2.0. For an in-depth technical overview of OS/2, get *The Design of OS/2* by H. M. Deitel and M. S. Kogan (ISBN 0-201-54889-5) from Addison-Wesley.

Van Nostrand Reinhold has published several new books, including *Client-Server Programming with OS/2 2.0* by Robert Orfali and Daniel Harkey (ISBN 0-442-01219-5), *Writing OS/2 2.0 Device Drivers in C* by Steve Mastrianni (ISBN 0-442-01141-5), and *OS/2 Presentation Manager GPI* by Graham Winn (ISBN 0-442-00739-6). Van Nostrand also offers a library of six books at a special price.

The Timing Is Right

Interest in OS/2 2.0 is growing by leaps and bounds. Even its most stubborn opponents have been impressed with its capabilities. The old OS/2 1.x supporters are still around, and they have been joined by an even larger group of users and developers eager to tap the multitasking and multiplatform support offered by OS/2 2.0.

IBM's aggressive pricing has prompted many Windows users to upgrade to OS/2 2.0 for only \$49.95; DOS users can upgrade for only \$99. Interest in OS/2 2.0 is also evident by the many messages that appear in public electronic conferences.

Have the tools arrived to develop the new-generation 32-bit software for OS/2 2.0? You better believe it. The time is right to begin development. Sure, you'll want to keep some of your DOS and Windows applications around, but you can realize the full power of OS/2 only with new 32-bit OS/2 2.0 applications. As PC users become more demanding, they'll begin to appreciate the power and flexibility of OS/2 2.0. The ability to download a file over the telephone while simultaneously updating a database, printing several files, and editing a document should convince the most skeptical user that OS/2 2.0 represents the best solution for desktop software applications. ■

Steve Mastrianni is president of Personal Systems Software in Bloomfield, Connecticut. He specializes in device drivers, operating systems, and real-time applications for OS/2 and Windows NT. You can reach him on BIX as "smastrianni" or on CompuServe at 71501,1652.

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ASK BYTE

File Convenience

I'll soon be getting a 486 computer. I do not look forward to reinstalling all my software, especially since I've customized most of my programs for the way I work. Can I use a file transfer utility to port over my program files to the new machine?

Monte Smith
Burley, ID

Moving all your files to the new machine using a file transfer application is a simple and quick method for getting your new machine up and running. Although you probably won't encounter any problems, several issues should concern you.

If you are transferring files from a 386SX or 386DX computer, you shouldn't have any problems. If you are moving from a 286 or 8088 machine, however, you may not be taking full advantage of some of your applications' capabilities.

Some applications determine your machine's configuration at installation time and install only the code for that processor. Although these programs will still run on the 386 or 486, you will not be getting the full advantage of a more sophisticated processor.

If you transfer applications from several logical drives to one larger drive on the new machine, you may need to run a setup utility to ensure that any internally maintained paths are updated to your new configuration. Once the files are transferred, you may want to run a file checksum program to ensure that the new files perfectly match the old ones. Checksum programs are available on many BBSes. Many antiviral applications also have checksum capability.

Make sure you don't transfer your copy of DOS from the old machine. This is very easy to do, and it may lead to some rather obscure and difficult-to-diagnose bugs. Finally, if you're moving Windows and you're not using the generic VGA driver, you'll have to run the Windows setup program and install the appropriate video driver before running Windows on your new machine.

—Raymond GA Côté

Bus Bust

I just bought a 1200-bps modem for \$49. When I plug it into my 12-MHz 286, I have to turn off the turbo mode before the modem will work. Why do I have to do this? My other 8-bit interface cards work fine. My computer has a generic motherboard that has no documentation.

Charlie Merritt
West Fork, AR

Your turbo switch probably changes the I/O bus speed as well as the processor speed. Modern motherboard I/O buses run at 8 and 10 MHz. Considering the price of the modem, it may be designed for operation only at 8 MHz, thus requiring you to turn off your turbo mode. Check the modem's documentation for recommended speeds.

—Raymond GA Côté



FTP Wanted

While reading the July BYTE, I was pleased to note that you have an Internet address. Is this address merely for correspondence, or does it contain an archive of some of your test programs that you use to do your benchmarks?

Matthew Hogan
s892983@minyos.xx.rmit.oz.au

I'm glad to see that you are on the Internet. Are you willing to answer technical questions over this network as you do when getting snail mail?

Klaus Hahn
Braunschweig, Germany

Yes, you can use Internet E-mail to reach BYTE editors. The name of BYTE's system is bytepb.byte.com. Our main connection for E-mail is through the most connected computer in the world, UUNET, in Falls Church, Virginia. We rely on UUNET for archived files and the source code to many of the Unix programs that we have written about in the Software Corner column.

Not all BYTE editors have accounts on bytepb, so address your letters to letters@bytepb.byte.com. Queries to specific authors or editors will be forwarded.

Address technical questions to askbyte@bytepb.byte.com. We'll try to answer your questions, but due to the volume of mail received, we can't guarantee a personal reply.

We do not currently make source code available via the Internet, but we're considering several options for doing so. One option is to establish a file transfer protocol connection to the network; another is to set up a mail server. Mail servers are less expensive and simpler. They also let users who don't have direct Internet access retrieve files. On the downside, sources must be broken into small files so they can move as mail messages, and there is an increased burden on intermediate sites in the mail path.

—Ben Smith, ben@bytepb.byte.com

Feeling Compressed

I just downloaded a compressed file of type .LZH. What utility should I use to decompress this file? I tried PKUnzip to no avail.

William O'Brien
Vienna, VA

You need LHA213.EXE, a free compression and archiving utility you'll find in the ibm.utils listings area on BIX and on many BBSes. LHA has a dual purpose. It's primarily designed to take normal executable or text files and make them smaller in size. This saves a great amount of storage space; typical files reduce to one-quarter to one-third of their original size. You can compress text files more than you can executable files.

LHA can also combine several files into one .LZH archive file. This lets you store complete hard disk directories in a single filename, and in a space typically one-half or less the original total. Putting many files into a

single compressed archive file makes distribution easier.

You'll find a wide variety of file-compression programs on BBSes and conferencing systems. Each creates its own file extension (e.g., .ARC, .DWC, .LZH, .PAK, .ZIP, and .ZOO). Each also has its own unique characteristics and compression format. Not all compression utilities are free, but most companies offer free decompression utilities. See the table for a listing of decompression utilities available in the *ibm.utils* listings area on BIX.

—Stan Wszola

BIX DECOMPRESSION UTILITIES

Extensions for most compressed files, the decompression utility to use, and the filename of each decompression utility in the *ibm.utils* listings area on BIX.

Extension	Utility	Filename
ARC	PKUNPAK.EXE	pk361.exe
ARJ	ARJ.EXE	arj230.exe
LZH	LHA.EXE	lha213.exe
PAK	PAK.EXE	pak251.zip
SDN	PAK.EXE	pak251.zip
SIT	UNFIT.EXE	unsit30.zip
TAZ	UNCOMPRES.EXE	comprs43.zip
ZIP	PKUNZIP.EXE	pkz110.exe
ZOO	ZOO.EXE	zoo210.zip

Necessary Literature

My daughter wants to buy a computer, and we need documentation that is detailed. I understand that the documentation with some computers is so meager as to be nothing more than a collection of component documents. With other machines, the documentation includes a detailed and complete exposition of the machine in toto. Has BYTE published any articles evaluating the quality and quantity of the documentation supplied by various vendors?

Howard E. Mayberry Jr.
Louisville, KY

In my long tenure at BYTE, I have never seen a review of computer systems based on the quality of the documentation. That would certainly be an interesting criterion for selecting a computer.

I've seen many computers and read a lot of documentation, but I'd be hard-pressed to pick the best company based on its manuals. The best advice I can give is that you purchase your computer from a major vendor. Check the ads in BYTE, and make a purchase from companies that are well established. Companies like Compaq, Northgate, Gateway 2000, and Dell have been successful because they pay attention to details like good documentation.—Stan Wszola

Installer's Tip

At BYTE, I often use a contact enhancer called Stabilant 22 when performing maintenance on computer

equipment. Stabilant 22 is a block polymer liquid that you apply as a thin film onto electrical contacts. It acts as a contact enhancer and corrosion inhibitor.

