ADVANCED OPERATING SYSTEMS

A look inside the next generation from IBM, Apple, Microsoft, Novell/USL, Sun, Next, and Taligent

PLUS

• New Microprocessors Challenge Intel PAGE 74
• 4 Cross-Platform Toolkits Reviewed PAGE 172
If you don't see it here, call us. We'll custom build a system just for you.

It's a personal commitment from Alice, Gregg, Jeff, Beverly and their associates at the IBM Personal Computer Company. Thousands of IBM people—many working around the clock—to keep you personally delighted with everything we do for you.

It starts—but doesn't end—with our hot-selling IBM ValuePoint™ PCs. Take a closer look at the systems shown here. Super PCs. Super prices. But if you don't see the system you want, call us. We'll build your PCs to your specifications—and your budget. We can even preinstall selected software.

Remember, ValuePoint is backed by IBM HelpWare®, including our 30-day moneyback guarantee. No qualms. No quibbles. No questions asked. And for one year with free round-the-clock telephone assistance and fast onsite service (even in the most remote locations!) from more than 10,000 IBM service representatives in over 1,600 locations nationwide.

Call us today. And discover how we're putting the personal in personal computing.

### ValuePoint DeskTop

<table>
<thead>
<tr>
<th>ValuePoint S1</th>
<th>ValuePoint S1</th>
<th>ValuePoint S1</th>
<th>ValuePoint S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>i486SX/25MHz</td>
<td>i486SX/25MHz</td>
<td>i486DX/26MHz</td>
</tr>
<tr>
<td>Hard Drive/Memory</td>
<td>120MB/4MB</td>
<td>212MB/4MB</td>
<td>120MB/4MB</td>
</tr>
<tr>
<td>Drive(s)</td>
<td>3.5&quot;</td>
<td>3.5&quot;</td>
<td>3.5&quot;</td>
</tr>
<tr>
<td>Monitor</td>
<td>IBM 14V 14&quot; SVGA N1</td>
<td>IBM 14V 14&quot; SVGA N1</td>
<td>IBM 14V 14&quot; SVGA N1</td>
</tr>
<tr>
<td>Operating System</td>
<td>IBM DOS &amp; WINDOWS™</td>
<td>IBM DOS &amp; WINDOWS™</td>
<td>IBM DOS &amp; WINDOWS™</td>
</tr>
<tr>
<td>Price* / IBM Credit Lease**</td>
<td>$1,469 / $53 per month</td>
<td>$1,893 / $58 per month</td>
<td>$1,819 / $64 per month</td>
</tr>
</tbody>
</table>

### ValuePoint Mini-Tower

<table>
<thead>
<tr>
<th>ValuePoint S1</th>
<th>ValuePoint S1</th>
<th>ValuePoint S1</th>
<th>ValuePoint S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>i486DX/26MHz</td>
<td>i486DX/26MHz</td>
<td>i486DX2/66MHz</td>
</tr>
<tr>
<td>Hard Drive/Memory</td>
<td>120MB/4MB</td>
<td>120MB/4MB</td>
<td>212MB/4MB</td>
</tr>
<tr>
<td>Drive(s)</td>
<td>3.5&quot;</td>
<td>3.5&quot;</td>
<td>3.5&quot;</td>
</tr>
<tr>
<td>Monitor</td>
<td>IBM 14V 14&quot; SVGA N1</td>
<td>IBM 14V 14&quot; SVGA N1</td>
<td>IBM 14V 14&quot; SVGA N1</td>
</tr>
<tr>
<td>Operating System</td>
<td>IBM DOS &amp; WINDOWS™</td>
<td>IBM DOS &amp; WINDOWS™</td>
<td>IBM DOS &amp; WINDOWS™</td>
</tr>
<tr>
<td>Price* / IBM Credit Lease**</td>
<td>$1,689 / $61 per month</td>
<td>$2,094 / $76 per month</td>
<td>$2,094 / $76 per month</td>
</tr>
</tbody>
</table>

### ValuePoint S1 Features:

- 486 processors
- SVGA VESA Local Bus Video
- Upgradability via Intel OverDrive™ technology all the way up to Pentium™
- 101-key IBM Enhanced Keyboard and IBM Mouse
- Zero Insertion Force (ZIF) socket for fast, easy processor upgrades
- A 32-bit VESA Local Bus slot for local bus speed on SCSI drives and other peripherals
- IBM HelpWare

**Some 486DX33MHz chips may be manufactured by IBM. "ValuePoint S1 systems do not include all features listed above chart. Please refer to product details listed at left, or call for more information. ValuePoint S1 prices listed reflect IBM Basic Keyboard only. IBM Enhanced Keyboard available at additional cost."
ValuePoint Si - NEW!

- Newest entry-level member of the ValuePoint family
- Compact size: 14.2" W x 4.8" H x 16.5" D
- VESA Local Bus Video
- 3 slots and 3 bays
- Choice of IBM Keyboard (Basic++ or Enhanced)
- A great, low-cost network client
- IBM HelpWare service and support
- IBM 14V 14" SVGA NI Monitor

ValuePoint DeskTop

- Plenty of room to grow: 5 slots (includes 1 VESA Local Bus slot), 5 bays
- A super combination of speed, power, upgradability and expandability
- IBM 14V 14" SVGA NI Monitor

ValuePoint Mini-Tower

- Convenient, compact Mini-Tower processor case measures 9.5" W x 168" H x 169" D
- Enormous room for growth: 8 slots (includes 1 VESA Local Bus slot), 6 bays
- Perfect format for high-powered computing (CAD/CAM, graphics, multimedia, etc.) or as a low-cost network server
- IBM 15V 15" SVGA FS NI Monitor

Save time! We'll preload and test your software for just $10!

Dozens of popular software applications are available through Soft Select™. Call us for a complete listing.
There was a time you couldn't expect onsite service if your site was as remote as this.
To IBM Customer Engineer Jay Pancost, going the extra mile often means exactly that. His service calls take him to homes and offices from the Grand Canyon to the Hopi and Navajo reservations. “When you buy a PC,” he says, “the company that made it should be there for you when you need them. I like the idea of a job where people are always glad to see me, even if they’re sometimes surprised I would go so far off the beaten path.” Wherever you may be, there are more than 10,000 IBM service representatives like Jay Pancost, in over 1,600 locations nationwide, at your service. Right where you want them.

If you’ve ever bought computers “direct,” we want you to know one important thing.

This time, it can be different.

FREE!

The IBM PC Direct™ Source Book.
It’s all here! ValuePoint PCs, hot-selling ThinkPad® notebooks, monitors, printers, memory and storage upgrades, multimedia, networking products and popular software. We’ve reserved a copy for you. Simply call 1 800 IBM-2YOU today and it’s yours!

Call 1 800 IBM-2YOU
refer to: BMN
1 800 426-2968
8a.m.-m.idnight M-F, EST
8a.m.-7p.m. Sat., EST
Purchase order is available for qualifying customers.

IBM PC Direct
We’re putting the personal in personal computing.
This time you can have it all.

Super prices on popular software!
IBM PC Direct has the popular software you want, at prices you'll love. Remember, if you don't see it here, or in our catalogs, call us. Chances are we can get it for you fast!

WinFax™ Pro (MM1632) .......... $79
STACKER® (MM2905) .......... $95
Quickten™ for Windows 9x (MM45070) .......... $45
WordPerfect® for Windows 5.2
3.5" (MM7799) .......... $289
5.25" (MM8915) .......... $305

Boost your processing performance.
Here's a super way to boost system performance without buying a new system. Our 256KB L2 Write-Back Cache Memory Kit, Video Memory Upgrade Kits and Intel OverDrive Processor make it easy to upgrade your ValuePoint system. And we now offer 1.2 Cache Memory Kits for the ValuePoint S1, too!

ValuePoint Options
256KB L2 Write Back Cache Memory Kit
(60G1625) .......... $219
256KB L2 Write Thru Cache Memory Kit
(60G1625) .......... $239
128KB L2 Write Thru Cache Memory Kit
(60G1624) .......... $199
1MB Video Memory Upgrade Kit (60G1623) .......... $89
Intel OverDrive Processor 486DX25 (MM99983) .......... $389

ValuePoint S1 Options
New! 128KB L2 Cache Memory Kit (73G3128) .......... $90
New! 256KB L2 Cache Memory Kit (73G3129) (requires part 73G3230) .......... $60
New! 512KB Video Memory Upgrade Kit
(73G3127) .......... $42

Save space inside your multimedia PC!
The IBM WindSurfer™ Communications Adapter is the complete small business/home office ISA solution. It's a data/fax modem, a telephone answering machine, a CD-quality sound system and MIDI synthesizer...all in one! Included are a V.32 Data Modem, 9600bps Fax/Modem, IBM Phone/FAX™ for Windows, Maware™ MIDI synthesizer with MIDI port, Trio Data/FAX LITE for Windows...and more.

Maware WindSurfer Communications Adapter
(83G7259) .......... $349

Improve your communications and connectivity!
Whether you need to communicate with outside customers, satellite offices or the person next door, we offer a range of options for keeping you connected.

Voca Research™ 144/144 Data/Fax Modem, including FaxWorks™ (MM2652) .......... $175
10Base-T ISA Ethernet® Adapter (60G0605) .......... $91
10Base2 ISA Ethernet Adapter (60G0605) .......... $100
IBM Token-Ring 16/4 AT Box Adapter
(2577867) .......... $940

Give your PC gigantic storage capacity!
There are more options than ever for upgrading your current system. Replace your hard drive to keep up with tomorrow's demands, or add an additional diskette drive for increased flexibility...the choice is yours!

IBM 5257 Internal, 12MB diskette drive
(3292847) .......... $99
340MB AT IDE Hard Drive (25G406) .......... $339
527MB AT IDE Hard Drive (25G406) .......... $999

The easy, affordable way to go to a speedy CD-ROM.
The ISA Internal CD-ROM has a fast 300KB/SEC maximum data transfer rate—double the speed of most CD-ROM drives! You can load your operating system and applications software from a typical 600MB CD-ROM disk. You save precious hard drive space and load onto your ISA system faster. It's priced to move fast too!

IBM ISA Internal CD-ROM Drive (32G2961) .......... $315

It's as simple as calling Angela Hardy, or any one of our other PC consultants. ValuePoint PCs, ThinkPad notebooks, peripherals, printers, monitors, add-ons, the most popular software and more (IBM and non-IBM) are all yours—at prices you'll find personally pleasing—when you call 1 800 IBM-2YOU. You'll speak to a PC consultant who'll either answer any question you have, or get you in touch fast with an expert who can. If you don't see it here, it's in our free catalog. And if it's not in the catalog, we can probably get it for you anyway. Either way...call!

FREE!
The IBM PC Direct™ Source Book. ValuePoint, ThinkPad, peripherals, add-ons, popular software...it's all here and it's all yours for the asking. Call 1 800 IBM-2YOU today!

*IBM prices only. The offerings, prices and products are subject to change or withdrawal without prior notice. Products you acquire may not be counted towards any existing Volume Purchase Agreement. The same offerings and products may be available through IBM Authorized Resellers. Reseller prices may vary. Shipping and handling charges are extra. **IBM Credit Lease prices are quoted for 36-month terms. Lease rates quoted are good through 1/31/94 after which time rates are subject to change without notice. Leaseeter available to qualified commercial customers only. Copies of warranty and 30-day money-back guarantee information available through IBM and IBM Authorized Dealers. Please call 1 800 426-2968 for details regarding IBM money-back guarantee and limited warranty. 2. At no additional charge during warranty period. Onsite service available Monday-Friday, 8am to 5pm in your time zone. APPLIES TO IBM DIRECT SALES ONLY. 3. Upgradable with Intel-Hyper Thru-Drive processor based on premium technology. IBM, HelpCenter, HelpWare, and ThinkPad are registered trademarks and ValuePoint, Maware, Phone/FAX, SoftSelect and WindSurfer are trademarks of International Business Machines Corporation. PC Direct is a trademark of Zif Communications Company and is used by IBM under license. All other brands or product names are registered trademarks, trademarks or service marks of their respective holders.
©1993 International Business Machines Corporation.

Call 1 800 IBM-2YOU
refer to: BMN
1 800-426-2968
8am-8pm M-F, EST
8am-7pm Sat., EST
Purchase order is available for qualifying customers.

IBM PC Direct
We're putting the personal in personal computing.
All the horsepower in the world is worthless if you can't make the most of it. And the same is true when it comes to computers. Performance is determined not only by the chip, but by the computer around the chip. After all, if the subsystems slow you down, having a powerful processor doesn't make much difference.

Which is why when our engineers built the all-new Compaq DeskproXE, every subsystem was designed to provide the highest overall system performance.

QVision Local Bus Graphics, for example, offers blink-of-an-eye performance.

486DX/31, 486DX/50, 486DX2/66, 60MHz Pentium • 486 models upgradeable to Pentium technology • QVision local bus graphics with 1MB VRAM • Enhanced Business Audio • Most 486 system Energy Star compliant • Plug and play ready • 172MB to 572MB Swap Driver • 4MB or 8MB standard RAM (upgradeable to 32MB on 486, 16MB on Pentium) • 4 ISA slots (one reserve) • 3 drive bays • 64K or 256K optional cache • Free 3-year warranty* • Free 7x24 phone support
New hard drives clock in with lightning-like seek times. And all the new Deskpro XE models offer second-level cache options.

For the ultimate in performance, however, we introduce the Deskpro XE with the Pentium processor. Compaq-designed TriFlex/PC Architecture optimizes the tremendous power of the Pentium chip, delivering significantly improved overall system performance. All at a price that you will find equally impressive.

For complete information on the new Deskpro XE computers, just call us at 1-800-345-1518. And discover why even when they have the same processor, other computers just aren’t up to speed.

© 1993 Compaq Computer Corporation. All Rights Reserved. Compaq Registered U.S. Patent and Trademark Office. Deskpro is a registered trademark of Compaq Computer Corporation. QVision, TriFlex, Enhanced Business Audio are trademarks of Compaq Computer Corporation. Porsche and the shape of the Porsche 911 are trademarks of Dr. Ing. h.c. F. Porsche AG. Used by permission of Porsche Cars North America, Inc. Certain restrictions and exclusions apply. For further details on our limited warranty, contact the Compaq Customer Support Center. Pentium and the Intel Inside logo are registered trademarks of the Intel Corporation.
News & Views

WINDOWS
Chicago Enters Beta Testing........ 18
Microsoft is working on a new version of Windows that takes several steps toward rivaling IBM's OS/2.

INTEROPERABILITY
Apple Provides PC on a Mac............. 19
Apple's new card lets you run DOS and Windows applications and cut and paste among your Mac and PC programs.

DISPLAY TECHNOLOGY
Competition for Active Matrix........ 24
The first commercial cold cathode field emission displays, which may compete with active-matrix screens, could show up this year.

BUSINESS SOFTWARE
Graphics Gets Down to Basics.......... 28
Though not as powerful as full-featured drawing programs, programs like Visio and SnapGrafx make it easy to generate professional graphics for business.

PROGRAMMING
A Giant Leap for Borland C++........ 32
Borland now has the best C++ environment, but just barely.

CD-ROM DRIVES
Speedy CDs Improve Video Performance.... 36
Toshiba and others are developing new CD-ROM players to improve the performance of video playback on multimedia computers.

REMOTE ACCESS
Remote Control Gets Redirected.... 40
Several programs offer an inexpensive, though less capable, alternative to dedicated hardware/software solutions for remote LAN access.