Stabilant 22 has another property—lubrication—that I didn't fully appreciate until I did extensive work with a variety of PGA (pin-grid array) chips. Installing a PGA chip (e.g., a 387DX math coprocessor) requires enough force that you may mash the pins or bend the motherboard and break some of the traces. Even with industrial-quality extraction tools, it's easy to reduce a \$200 chip to a paperweight.

Stabilant 22 reduces the force required to insert and extract a chip from its socket. It is also effective for DIP chips and leadless chip sockets. A half-ounce bottle of concentrated Stabilant 22 sells for \$68.50. It's available from D.W. Electrochemicals, Ltd., 97 Newkirk Rd. N, Unit 3, Richmond Hill, Ontario, Canada L4C 3G4, (416) 508-7500.—Stan Wszola

Next Monitor

I used an Eizo 21-inch monochrome monitor on my previous system. I plan to buy a monochrome Nextstation and would like to use the Eizo monitor. It is in many respects superior to the 17-inch Nextstation monitor. Is this possible?

I guess I'll have to connect the keyboard and mouse to the Nextstation via a sound box and make a special cable for the video signals. I assume this is more or less how things work with a Nextcube and a Nextdimension board. I don't mind doing some hardware work myself, but I want to be sure this is possible before investing too much money in such an experiment.

Andreas Muller
Bures-sur-Yvette, France

The Nextstation monitor has a 100-Hz video bandwidth and a 68.3-Hz vertical refresh. The pin-outs for the D-19 plug are as follows:

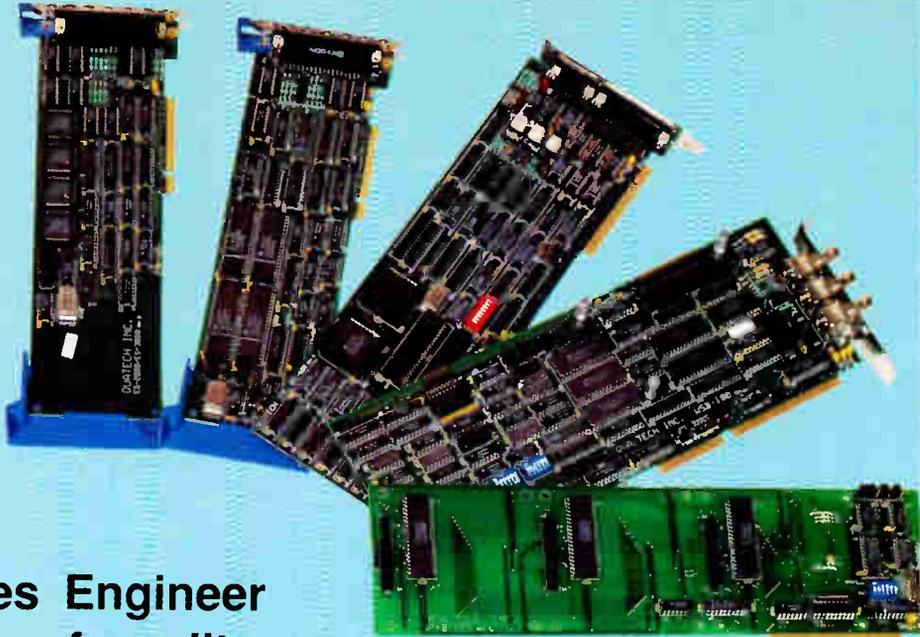
1	+12 V	11	+12 V
2	-12 V	12	-12 V
3	Monitor clock	13	Ground
4	Monitor data out	14	Ground
5	Monitor data in	15	Ground
6	Monitor power switch	16	Ground
7	Not used	17	Ground
8	Vertical sync	18	Ground
9	Horizontal sync	19	Ground
10	Video signal		

This should be enough information for you to at least decide if it will be feasible to use your Eizo monitor. Unfortunately, I was unable to find any data on your monitor.—Ben Smith ■

The BYTE Lab welcomes your questions. Address correspondence to Ask BYTE, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send BIX mail c/o "editors."

We read every letter, but due to the volume of mail received, we cannot guarantee a response. We edit all letters for clarity and brevity.