EUROPEAN COMMUNICATIONS
Falling Prices Boost ISDN............. 40
The falling prices of ISDN in Europe may spark growth in telecomm and videoteleconferencing applications.

NEW PRODUCTS
What's New.......................... 254
A desktop unit that faxes, prints, copies, and scans; a wireless device that coexists with your mouse; software that learns from experience; and more.

Special Report

ADVANCED OPERATING SYSTEMS

Introduction: The Great OS Debate 117
BY JON UDELL

Small Kernels Hit It Big 119
BY PETER D. VARHOL Microsoft, IBM, USL, and others differ in their opinions on how best to implement microkernel architecture into new operating systems.

The Chorus Microkernel 131
BY DICK POUNTAIN Fountain takes a look at Chorus/MiX, a microkernel-based distributed Unix operating system from France.

Objects on the March 139
BY PETER WAYNER The trend is toward an object-oriented approach to the design of operating systems.

Personality Plus 155
BY FRANK HAYES Multiple operating-system personalities are here to stay.

Personality Plus 155
BY FRANK HAYES Multiple operating-system personalities are here to stay.

1993 BYTE Awards
COMPiled by MICHAEL NADEAU The best products of 1993 provide a window to the trends of 1994.

State of the Art

NEXT-GENERATION CPU'S

Microprocessor
Trends 74
BY DICK POUNTAIN
Several trends converge to threaten the near monopoly the Intel 80x86 architecture enjoys on the desktop.

Power2 Takes the Lead, For Now—77

M1 Challenges Pentium 83
BY BOB RYAN
Cirix will compete with Intel's Pentium using an innovative 80x86 superscalar processor.

Pipeline Hazards—87

RISC Grows Up 91
BY BOB RYAN AND TOM THOMPSON
RISC vendors expand their offerings to respond to the needs of a wider variety of applications.

Intel/VLSI Join the PDA Fray 101
BY PAUL STATT
The Intel/VLSI Polar chip set brings the 80x86 architecture to the PDA realm.

The Am386SC Does DOS and Windows—104
The AT&T Hobbit Enters Its Second Generation—105
CROSS-PLATFORM TOOLKITS
Paths to Platform Independence
BY STEVE APIKIAN With multiplatform toolkits, you can build applications for Windows, the Mac, X/Motif, OS/2 Presentation Manager, and a variety of other platforms—from a single set of sources. Apikian develops an application with Liant Software's C++/Views, WNDX, XVT Software's XVT, and Zinc's Application Frameworks and evaluates each product for its programming environment and for its portability across multiple operating systems.

DESKTOP SYSTEM
New Mac Blazes Technology Trails
BY TOM THOMPSON Apple's new Mac Quadra 840AV makes the move into video and voice communications with a faster CPU, a built-in DSP, video connections, and software for voice recognition and text-to-speech conversion.

MULTIMEDIA
Opening Night for Premiere 3.0
BY BOB LINDSTROM For multimedia audio and video, Adobe Premiere 3.0 offers impressive editing capabilities—if you've got the hardware to handle it. Lindstrom evaluates the latest version of Premiere as a professional tool for video development.

UNIX WORKSTATION
Digital-Media Power
BY BEN SMITH Imaginative packaging and start-up software add some fun to SGI's new low-price workstation. The fun doesn't detract from the Indy's computing price/performance, 2-D graphics strengths, and ability to work with both Macs and PCs. Ben Smith's hands-on testing finds the new Indy serious about 2-D graphics and SGI's concept of digital media.

PROGRAMMING TOOLS
NT Programming's Early Leader
BY OLIVER SHARP Microsoft's Visual C++ 32-bit Edition shows some flaws, but overall, it delivers effective tools for Windows NT programming and for porting 16-bit Windows applications.

COLOR MONITORS
Lab Report: 70 Color Monitors
We evaluate 70 15- to 21-inch color monitors and choose the best for important business applications.

Best Monitors for Spreadsheets and Graphics—214
Emissions Overview—214
Is Bigger Better?—218
Best Monitors for Complex Graphics & Presentations—220
Color-Matching Monitors—220
Do-It-Yourself Monitor Testing—222
Honorable Mentions—222

Opinions
Pournelle:
Travels and Travails............ 243
BY JERRY POURNELLE An especially busy month finds Jerry roaming the country but also active at Chaos Manor.

Books & CD-ROMs:
Low-Cost Data Acquisition....... 41
BY HOWARD EGGLESTON, BEN SMITH, AND MICHAEL NADEAU All you want to know about data acquisition, an improved Encarta, open systems, and more.

Commentary:
Shakespearean Wisdom ......... 312
BY THORNTON A. MAY Richard III and information technologists have much in common, but there are differences.

Editorial ..................... 10
BY DENNIS ALLEN

Letters .......... .......... ........... 14
Readers share their views on PDAs, time synchronization, the software bugle battle, and more.

Hands On
Digital Video Goes Real-Time
BY PETER WAYNER Real-time video might soon be on your desktop thanks to C-Cube's VideoRISC Compression Architecture, which can encode video on the fly using either MPEG 1 or MPEG 2.

NETWORKING
Beyond DOS:
Wide-Area Windows Networking.............. 227
BY JON UDCELL Experimenting with routable protocols for Windows networking.

CD-ROM
Under the Hood:
A Standard for Writing Recordable CDs........ 231
BY JASON HYON A look at a CD-recordable standard, ISO 13490, that supports adding sessions and support for new operating systems.

PROGRAMMING
Some Assembly Required:
Subclassing in OLE 2.0.......... 237
BY GEN KIYOOKA On the road to object-oriented system services.
This page presents the articles in this issue according to their subject's relevant computing platform.

**DOS/WINDOWS**

**Chicago Enters Beta Testing**.........................18
Microsoft is developing a new version of Windows that may rival OS/2.

**Apple Provides PC on a Mac**....................19
If you’re using PC software but want what you really want is a Mac, Apple has a new solution for you.

**Graphics Gets Down to Basics**...................28
New software marks a trend toward quick and easy drawing tools.

**A Giant Leap for Borland C++**..................32
Borland’s new version 4.0 for Windows includes an advanced compiler and quick development utilities.

**LapLink Cuts the Cable**..........................32
Radio transmission technology and new software lets you send files between PCs without wires.

**Speedy CDs Improve Video Performance**........36
New drives and discs will mean zippier multimedia performance.

**M1 Challenges Pentium**..........................83
A new Cyrix processor will give users another choice in high-performance 80x86-compatible systems.

**Special Report: Advanced Operating Systems**...113
Understanding the architectural differences of these new systems will help you decide which one’s right for you.

**Paths to Platform Independence**................172
If you’re building an application for Windows, OS/2, the Mac, and X, you’d do well to consider one of these toolkits.

**NT Programming’s Early Loader**.................189
Microsoft’s Visual C++ 32-bit Edition, our reviewer finds, delivers effective tools for Windows NT programming and easy ways to port existing 16-bit Windows applications.

**Lab Report: 70 Color Monitors**..................202
Looking for a display that can handle demanding graphics? We tested and picked the best for different applications.

**Some Assembly Required: Subclassing in OLE 2.0**...237
A developer looks at the Component Object Model of OLE.

**Beyond DOS: Wide-Area Windows Networking**....227
Jon Udell dives into the web of Windows and WANs.

**OS/2**

**1993 BYTE Awards**.............................46
We rank OS/2 2.1 as one of the most excellent products of 1993.

**Special Report: Advanced Operating Systems**...113
IBM’s WorkPlace OS is one of the next-generation environments you’ll be choosing from in the near future.

**Paths to Platform Independence**................172
This roundup reviews toolkits for developing applications that run under OS/2, Windows, Mac, and X.

**MACINTOSH**

**Apple Provides PC on a Mac**.....................19
With a new board that plugs inside a Mac, you can toggle into the world of DOS and Windows software.

**1993 BYTE Awards**.............................46
The Quadra 840A/2/3, PowerPC chip, and Newton technology stand out as outstanding developments of the past year.

**Special Report: Advanced Operating Systems**...113
As Taligent and other environments arrive on the scene, you’ll have to decide which is right for you. To help you, we provide an in-depth look at their architectural differences.

**Paths to Platform Independence**................172
If you’re looking to develop software that runs on the Mac, as well as Windows and OS/2 PCs, as well as X desktops, you need one of these toolkits.

**Opening Night for Premiere 3.0**..................179
Adobe improves its multimedia editing suite with a streamlined interface, more audio and video tracks, and ways to fine-tune images.

**New Mac Blazes Technology**

**Trails**........................................197
The Quadra 840A/2/3 offers built-in video I/O, voice recognition, and a text-to-speech engine.

**Lab Report: 70 Color Monitors**..................202
If you’re looking for a new display, this report will point you toward the one that’s right for you.

**UNIX**

**Novell Opens Unix**............................36
Big Red is turning the Unix trademark over to X/Open, which could be another step toward unification.

**RISC Grows Up**................................91
New processors from DEC, Sun, and others will mean less-expensive systems that don’t skimp on performance.

**Special Report: Advanced Operating Systems**...113
In this series, we present the architectural differences between the new operating environments.

**Paths to Platform Independence**................172
If you’re working on an X/Motif application that you also want to port to OS/2, Windows, and the Mac, you can save yourself major grief by using one of these cross-platform development toolkits.

**Digital-Media Power**............................183
Silicon Graphics’ new workstation is built to effectively handle digital images, including video, without busting your budget.

**NETWORKS**

**Remote Control Gets Redirected**.............40
If you need to access data on a remote PC or LAN, you’ve got a choice of new programs that can help.

**Beyond DOS: Wide-Area Windows Networking**....227
Can Windows networks be wide-area networks? Microsoft is now trying to answer that question in several different ways.

**Pourmelle: Travels and Travails**.................243
The good news at Chaos Manor: the Novell Net server is up and running. Jerry also reports on Windows for Workgroups; "it does have limits," he finds.

**Index**

<table>
<thead>
<tr>
<th>Alpha</th>
<th>91</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awards</td>
<td>46</td>
</tr>
<tr>
<td>Books</td>
<td>41</td>
</tr>
<tr>
<td>C++</td>
<td>32, 189</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>36, 41, 231</td>
</tr>
<tr>
<td>Chorus</td>
<td>131</td>
</tr>
<tr>
<td>COM</td>
<td>241</td>
</tr>
<tr>
<td>Compression</td>
<td>107</td>
</tr>
<tr>
<td>CPUs</td>
<td>74, 83, 91, 101, 107</td>
</tr>
<tr>
<td>Cross-platform tools</td>
<td>172</td>
</tr>
<tr>
<td>Displays</td>
<td>22, 24</td>
</tr>
<tr>
<td>DOS</td>
<td>19</td>
</tr>
<tr>
<td>Emulation</td>
<td>155</td>
</tr>
<tr>
<td>Graphics</td>
<td>28, 183</td>
</tr>
<tr>
<td>ISDN</td>
<td>40</td>
</tr>
<tr>
<td>Microkernels</td>
<td>119, 131</td>
</tr>
<tr>
<td>Modems</td>
<td>243</td>
</tr>
<tr>
<td>Monitors</td>
<td>202</td>
</tr>
<tr>
<td>Multimedia</td>
<td>107, 179, 183</td>
</tr>
<tr>
<td>Networks</td>
<td>40, 227, 243</td>
</tr>
<tr>
<td>NextStep</td>
<td>119, 139</td>
</tr>
<tr>
<td>Notebooks</td>
<td>22</td>
</tr>
<tr>
<td>Objects</td>
<td>131, 139, 237</td>
</tr>
<tr>
<td>OpenDoc</td>
<td>139</td>
</tr>
<tr>
<td>Operating systems</td>
<td>18, 113</td>
</tr>
<tr>
<td>OLE 2.0</td>
<td>139, 237</td>
</tr>
<tr>
<td>PDA</td>
<td>101</td>
</tr>
<tr>
<td>Pentium</td>
<td>83</td>
</tr>
<tr>
<td>PowerPC</td>
<td>10, 91</td>
</tr>
<tr>
<td>Programming</td>
<td>32, 172, 189, 237</td>
</tr>
<tr>
<td>QuickTime</td>
<td>179</td>
</tr>
<tr>
<td>RISC</td>
<td>74, 91</td>
</tr>
<tr>
<td>SOM</td>
<td>139</td>
</tr>
<tr>
<td>SPARC</td>
<td>91</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>229</td>
</tr>
<tr>
<td>Unix</td>
<td>36, 113, 131, 183</td>
</tr>
<tr>
<td>WANs</td>
<td>227</td>
</tr>
<tr>
<td>Windows</td>
<td>18, 19, 32, 227</td>
</tr>
<tr>
<td>Windows NT</td>
<td>18, 113, 189</td>
</tr>
<tr>
<td>Wireless</td>
<td>32, 40</td>
</tr>
</tbody>
</table>
Pinnacle introduces a new line of high capacity Novell® Network Storage Systems that provide lightning fast, reliable on-line storage.

Pinnacle's new Optical Hard Drive Library Systems range from 20-186 gigabytes and perform at hard drive speeds at a fraction of the cost. That's only 49¢ per megabyte to store databases, CAD files, images or back-ups on a centralized storage system which can be accessed by any user on the network.

Pinnacle's unique Virtual File System (NLM) allows each Optical Library System to act as one large hard drive by combining access to standard Novell® volumes and Novell's® Media Manager. With support for Novell's® data migration and sophisticated caching algorithms, your data can be accessed quickly and efficiently.

Pinnacle's Optical Library Systems provide a nucleus for your network, improving office productivity and communication.

Pinnacle's optical solutions will help you manage gigabytes of data into the future. For further information call: 800.553.7070
NOW THERE'S A 16-BIT SOUND BLASTER 
FOR EVERY APPLICATION AND BUDGET...AND NO MORE 
EXCUSES FOR OWNING ANYTHING LESS.

Every day, more people buy Sound Blasters than any other PC audio card. Except for a few of you, who keep putting off that all-important Sound Blaster™ decision. You know who you are. Well, our new line will make you a true believer.

SOUND BLASTER 16 BASIC: 
MORE VALUE.

For instance, some of you told us you were looking for 16-bit performance, but an 8-bit price. So our new Sound Blaster 16 Basic offers the same great hardware as our premium models. But in a $199.95* no-frills package that's perfect for the first-time 16-bit user.

SOUND BLASTER 16 MULTICD: 
MORE CD-ROM OPTIONS.

Perhaps you'd bought another manufacturer's
CD-ROM drive. Probably an oversight, we know, but that’s no longer an excuse to deny yourself the finest in PC audio.

Just plug in a Sound Blaster 16 MultiCD. Its format is 100% compatible with best-selling drives from Sony, Mitsumi and Panasonic.

The Sound Blaster 16 MultiCD can even run two different drives at the same time. Which only makes sense, considering our $249.95* price will save you enough money to buy the second one.

SOUND BLASTER 16 SCSI-2: MORE SCSI COMPATIBILITY.

Maybe you were waiting for a full-featured SCSI interface. Well, wait no longer.

As the name implies, our Sound Blaster 16 SCSI-2 meets the new, more comprehensive generation 2 SCSI standards. Others don’t.

And our card runs the complete battery of SCSI peripherals, not just CD-ROM. Best of all, it includes one of the most comprehensive software bundles in the business and does it for a remarkable $279.95.*

TRUE “PLUG & PLAY” UPGRADEABILITY.

Speaking of things other cards can’t do, our unique scalable platform lets you add advanced options as you need them.