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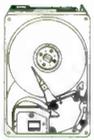
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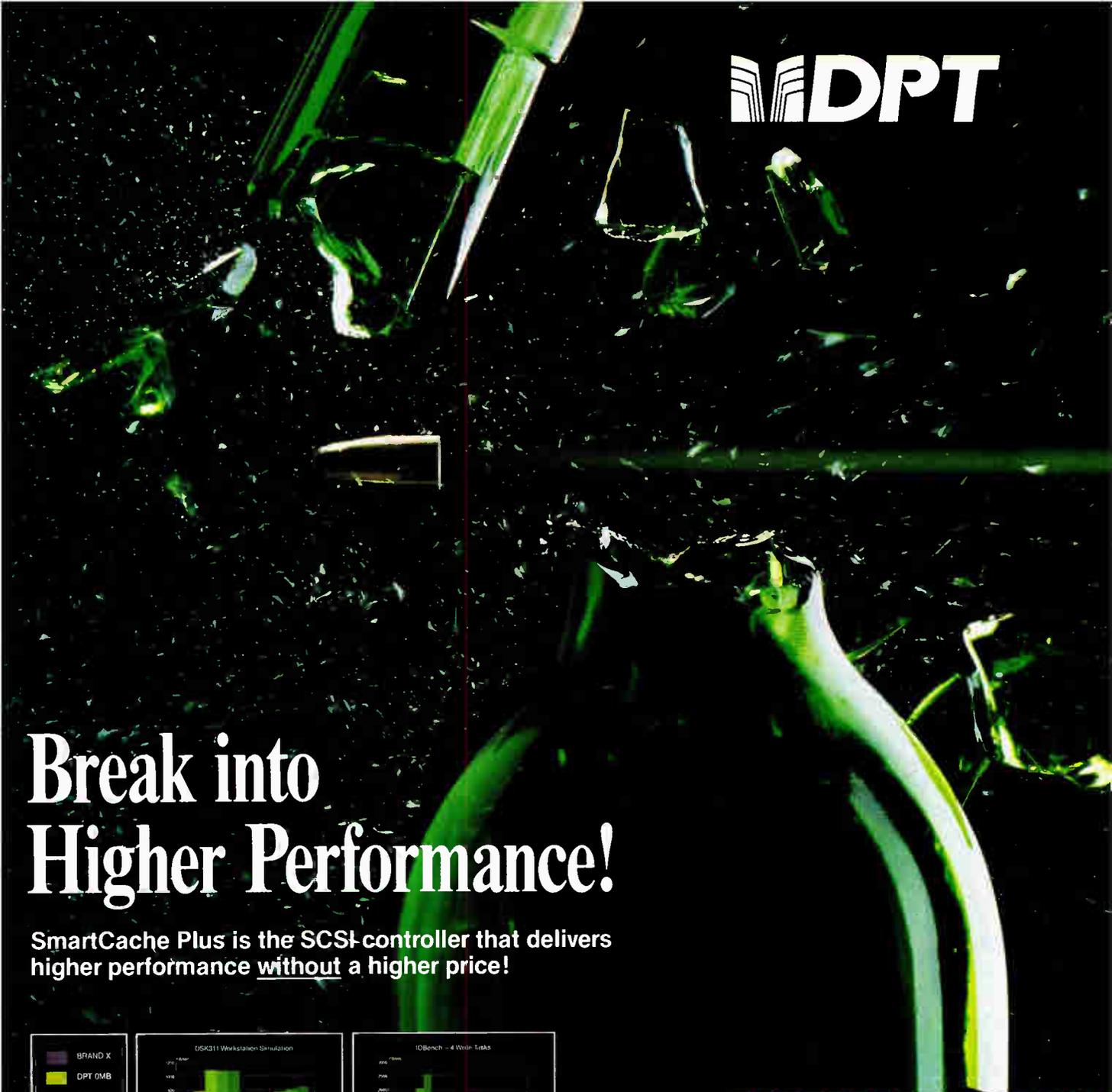
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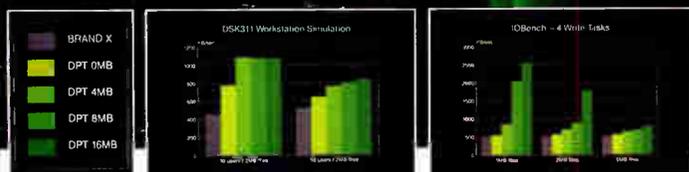
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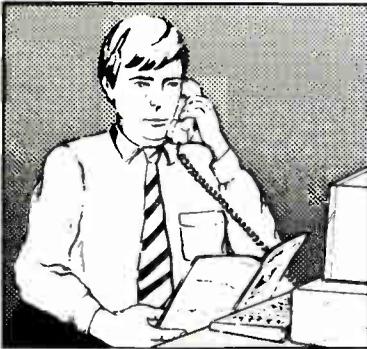
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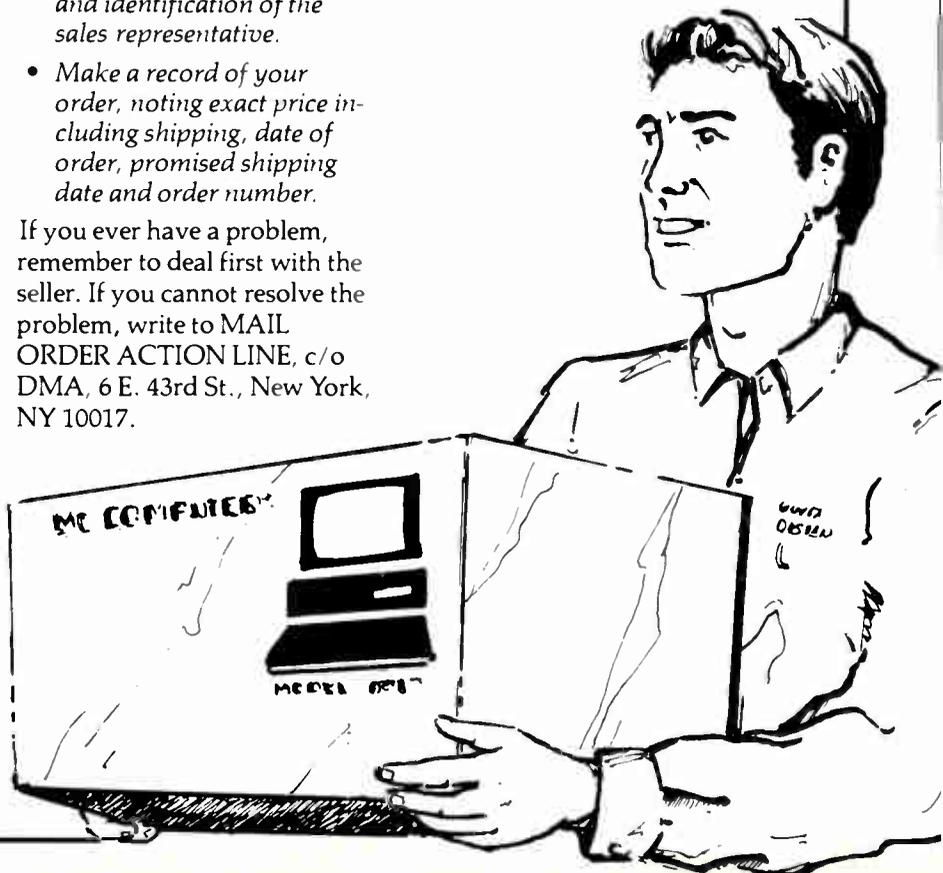
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DC600A-3M	60 Megabyte	19.99
DC6150-3M	150 Megabyte	20.99
DC6250-3M	250 Megabyte	24.99
D8-112-3M	8MM up to 5.0 GB	12.39

3M DISKETTES

3-1/2" Diskettes		
Part#	Description	Per Box/10
3.5DS	DSD	\$6.99
3.5DS/F	DSD Formatted	7.49
3.5SDH	DSHD	13.39
3.5SDH/F	DSHD Formatted	13.99
5-1/4" Diskettes		
Part#	Description	Per Box/10
5.25DS	DSD	\$4.89
5.25DS/F	DSD Formatted	5.39
5.25SDH	DSHD	8.49
5.25SDH/F	DSHD Formatted	9.19

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2C87-12	For 286 up to 12.5 MHz	\$53
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3C87-20SX	For 386SX up to 20 MHz	68
3C87-25SX	For 386SX up to 25 MHz	70
3C87-33SX	For 386SX up to 33 MHz	78
3C87-25	For 386 up to 25 MHz	76
3C87-33	For 386 up to 33 MHz	79
3C87-40	For 386 up to 40 MHz	101

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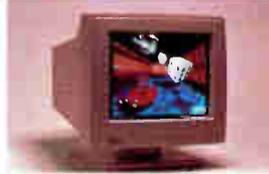


- M1440I BOCA V.32BIS, 14.4K Modem Internal \$239
- M1440E BOCA V.32 BIS, 14.4K Modem External \$319
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- MON-06 Paper White TTL 14" \$112
- MON-10 CGA/RGB (640x240) 14" \$219
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1MEGX9-70	1MB x 9-70 NS SIMM	38.00
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LS-604	LS-600 with HI voltage regulation	98
LC-1200	1200 Watts, 4 Outlets	139
LC-1800	1800 Watts, 6 Outlets	188
LC-2000	2000 Watts, 208/220/240 Volt	243
LC-2000X	220/240 V, 2000 watts, 6 Outlets	243
LC-2400	2400 watts, 110 V, 6 outlets	243
LCR-2400	2400 watt rack mt., 110 V, 14 outlets	287

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2 year warranty.

Part#	Description	Each
ISOTEL	Lifetime warranty, 4 outlet, 6 ft. cord and modem protector ("Gold Seal)	\$59
ISOFAFX	ISOBLOK w/ Modem protector	36
TSB	3 stage Modem/Fax protector	38
MP	Economy Modem/Fax protector	14
SMP	1 AC outlet w/modem/fax protector	29
SMP-GS	Lifetime guarantee. ("Gold Seal)	35

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Part#	Description	Each
IB2-0	2 outlet direct plug-in	\$23
IB2-0/20	2 outlet, 20 amp, direct plug-in	39
IB2-6	2 outlet, 6 ft. cord ("Gold Seal)	32
IB4	4 outlet, 6 ft. cord ("Gold Seal)	43
IB4/220	4 outlet, 6 ft. cord, 220 Volt	49
IB6	6 outlet, 6 ft. cord ("Gold Seal)	51
IB8	8 outlet, 12 ft. cord ("Gold Seal)	61
IB-8RM	8 outlet, 12 ft. cord w/remote power switch	69
EUROBAR	4 outlet, 6 ft. cord, 220/240 Volt Euro connectors	52
IBR-12	12 outlet, 19" rack mountable	89

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DDH-06	5 1/4 inch DSHD 1.2MB beige faceplate	59
DDH-09	3 1/2 inch 720K beige w/bracket	59
DDH-10	3 1/2 inch 1.44MB beige w/bracket	59
DDH-11	Same as DDH-10 without 5-1/4" Mounting bracket. Fits in 3-1/2" bay	55

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ST-3120A	105MB, 15MS IDE, 3-1/2"	\$319
ST-3144A	120MB, 19MS IDE, 3-1/2"	\$359
ST-1239A	210MB, 15MS IDE, 3-1/2"	\$639
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ST1480N	Seagate 426MEG, SCSI, 14MS, 3-1/2"	\$1399
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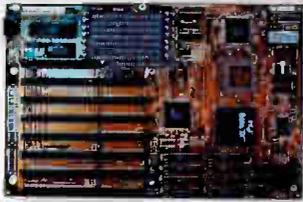
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MB286-20	20 MHz 286 Motherboard	\$95
MB386SX-25	25 MHz 386 Motherboard	\$159
MB386-33C	33 MHz 386 Motherboard	\$229
MB486-33	33 MHz 486 Motherboard	\$579

Descriptions and Prices on Mother Boards Subject to Change.

EXPANSION BOARDS

Part#	Description	Each
IFC-12	Serial Board PC/XT	\$11
IFC-25	2 Serial, Parallel, Game Board XT/AT	\$16
IFC-13	Parallel Board XT/AT	\$9
IFC-20	Game Board XT/AT 2 Ports	\$9
IFC-70	BOCA 2 Serial, 2 Parallel I/O Board	\$49

DISK CONTROLLER BOARDS

Part#	Description	Each
IFC-14	2 Floppy Controller Board PC/XT	\$13
IFC-15	Disk I/O Board Serial, Parallel, Clock, Game PC/XT	\$25
IFC-24	Fixed Disk MFM 2 Floppy Controller AT	\$69
IFC-27-2 AT	2/IDE 2/Floppy Controller	\$19
IFC-28	Fixed Disk Controller Board PC/XT XT MFM hard drive controller board.	\$47
ST-01	8-Bit SCSI Controller Board	\$29
ST-02	8-Bit SCSI/Floppy Controller Board	\$47
IN-2000	16-Bit SCSI Hard/Floppy Controller Board	\$189

POWER SUPPLIES

Part#	Description	Each
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PS-200M	200 watt XT power Supply	49
PS-200	200 watt AT Power Supply	59
PS-230	230 watt Large Vertical Case	79
PS-200MINI	200 watt Baby Vertical Case	59

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K-160	Enhanced Style Narrow Footprint	\$36
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K-158	Enhanced Style Small Footprint	\$43
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K-158-1	Small Footprint Spanish Language	\$47
KBY-39	Enhanced Style, 12 Function Keys, XT or AT	\$49
KBY-TRACK	Keyboard Trackball	\$79
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PPC301-6RA	DB25-36P 6 ft. (Rt. angle)	4.99
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PPC301-10RA	DB25-36P 10 ft. (Rt. angle)	5.99
PPC301-15	DB25-36P 15 ft.	4.99
PPC301-20	DB25-36P 20 ft.	5.99
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Part#	Desc.	Each	Part#	Desc.	Each
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25MM-10	10 ft.	4.99	25MF-10	10 ft.	4.99
25MM-15	15 ft.	6.99	25MF-15	15 ft.	6.99
25MM-20	20 ft.	7.99	25MF-20	20 ft.	7.99
25MM-25	25 ft.	8.99	25MF-25	25 ft.	8.99
25MM-50	50 ft.	16.99	25MF-50	50 ft.	16.99
25MM-100	100 ft.	32.99	25MF-100	100 ft.	32.99

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AB25-3E	3 Way Economy	13.99
AB25-4E	4 Way Economy	15.99
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PLE110	DB25 Male to Centronics 36 Pin Male with 50 Ft. of cable	\$59.95

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Ethernet BNC Cables

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58BC-10	RG-58 male-to-Male 10 ft.	\$4.59
58BC-25	RG-58 Male-to-Male 25 ft.	6.79
58BC-50	RG-58 Male-to-Male 50 ft.	8.89

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Part#	Description	Each
62BC-10	RG-62 Male-to-Male 10 ft.	\$6.89
62BC-25	RG-62 Male-to-Male 25 ft.	9.39
62BC-50	RG-62 Male to Male 50 ft.	13.89