So once you stop making excuses and get your Sound Blaster 16, upgrading to Wave Blaster™ Sampled Wave Synthesis (courtesy of the MIDI wizards at E-mu) or our own Advanced Signal Processing option (a Creative Labs exclusive) is literally as easy as adding a daughter board or plugging in a chip.

JUST WHEN YOU THOUGHT YOU’D HEARD EVERYTHING...

Along comes Sound Blaster 16. The no-more-excuses sound card. Exactly what you’d expect from Creative Labs, developers of the industry standard 16-bit audio platform.

For more information and the name of your nearest Creative Labs dealer, call 1-800-998-5227.

<table>
<thead>
<tr>
<th>Sound Blaster 16</th>
<th>Sound Blaster 16 MultiCD</th>
<th>Sound Blaster 16 SCSI-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>16-bit stereo</td>
<td>16-bit stereo</td>
</tr>
<tr>
<td>Advanced Signal Processing Upgradability</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Wave Blaster Upgradability</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CD-ROM Compatibility</td>
<td>Creative Labs/Panasonic</td>
<td>Sony, Mitsumi, Creative Labs/Panasonic</td>
</tr>
<tr>
<td>Bundled Hardware</td>
<td>Microphone</td>
<td>Microphone</td>
</tr>
<tr>
<td>Suggested Retail</td>
<td>$199.95</td>
<td>$249.95</td>
</tr>
<tr>
<td>W/Advanced Signal Processing</td>
<td>Not applicable</td>
<td>$299.95</td>
</tr>
</tbody>
</table>

All other trademarks are the property of their respective holders. © Copyright 1993 Creative Technology Ltd. All rights reserved. *SRP. Note: Sound Blaster 16 MultiCD works with Sony CDU31A; Mitsumi CRMC-LU005 and -FX001; and Creative Labs/Panasonic CR-523 and -563.
Power Personal Systems

Will IBM set the standard for the next generation of desktop systems with its new line of PowerPCs?

The IBM folks at the Power Personal Systems Division are up to some pretty interesting things. As the name suggests, the division will make systems based on the PowerPC chip, which IBM co-developed with Motorola and Apple. The RISC-based PowerPC chip consumes less power, generates less heat, runs up to five times faster, and costs much less than an Intel Pentium.

Although final systems won't be available until about midyear, IBM recently showed me several prototypes and talked about its plans. In a nutshell, the prototypes were hot (in the "way-cool" sense) and the plans are, well, visionary.

What I saw was a desktop system using a 66-MHz PowerPC 601 running IBM's "personal" AIX (a scaled-down implementation of IBM's Unix) in an unconventional way. It was surprising to see the first PowerPC system running SunSelect's Wabi (Windows Application Binary Interface) running on top of AIX and Microsoft Excel on top of that. In fact, it looked more like a Windows system than a Unix system.

To make the demonstration even more interesting, it was blazingly fast, though we have not done any benchmark tests yet. However, I've seen a lot of spreadsheets run on just about every kind of system you can imagine, and what I saw on the PowerPC was the fastest yet.

In other words, without the benefit of, say, Windows NT and applications software compiled in native code, the IBM PowerPC system promises to run Windows software faster than anything else. Given the dominance of the Windows installed base, being the fastest Windows machine is a good place to start.

On the lower end, IBM showed off an "ergonomic" desktop system that had a flat-panel display on an eye-level stand. The system unit box was too small for traditional plug-in adapter cards, but it had several PCMCIA slots instead. The ergonomic desktop was based on the somewhat slower PowerPC 603.

IBM also had a nonworking slim notebook prototype based on the PowerPC 603. Its low-power design makes the 603 chip ideally suited for portables. In contrast, the only Pentium-based portable announced, the Dolch PAC-586, consumes so much power and gets so hot that it must use a liquid cooling device on the chip.

For added measure, the prototype I saw also had a built-in CD-ROM player beneath the keyboard. Even more impressive was the video camera built just above the display. The camera was complete with a sensor so that, according to IBM, the computer would know when you leave and could power itself down.

Other goodies on the portable prototype included stereo speakers and a microphone. All of this would add to the price if IBM had to incorporate digital-signal-processing hardware for all those devices. However, IBM says it will let the PowerPC chip do all the work, and that makes a lot of sense.

Because no additional hardware is required, IBM's PowerPC portables can incorporate speech-to-text software inexpensively. IBM already has its Personal Dictation System software, and the PowerPC could easily handle that program. Add to that IBM's ambitious plans to eventually incorporate its speech-parsing technology so that software speech "agents" can understand your commands and do tasks for you. I call those plans "ambitious" because IBM has not yet demonstrated its agent technology: when it does, BYTE will tell you about it.

Perhaps even more ambitious are IBM's plans to work with software vendors to port Windows NT, Solaris, Workplace OS, and Taligent to its PowerPC platforms. And IBM is sharing the architecture of its systems so that other vendors will make PowerPC systems, too.

The first IBM PC became a standard by happenstance. Yet that standard has been the basis of the computer industry for the last 10 years. Now, IBM has created a new box for everyone to copy, and this time IBM is encouraging third-party manufacturers to do so. That's why I call IBM's plans visionary.

IBM seems to have learned from the past. The original IBM PC succeeded only in part because it carried the IBM name. The greater part of its success was owed to its open architecture, which fueled competition and created de facto standards that, in turn, created a market bigger than anyone would have dreamed.

My bet is that IBM's Power Personal Systems will have an impact as great as that of the original IBM PC.
What Lotus doesn't want you to know about new Quattro Pro 5.0

Shhhhh! Lotus has a secret they don't want anyone to know. Quattro® Pro consistently ranks as the #1 spreadsheet in virtually every head-to-head comparison with both 1-2-3 and Excel. Take *PC Week*'s September review where Quattro Pro beat 1-2-3 in four out of five categories. Or *PC Magazine*'s annual customer satisfaction study where "Lotus lost the crown for overall satisfaction to both the DOS and Windows versions of Quattro Pro . . ."

Quattro Pro keeps winning because it has more power, more analysis tools, and is easier to learn and use. And now there are three brand new versions of Quattro Pro 5.0 (Windows, DOS, and Workgroup Edition) that are even better. The chart shows you how Quattro Pro's Workgroup Edition offers you built-in capabilities not found in Lotus 1-2-3 for Windows Release 4.

Now we'll let you in on our little secret. We want every Lotus user to try Quattro Pro, so we are making incredible introductory offers on all new versions of Quattro Pro.

Sorry, Lotus, the secret is out.

---

**You get more!**

### Quattro Pro 5.0

1. "Experts" that do sophisticated tasks (like statistical analysis) for you
2. Interactive tutorials that teach you by using your own data
3. Complete documentation available online
4. Improv-like crosstabs and data modeling tools *built in*
5. Built-in workgroup information sharing with any network or E-mail system
6. Analytical graphs to find trends in your data
7. Over 360 @functions—more than any other spreadsheet
8. Integrated user interface builder to make spreadsheet development easy
9. Complete slide show capabilities *built in*, including light table sorting
10. Database forms that let you manage data without having previous database experience

### Lotus 1-2-3 R4

1. Not!
2. Not!
3. Not!
4. Not!
5. Not!
6. Not!
7. Not!
8. Not!
9. Not!
10. Not!

*Offer good for owners of Lotus 1-2-3 or Excel; Quattro Pro owners get an additional $20 off. Copyright © 1993 Borland International, Inc. All rights reserved. All Borland product names are trademarks of Borland International, Inc. Offer good in the United States and Canada only. All prices in U.S. dollars. Dealer prices may vary. BI 6293

Circle 66 on Inquiry Card (RESELLERS: 67).
The DIGIS-486EL EDRAM System combine Intel's highest speed 486 microprocessors running at 25, 33, 50 or 66 MHz clock rates with up to 32 MBytes of 15 ns EDRAM with Quickcache™ to achieve the highest benchmarks of performance available.

15 ns EDRAM With Quickcache™
The Mother board
For DIGIS-486EL System

- Intel 486SX 25, 33, 486DX 25, 33, 486DX2 50 or 66MHz Microprocessor
- Ready For Future Pentium™ Class CPU
- Up To 32 MBytes Of 15 ns EDRAM With Quickcache™
- Ready For Demands Of Multitasking Operating Systems
- 3 High Speed VESA VL-Bus I/O Slots
- 8 ISA Bus I/O Slots
- AMI BIOS
We Don’t Waste Cache With SRAM. Because We Add Quickcache™ On the Board

Dramatic Performance Improvements On All Applications

The 486EL System running clock doubled at 50 MHz (486DX2-50) even achieves better benchmark performance than a 486DX-50 microprocessor with a standard SRAM cache plus DRAM memory subsystem.

So let Digicom help your next product to succeed. Call today for more information.
Personal Digital Assistants

I read with interest and fascination the excellent article on PDAs (“PDAs Arrive But Aren’t Quite Here Yet,” October 1993) written by Tom Halfhill. At the same time, I confess I was somewhat irritated by the absence of any reference to Psion. Psion has manufactured and sold well over 1 million handheld/palm-top computers, which is superior to many of the other companies you cited.

One area of your comparison table where we strongly ally Hewlett-Packard is in the use of pen as an input device. It will be interesting to see which way the market jumps. Psion’s view is that the pen is wholly inappropriate as an input device in the consumer sector. Today’s pen technology cannot deliver the level of performance or satisfaction that an “early majority” customer demands. We shall see.

David Elder
President, Psion, Inc.
Concord, MA

Our story was about PDAs and was not intended to be a general survey of widely known PDA-like devices. Of course, you may disagree with our definition of a PDA. But we believe pens are already as good as miniature QWERTY keyboards for typical PDA functions—and pen interfaces are rapidly evolving, while keyboards are not.—Eds.

I want to talk to my Newton. As a loyal Apple consumer, I bought a MessagePad only to take it back two days later because it failed to live up to the Sculley promise of an easy-to-operate, do-it-all assistant. But if Apple could merge the Intelligent architecture of handwriting recognition and communications with the voice recognition of Mac AVs, I’d want to put on the beta-user list. Perhaps Apple could accomplish this by decreasing the size of the DSP it uses for voice in Mac AVs to fit in the MessagePad. Imagine picking up your Newton and saying, “Newton, take a memo, blah, blah, blah. Newton, fax a memo to Mr. X.” If the MessagePad could accomplish these commands wirelessly, it would be a true personal digital assistant.

William Bartee
Norman, OK

Visual Basic

I really enjoyed your article “BASIC Windows Programming” (October 1993). However, your inference that Visual Basic 3.0 does not support Paradox tables is incorrect. I, too, spent many hours attempting to connect a Paradox table without success. The problem is a typo (or omission) in the provided documentation. The answer is in the VB.INI file under the “Installable ISAMs” section. The line that refers to Paradox tells you to enter the characters left of the equals sign as the connect property of the data control. You then simply follow the rest of the instructions, and your Paradox tables will work with Visual Basic 3.0 as described.

Gregory K. Grieb
Allentown, PA

Keeping Time

Michael Lombardi’s article “Keeping Time on Your PC” (October 1993) was interesting, although I believe this quest for the most exacting universal time is only worthy of Don Quixote. I understand the need for precision, but I also understand the inherent relative nature of time, which is why I keep all the computers in time synchronization on my IBM LAN Server networks by running a REXX program on the domain controllers as an AT job. The nodes are brought into time synchronization when employees log on to the LAN. Because all applications are networked, employees cannot do any business-related work until they log on. As for my home computer, since I cannot watch TV and code at the same time, I give or take a couple of minutes doesn’t matter.

Kenneth Reiss
Passaic, NJ

Worried

In “The State of Multimedia” (October 1993), Jerry Pournelle hit it right on the head when he said, “students will always be successful if you redefine success.” Unfortunately, this isn’t a problem that affects only multimedia usage in schools.

It’s affecting the core of our society, and I’m worried.

Robert Plaza
Houston, TX

The Battle of the Software Bulge Continues

I have a big 486 with many bells and whistles—including one of the best video cards, a caching disk controller, 8 MB of memory—and I’ve run into a performance barrier. Quatro Pro for Windows crawls, WordPerfect for Windows will barely fit (by itself), and Paradox for Windows crashes my machine. I almost threw my computer out the window when it took 12 minutes for Excel 4.0 to add a single column to one of my spreadsheets.

Instead, I decided to ditch my software. I reinstalled old DOS favorites like WordPerfect 5.1, Quattro Pro 4.0, SuperCalc, and the new Paradox 4.0. On a big 486, my applications fly, and I can still use Windows as a task switcher. My software may not have fancy features like DDE and OLE. But I’m getting work done!

Charles Ramcharan
North York, Ontario, Canada

Fixes

The November 1993 article “Get Your Kicks with Switched 56” might be misleading about the compatibility between ISDN and 2-wire Datapath. You can communicate among ISDN, Datapath, and Switched 56 4-wire services. At the equipment level, however, these technologies are not interchangeable.

In “Ease of Use Is Relative” (October 1993), we incorrectly identified the vendor of Pensil. The company is First Pen Systems, Inc., and Pensil is a native PenPoint object editor, not a C development tool.

On page 222 of the October 1993 issue, Jerry Pournelle stated that the Chinon drive he purchased was made by Toshiba. However, the entire line of Chinon CD-ROM drives has always been made (from design to manufacture) entirely by Chinon.

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

14 BYTE JANUARY 1994
You Can Play Around With Windows NT On Another Microprocessor.
Now Imagine Letting NT Fly On Alpha AXP.

You’re going to blaze some new trails with the mainframe power of Windows NT™. Don’t compromise it. Run it on the fastest vehicle you can get—an Alpha AXP™ microprocessor. Choose from a family of fast server microprocessors with performance as high as 170 SPECInt, more than twice that of Pentium™ or PowerPC™—and priced to compete. Or choose from low-cost desktop PC microprocessors with prices that start below an i486. Alpha AXP runs Windows NT with thundering speed, as well as your existing DOS/Windows™ applications. And that’s just the beginning of a long-term architecture based on a scalable RISC design and standards like the PCI local bus. Available to any PC maker—from us now, and in 1994 from our second source Mitsubishi Electric Corp. The decision with Windows NT is simple. On other microprocessors, it runs. On Alpha AXP, it flies. Which way would you rather cover new ground? Call your PC maker and ask about the Alpha AXP family. Or call us at 1-800-332-2717—and kick start your future.
Chicago Enters Beta Testing

Early reports indicate that the next version of Windows is an evolutionary step up from Windows for Workgroups 3.11

BY DAVE ANDREWS

This month marks the tenth anniversary of the now-famous one-time commercial that Apple ran during the Super Bowl to introduce its new Macintosh computer to the world. Ten years later, Microsoft has entered beta testing on a new version of Windows (commonly referred to as Windows Chicago) that only now catches up to features that have been present for years in the Mac OS.

The market success of Windows 3.1 is undeniable: The Software Publishers Association says that in 1992, North American sales of Windows accounted for $1.93 billion, compared to the Mac’s $990 million. Yet in terms of built-in support for networking and plug-and-play configuration, the Mac OS has often led where Windows eventually followed. The next version of Windows will attempt to remedy this situation, but it will find strong competition on the Intel architecture from IBM’s OS/2 2.1, which has been shipping since June 1993.

In December, Microsoft was expected to release the first development kits to programmers who want to get an early start on developing Windows Chicago applications. (The version number has not been officially decided on, although industry insiders say Microsoft will call it Windows 4.0.) This next version of Windows is not expected to ship until sometime during the first half of this year at the earliest.