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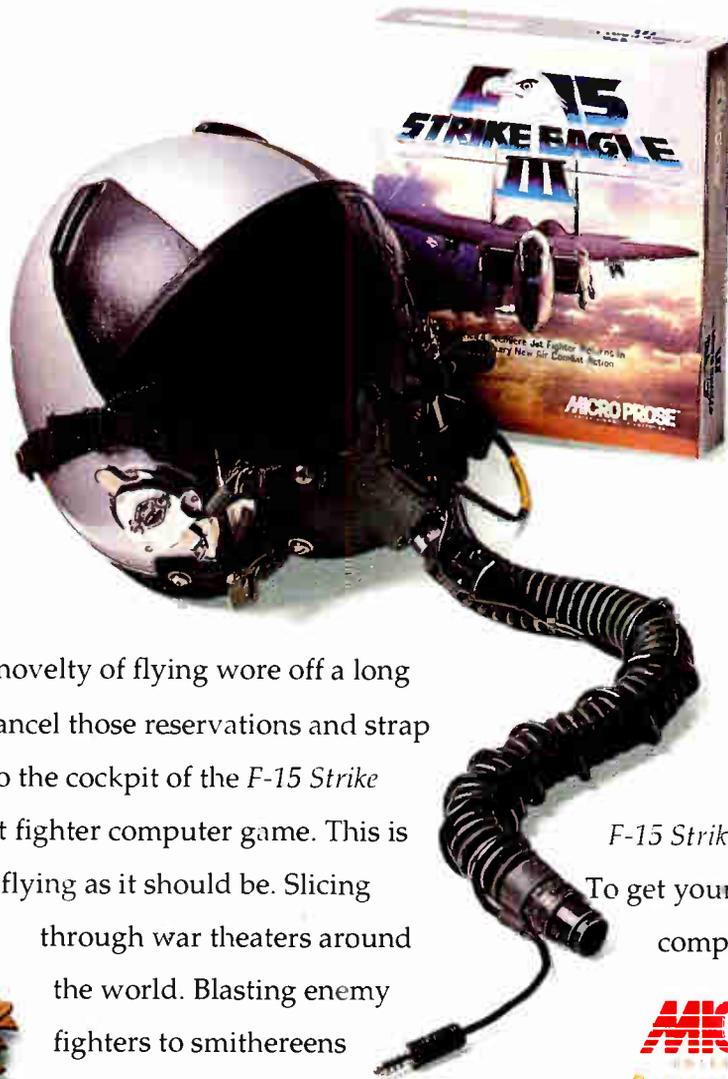
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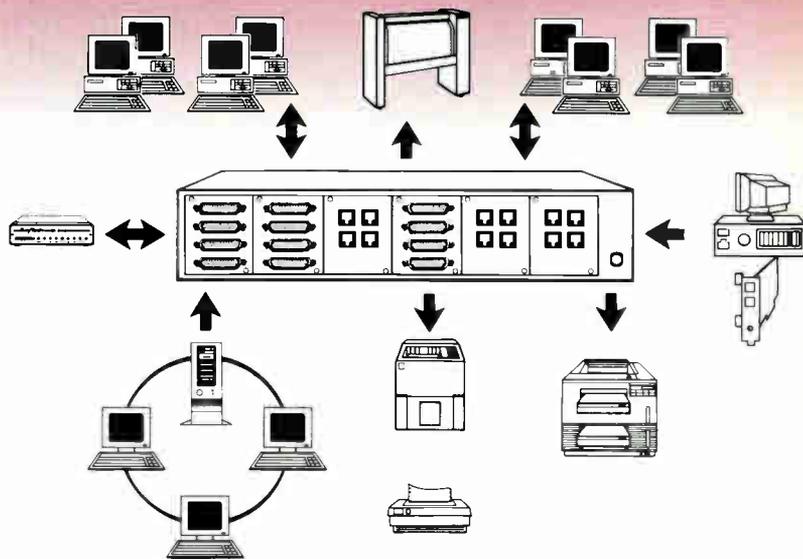
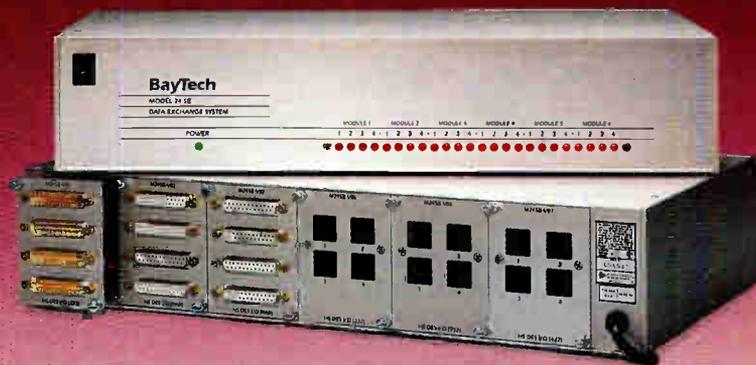
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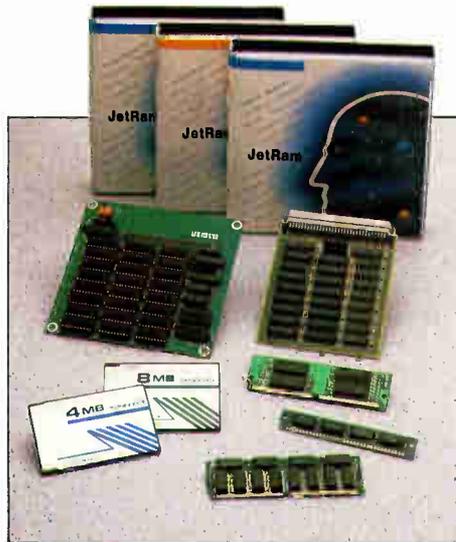
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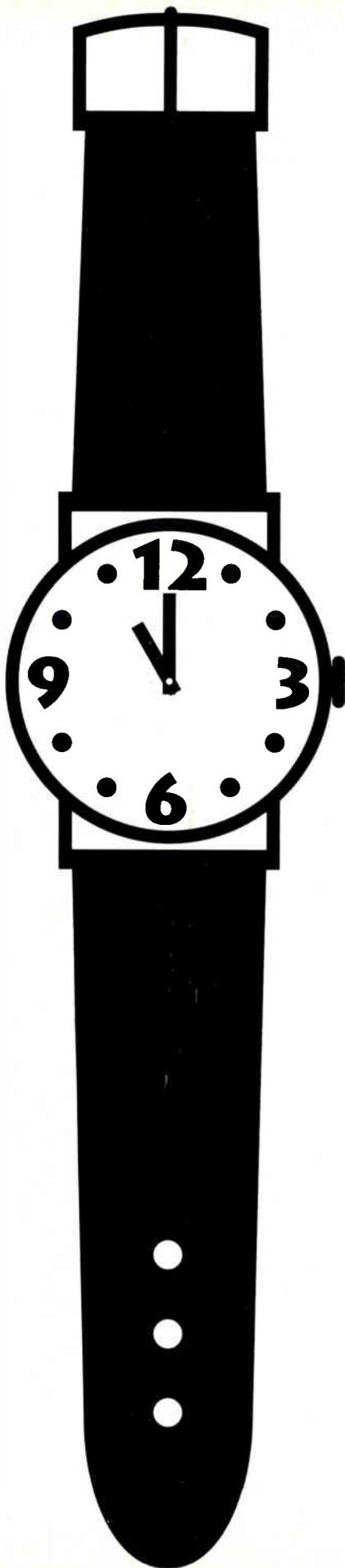
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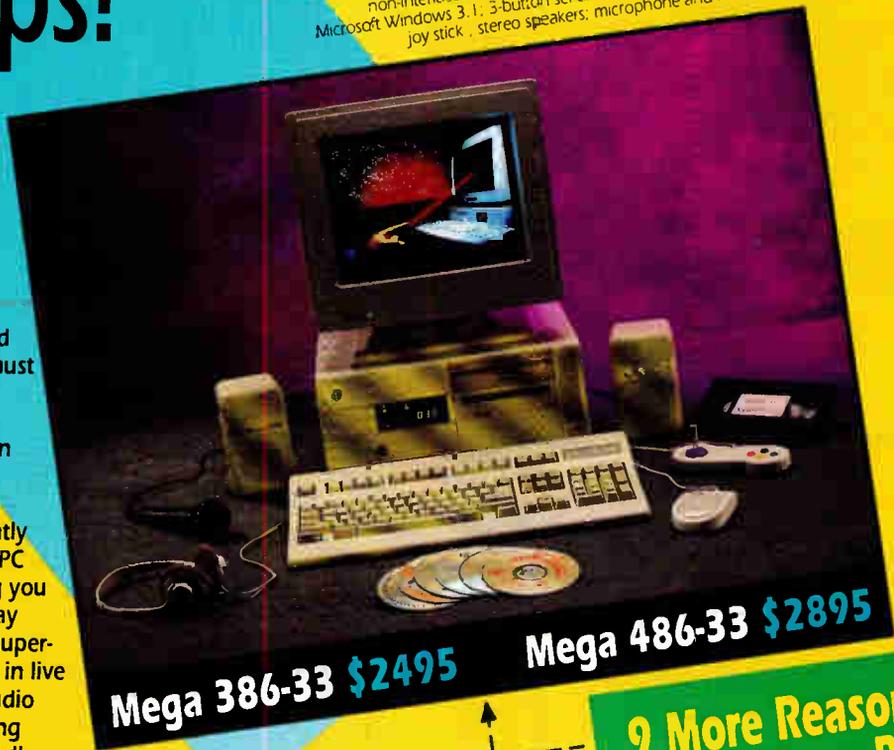
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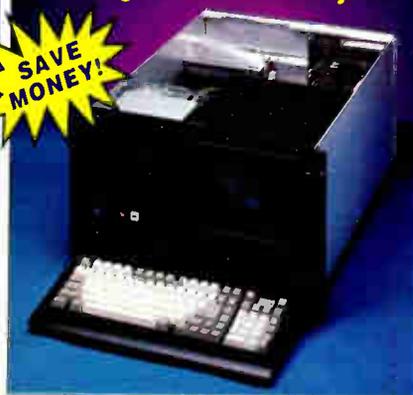
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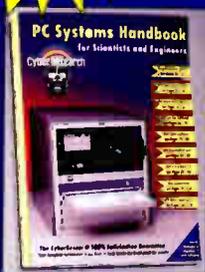
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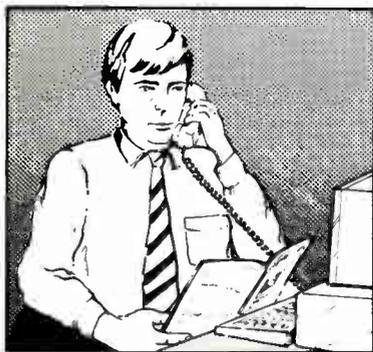
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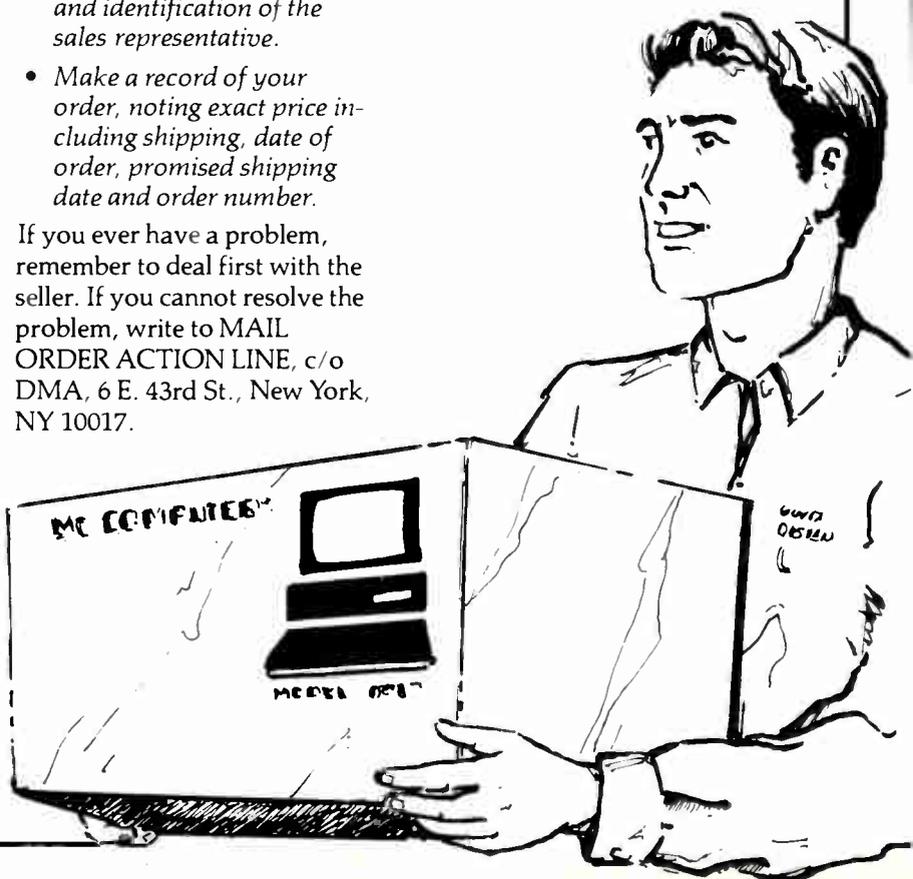
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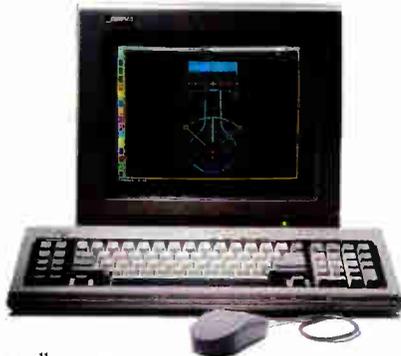
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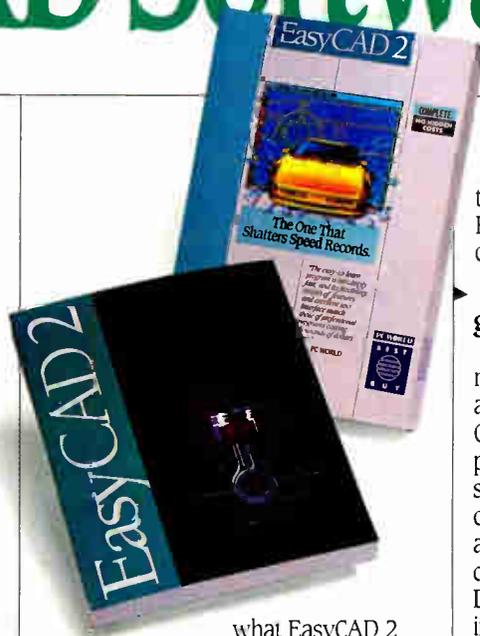
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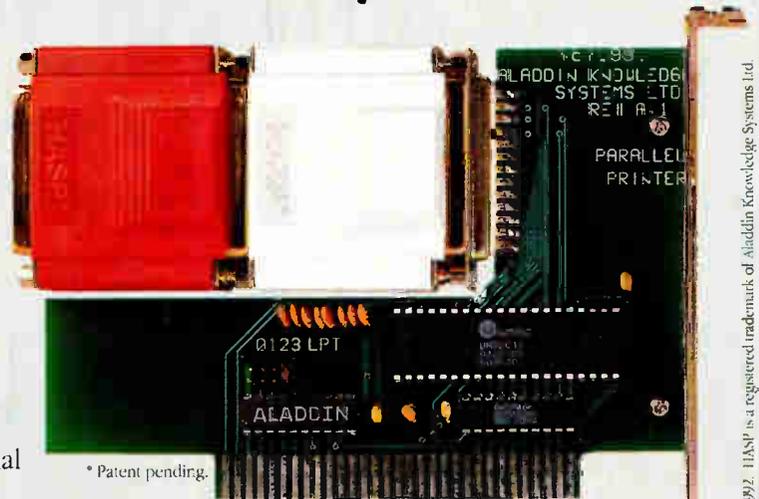
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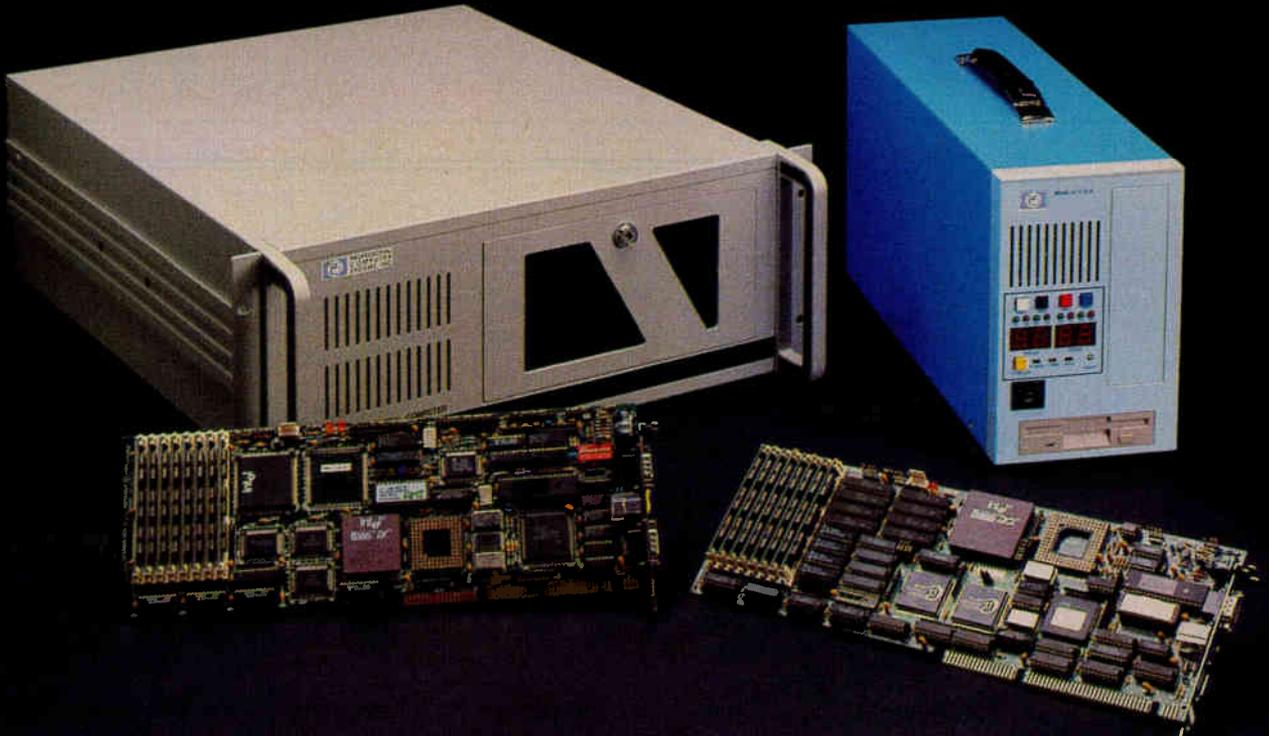
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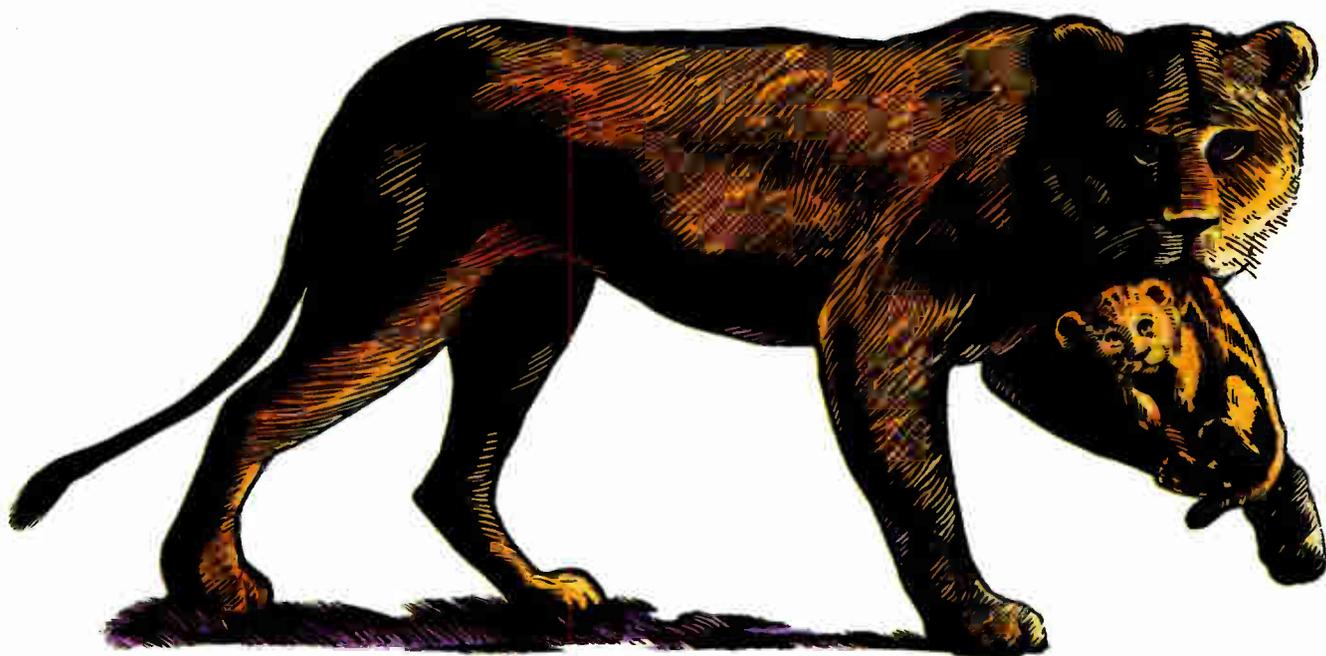