Microsoft will position Chicago as a universal client that will offer preemptive multitasking, plug-and-play identification and configuration of system-board devices, the Win32S subsystem, Video for Windows, OLE 2.0, a new interface, the full MAPI (Messaging API) 1.0 subsystem, filenames longer than the “8.3” format, and better integration with NetWare. The big question—Can the company do all this in an operating system targeted at a 386 or 486 system with as little as 4 MB of RAM?—will have to wait until the company releases this product. Furthermore, whether Chicago provides a dramatic improvement as a platform for running Windows 3.1 and DOS applications will also have to be determined later.

“The bottom line is that a very large set of services [now available in Windows NT] will be implemented in the next version of Windows,” says Jeff Thiel, product manager of Windows marketing at Microsoft. “But if you’re looking for a production application server, you’re probably going to want to use NT.” The design

Plug-and-Play: Chicago will include the Plug-and-Play BIOS, bringing the operating system closer to putting an end to the “DIP-switch blues” once and for all for users of new ISA cards. Supports automatic installation and configuration of add-on devices. Notebooks will automatically reconfigure themselves when removed from a docking station. Microsoft and IBM will likely cooperate on adding Plug-and-Play for Micro Channel cards under Windows. Plug-and-play EISA cards will also be supported.

Preemptive: Microsoft says Win32 programs running in Chicago will be able to preemptively multitask, meaning a task can interrupt a task with a lower priority instead of waiting for the lower-priority task to finish.

New interface: Alpha testers report the File Manager and Program Manager are now combined and the new interface incorporates features of the Mac, OS/2, and X Window System.

Win32S: Allows 32-bit applications to run on Windows 3.1, Chicago, and Windows NT.

MAPI 1.0: Originally slated for release in the third quarter of 1993. Allows replaceable directory service providers.

Better networking: Built-in support for peer-to-peer networking. Better integration with NetWare, thanks to Microsoft’s own NetWare redirector, a 32-bit protected-mode driver that reduces the conventional memory footprint. Support for IPX lets Windows workstations communicate on either side of an IPX router.

OLE 2.0 integration: OLE 2.0 programs will be able to pass information to the Windows shell, possibly allowing thumbnail images of documents.

Enhanced-mode support only: No longer supports standard mode (won’t run on 286-based PCs).

TAPI support: Better integration of Windows to the phone system.
Apple Provides PC on a Mac

Apple has developed a board that offers the ultimate oxyoron of software and hardware: a Mac running DOS programs. This feat is accomplished by placing a 25-MHz 486SX processor, a Chips & Technologies BIOS, a VGA chip set, and some of Apple’s custom ASICs (application-specific ICs) on a 68040 Processor Direct Slot plug-in board. The whole affair is dropped into a competitively priced Quadra 610, offering the best of both worlds on one system.

The DOS card can have up to 32 MB of RAM on it, or it can share memory on the Mac’s main logic board. At boot time, the board is scanned for RAM. If none is found, a user-determined amount of RAM on the main logic board is dedicated to the DOS environment. Hardware transceivers in a custom ASIC on the DOS card handle the endian byte-swapping required by the different processor architectures. A memory controller in this ASIC functions to keep the address spaces of the two environments separate. Also, the Mac’s SuperDrive is mapped as A by the system. The MSCDEX extension is provided so that, on a Quadra with a built-in CD-ROM drive, DOS can access DOS CD-ROMs.

The PDS board operates independently of the Mac so that DOS/Windows applications can run concurrently with the Mac OS. However, Apple has taken its integration skills to fuse the two systems into one easy-to-use whole. For example, selecting a printer via the Mac Chooser automatically selects the same printer for the DOS environment. DOS print commands are intercepted by the Mac OS and routed to the selected printer. For example, say you have a Hewlett-Packard printer connected to your Mac. You select the HP printer driver from the Chooser. Under DOS, you print an HPG file (Hewlett-Packard Graphics Language) graphic. The HPGL commands are redirected to the HP driver, which sends them to the printer. Running CorelDraw under Windows? No problem: Select a PostScript printer from the Chooser, switch back to CorelDraw, and print. For serial work, you can assign COM1 to, say, the Mac’s modem port and COM2 to its printer port.

Switching between the Mac and DOS environments is easy. With a single monitor on the Mac, you press a user-selectable hot-key sequence, which toggles you from the Mac Desktop to a DOS screen. Pressing the same key sequence again swaps you back. If the Mac has two monitors, you can pick which monitor shows the Mac Desktop, while the other displays the DOS/Windows environment. Support for 14- and 16-inch VGA and Super VGA monitors is provided.

DOS files are maintained inside a container file that has the structure and organization of a DOS hard drive (a trick pioneered by Insignia Solutions’ PC emulator). However, Apple lets you “mount” this file as a Mac volume that you can double-click on to open and examine DOS files and subdirectories (i.e., folders). DOS file extensions can be mapped to the appropriate Mac applications, such as .XLS to Microsoft Excel and .DOC to Microsoft Word. With the file-extension mapping in place, double-clicking on a DOS file launches the corresponding Mac application. (Remember that many of today’s cross-platform applications use the same file format, so this little trick works transparently to the user.) Cutting and pasting between Windows and Mac applications is supported.

You can configure the system to start DOS when you shut the Mac down, the Mac OS checks to see if the DOS environment is active and will give you a warning to shut down DOS before proceeding. A single Control Panel lets you set up the DOS environment (e.g., its memory size and serial-port mapping). Not supported now are NetWare operations and Sound Blaster I/O.

Apple sees several target audiences for this product. First, the home office, where multiple users have different platform needs (e.g., the kids using Macs at school, the parents using DOS at the office). Second, the small office, where folks don’t have an expert to maintain their systems, and they don’t care to wrestle with the technology. At the same time, these folks might need to run several vertical DOS applications. Finally, for training and education, where tight budgets require the most bang for the buck.

The board will cost $500 without memory. MS-DOS 6.2 will be provided, along with utilities like Double Space. A complete Quadra 610 with a keyboard, a 14-inch monitor, 8 MB of RAM, a 160-MB hard drive, built-in Ethernet, and a DOS card should cost about $2000. Retailers might bundle Windows with the system. Ironically, the ability to run DOS or Windows applications on the Mac may be the ultimate Trojan horse that garners the Mac market share.

—Tom Thompson
The new HP DeskJet 310 printer.
Print high-quality black & white or color wherever you want to work.

Hewlett-Packard presents the DeskJet printer that doesn't require a desk. The HP DeskJet 310 is small and light enough to let you print anywhere. At the office, at home or on the road. And it gives you sharp, 300-dpi print quality, in black & white or color.

The HP DeskJet 310 costs only $379*, yet it comes loaded with 84 typeface, size and style combinations, along with a new lightweight, multi-voltage power adapter. It prints portrait and landscape on plain paper, transparencies or labels, and it uses HP's own inkjet technology for clear, crisp output at up to three pages per minute.

If that's not enough for you, a whole family of optional accessories is available, including a color kit for just $49, and a multi-page sheet feeder for easier desktop printing.

HP has managed to fit everything you could want into a little printer package. To see for yourself, look in the Yellow Pages, or call 1-800-552-8500, Ext. 7858 for the name of the HP dealer nearest you!

DeskJet Printers
Make it happen.

Buyers Flock to Better Notebook Displays

On this chart, a StoreBoard ranking of the five top-selling portable PCs in units sold over a recent five-month period, a number of points are worth noting. First, it's a surprise that any system with a color active-matrix display would rank here at all, as does the Compaq LTE Lite 4/25C. Second, our survey is a small sign that major system vendors on the PC side are overcoming supply problems. Compaq is among these vendors, and the IBM ThinkPad 720C ranks in the top 10, although it is not listed here. The presence of three PowerBooks in the top five is no surprise, given the runner-up Readers' Choice award BYTE readers gave this line last spring. Infocorp analyst Kim Brown estimates that 2 million notebooks with dual-scan, passive-matrix displays will ship in the coming year—one of them, the Contura, already leads the pack in sales. Passive-matrix screens should find continued competition from active-matrix screens. A report by Frost & Sullivan, noting that in June 1993 the U.S. Department of Commerce ended tariffs on imported active-matrix screens, predicts lower prices for active-matrix screens and fewer backlogs.