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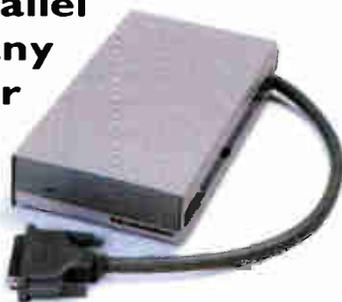
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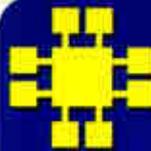


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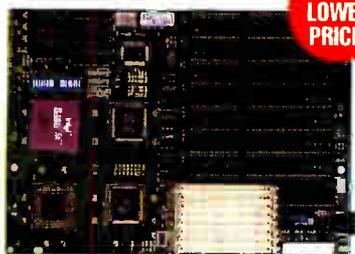
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19ms	3.5" IDE	\$269
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421000A9B-10	1M x
421000A9B-80	1M x
421000A9B-60	1M x
424000A9B-80	4M x
424000A9B-60	4M x

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SPEED	TYPE	PRICE
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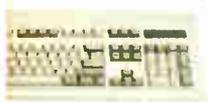
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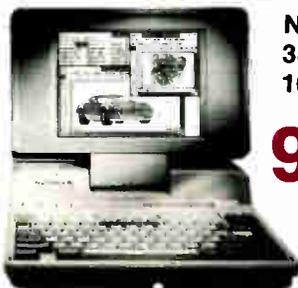
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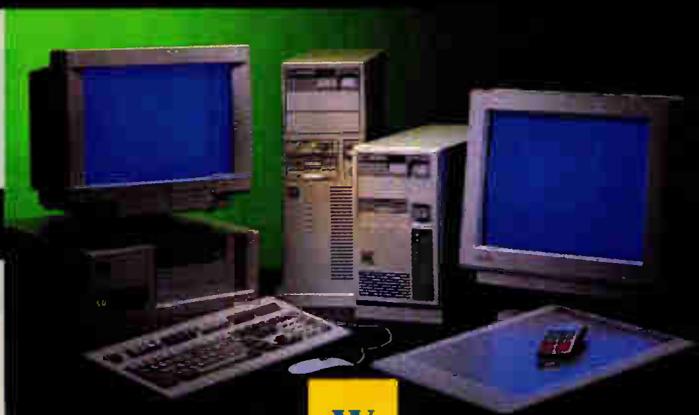
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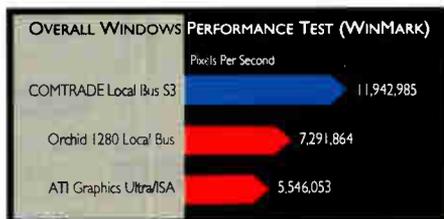


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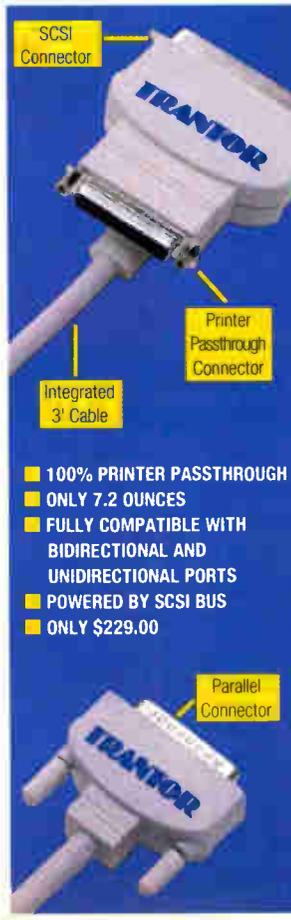
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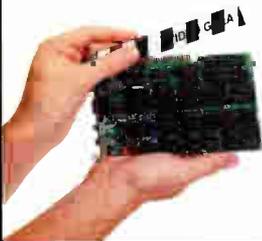
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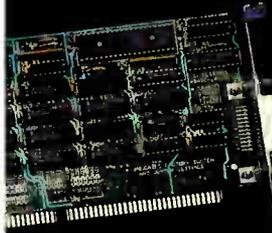


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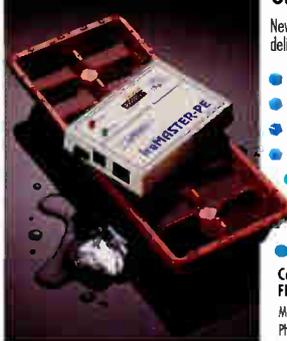
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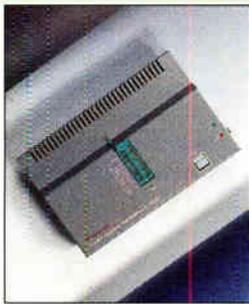
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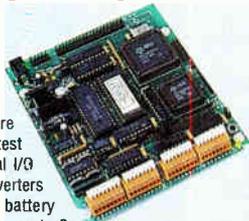
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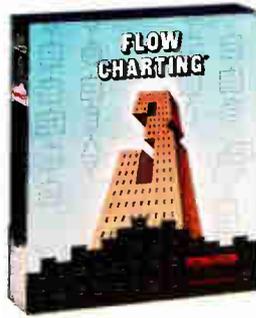


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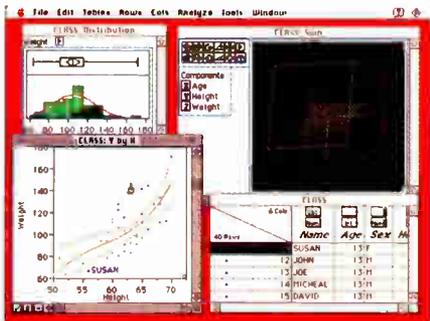
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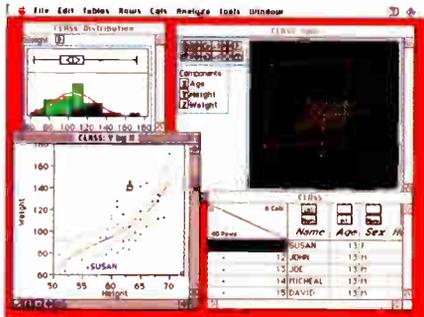
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- 7 Senior-level
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- 10 Yes
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D. What operating systems are you currently using? (Check all that apply)

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Fax Boards/Machines	9	Laptops & Notebooks	13	21
Graphics Tablets/Mice/		Mail Order	14	22
Pen Input	10	Memory/Chips/Upgrades	15	23
UPS	11	Miscellaneous Hardware	16	24
Software	12	Modems/Multiplexors	17	25
Business	13	Monitors & Terminals	18	26
CAD/CAM	14			27
Communications/Networking	15			28
Data Acquisition	16			29
				30
				31
				32
				33
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				35
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				37
				38
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				40
				41

30	Shareware	42
31	Software Duplication	43
32	Spreadsheets	44
33	Unix	45
34	Utilities	46
35	Windows	47
36	Word Processing	48
37	General	49
38	Books/Publications	50
39	Recruitment	51
40	Miscellaneous	51
41		

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 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
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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 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	1162	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
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1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

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 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
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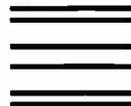
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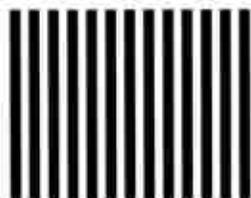
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 3 Administration/Management
 4 Sales/Marketing
 5 Engineer/Scientist
 6 Other

B. What is your level of managerial responsibility?

- 7 Senior-level 9 Professional
 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)

- 12 PC/MS-DOS 15 Unix
 13 DOS + Windows 16 MacOS
 14 OS/2 17 VAX/VMS

E. For how many people do you influence the purchase of hardware or software?

- 18 1-25 20 51-99
 19 26-50 21 100 or more

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Product Category Information	Disks & Optical Drives	7	Multimedia	19	Educational
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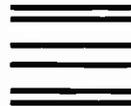
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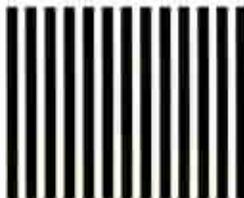
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World Radio History





STOP BIT

DANIEL
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TRIVIAL PURSUITS

Every morning, I turn on my computer and note with satisfaction that once again it has spared me the task of calculating my age. Its opening shot: "Hello again. This is day no. [A] of your life. Think you can handle it (Y/N)?" (The bracketed A is a number, currently spiraling toward 25,000, that increases by one each day.) I touch the Y key, which puts me into XyWrite, and the day's word processing begins.

Inventing new computing conundrums is an art in itself

XyWrite? (Confession: It does that even if I hit the N key.) Shouldn't a doomsday mushroom cloud appear on the screen? Yes, it should, and work on this project continues.

Grown-ups are supposed to think of the PC as a piece of business equipment, and it certainly qualifies as one for us writers. But there is a class of users—I can't be the only one, can I?—for whom the PC is the greatest adult toy in history. I am not talking about folks who spend all day playing computer games, but about those like me who find computing itself to be fun and work hard at inventing problems to be solved.

Like asking the computer to print out all the possible sequences in which a chap can put on 11 items of clothing—shoes, socks, briefs, undershirt, shirt, tie, vest, jacket, pants, topcoat, and Stetson hat. (The correct answer to this one, assuming that the undershirt has to go on before the hat, and the pants before either the shoes or the topcoat: 5327.)

Or using BASIC to randomly seat dinner-party guests according to "legal" bourgeois rules, which forbid participants from sitting next to spouses or persons of their own sex. Or creating a program wherein the Lotus random-number generator throws up a twentieth-century date on the screen when you press F9, asks for the date's day of the week, checks the time it takes you to respond, and congratulates you if you type in the right answer.

A personal favorite was the six-card-draw problem. In a spirit of whimsy, our monthly poker game had adopted a special rule: Participants in draw poker had the option not only of drawing to two pairs and other improvable hands, but of throwing in all five cards and receiving six. We all knew that it was a suboptimal strategy, but occasionally someone ended up winning a sizable pot

doing it—and leaving us pondering the odds.

The odds at first proved elusive. Boggled down in confusion over the overlapping possibilities in sets of six cards (e.g., a set could include both a straight and a flush), I was ready to abandon my efforts to construct a probability distribution for such hands. Then I had a thought that caused my heart to leap. Why not attack the problem via a Monte Carlo simulation? This was the perfect solution for anyone with an underutilized toy and a working knowledge of BASIC.

The idea was to simulate the dealing of some large number of six-card sets, tell the computer how to classify each set, and note the relative probability of each kind of hand. The exercise was great fun, and after working with it for two months, I had my probabilities lined up. It was clear, for example, that in a six-card draw, there was almost one chance in two of getting one pair and one chance in 28 of getting three of a kind. But there was a maddening flaw in the program. When I ran a million trials and asked it to count occurrences of each kind of hand, the sum of the hands kept coming to a little less than a million—typically, 999,950 or so. Obviously, some kind of hand was being undercounted.

This problem arguably subtracted two articles from my 1991 writing output, but I finally solved it. I was not picking up all four-of-a-kind hands. My BASIC program had been instructed to think of four of a kind as any hand containing four identical values plus two separate values. But, of course, four identical values still count as four of a kind even if the fifth and six values are also identical, as in four jacks and a pair of sevens. Hands like this are rare—the probability is 0.000046, I was later told by a professor of statistics—but in a million deals, you run into some of them.

The findings of my corrected program were generously shared with the entire table. They did not noticeably affect anybody's play. But I still think the guy who did the work embodies a niche market. The question is about its size—and sanity. ■

Daniel Seligman is a contributing editor for Fortune magazine. He also writes Fortune's Keeping Up column. You can reach him on BIX c/o "editors."

Stop Bit is a forum for informed opinion on personal computing topics. The opinions expressed are those of the author and not necessarily those of BYTE. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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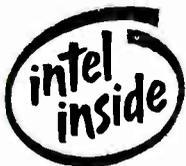
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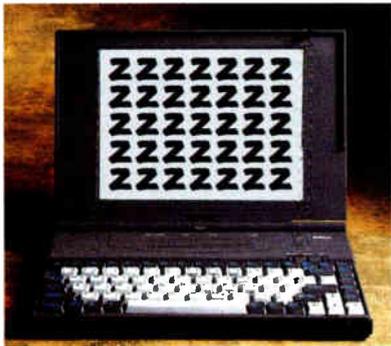
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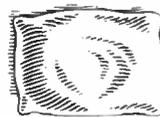
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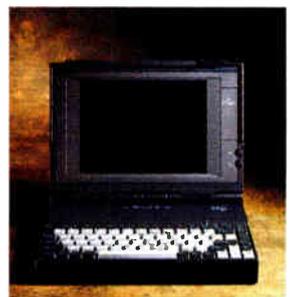
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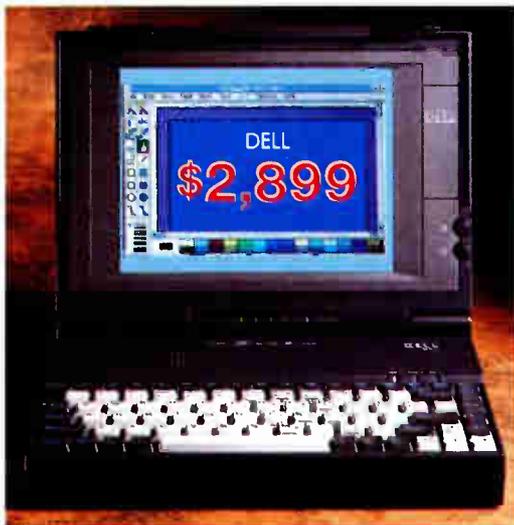
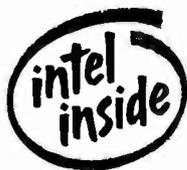
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