Prices given are estimated street prices. For Apple, they range according to configuration. The "Possible features ..." column represents BYTE editors' most reasonable presumptions as to what the next generation of these systems might offer, based on established vendor patterns and market pressures. (StoreBoard ranking information courtesy of Computer Intelligence-Infocorp of Santa Clara, California.)

—Ed Perratore

<table>
<thead>
<tr>
<th>Product</th>
<th>Basic features</th>
<th>Introduction date</th>
<th>Introductory price range</th>
<th>Current price range</th>
<th>Notable features</th>
<th>Possible features of succeeding-generation model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaq Contura 4/25</td>
<td>486SL-25 CPU, dual-scan monochrome VGA passive-matrix display, 4 MB of RAM, 120- or 209-MB hard disk</td>
<td>3/9/93</td>
<td>$1999 (120 MB)</td>
<td>Same</td>
<td>Hibernation, auto-shutdown on low battery, fax modem, cellular data hookup to Motorola or Nokia phones, three-year warranty</td>
<td>486SL-33 CPU, EasyPoint built-in trackball, active-matrix display standard, improved docking station capabilities</td>
</tr>
<tr>
<td>Apple Macintosh PowerBook 180</td>
<td>Motorola 68030-33 CPU, active-matrix gray-scale display, 4 MB of RAM, 80- or 120-MB hard disk</td>
<td>10/19/92</td>
<td>$4109-$4469</td>
<td>$2479-$2969</td>
<td>8-bit Apple Sound Chip, security slot for third-party locking devices, two-level keyboard tilt adjust, disability access, 68882-33 math coprocessor</td>
<td>Modular system design, PCMCIA slots, reduced voltage Motorola 68040 CPU</td>
</tr>
<tr>
<td>Apple Macintosh PowerBook 160</td>
<td>Motorola 68030-25 CPU; STN gray-scale display, 4 MB of RAM; 40-, 80-, or 120-MB hard disk</td>
<td>10/19/92</td>
<td>$2429-$3149</td>
<td>$2479-$3149</td>
<td>Same as Model 180 minus math coprocessor</td>
<td>Next-generation model is PowerBook 165, with 33-MHz 68030</td>
</tr>
<tr>
<td>Compaq LTE Lite 4/25C</td>
<td>486SL-25 CPU, active-matrix color, 209-MB hard disk</td>
<td>11/9/92</td>
<td>$4099 (120 MB)</td>
<td>$4399 (209 MB)</td>
<td>Standby up to 80 hours, hardware/ software security, hot keys for system functions, three-year warranty</td>
<td>Decreased weight, multimedia features, improved APM, greater telecommunication options</td>
</tr>
<tr>
<td>Apple Macintosh PowerBook Duo 230</td>
<td>Motorola 66030-33 CPU, STN gray-scale display, 4 MB of RAM, 80- or 120-MB hard disk</td>
<td>2/9/93</td>
<td>$3219</td>
<td>$1969-$3179</td>
<td>RAM capacity of 24 MB, 4.2-pound weight, Duo MiniDock option, up to 4½ hours of battery life</td>
<td>Modular models, PCMCIA slots, and low-voltage Motorola 68040 CPU, or even PowerPC 603</td>
</tr>
</tbody>
</table>
It's time for a truly objective discussion about application development. IBM's System Object Model (SOM) (currently shipping with OS/2® 2.1) is a language-neutral mechanism for developing object-oriented class libraries. Together with our new IBM SOMObjects™ Developer Toolkit, you can write apps faster and more efficiently than ever before.

SOMObjects tools let you take full advantage of the object-structured protocol of SOM—applications can access and use objects and object definitions regardless of what programming language created them. Now reuse is a reality. Instead of recompiling apps due to implementation changes, just reuse the objects. That saves time and money. And SOMObjects incorporates Distributed SOM (DSOM) technology to provide a base for object-oriented programming development and use over entire networks. What developer could object to that?

SOMObjects is available for both OS/2 2.X and IBM AIX/6000™ 3.2 (or higher) operating systems and is planned for the Windows™ environment. It complies with industrywide standards of the Object Management Group's (OMG®) Common Object Request Broker Architecture (CORBA). To find out more or to order the SOMObjects Developer Toolkit, call 1800 3-IBM-OS2 today. If your object is easier development, it's a more desirable way to work.

Making reuse a reality.
Competition for Active Matrix

The 1990s may be the decade of mobile computing, but so far, computing "anywhere, anytime" has been limited by LCDs that don't provide enough contrast for use in a wide variety of lighting conditions, even with power-consuming backlighting. In addition, LCDs are temperature-sensitive, requiring warm-up time and providing slow response in cold temperatures.

One of the most promising technologies to solve some of these problems is the cold-cathode FED (field-emission display). BYTE covered cold-cathode FEDs a while back (see "LCDs and Beyond," February 1991 BYTE). At that time, the forecast was for working products to come out in about two years. Almost three years have passed and there are still no commercial FEDs, but 1994 may finally be the year, as several projects are under way to develop them.

Cold-cathode FEDs operate on the same principle as the CRT, but rather than using a bulky high-voltage electron gun, FEDs use an array of low-voltage electron emitters to excite light-emitting phosphors that illuminate the screen.

Cold-cathode FEDs produce far brighter contrast displays than LCDs, are insensitive to temperature, and consume substantially less power than backlighted LCDs such as active- and passive-matrix displays (a 10-inch full-color FED would consume less than 5 W of power).

Three companies in the U.S. are working on cold-cathode FEDs. In addition, a French company, Pixel International, has demonstrated a 6-inch prototype cold-cathode FED.

A small company in Houston, Texas, SI Diamond, is working on an FED using a diamond coating for the field-emitter surface, unlike more conventional metal field emitters (see "SI Diamond's Architecture").

The company's design does not call for traditional, expensive diamonds, however. Instead, the diamond material will be manufactured through a process in which a high-intensity laser transforms graphite (i.e., soft carbon) into diamond.

SI Diamond is working with Microelectronics and Computer Technology (Austin, TX) to develop the FED. The company hopes to have a 1- by 1-inch prototype display early this year and 6-inch and larger displays later on.

The other companies working on FEDs in the U.S. are Micron Display Technology of Boise, Idaho, and Silicon Video of Cupertino, California. Silicon Video has some former employees of Coloray, which, before it went out of business, was the primary developer of FEDs in this country. Micron is working on a metallic-emitter design, while Silicon Video would not disclose the nature of its design. Silicon Video's Bob Dubak said, the current crop of competitors' FED prototypes require expensive drivers for switching voltages on and off and also suffer from non-uniformity in the displayed image. Dubak says that Silicon Video is working on lowering switching voltages to 50 or 60 V rather than 250 V, which is the minimum in other designs.

In any case, we should be seeing some prototypes from all three companies this year, says David Mentley of Stanford Resources, a display consulting firm in San Jose, California, FEDs "can put pressure on active-matrix displays."

-Nicholas Baran
Seven years of experience in developing powerful SCSI software, a commitment to our customers' needs and our all-in-one philosophy have made us a leader in SCSI software products. By listening to your needs, we have created a complete solution that has the power to meet the demands of MIS managers now and in the future. New CorelSCSI Network Manager is the best way to connect CD-ROM, WORM, rewritable and multifunction optical drives and jukeboxes to your NetWare file server, and features:

**Speed!**

High Performance CD-ROM Server Software

CorelSCSI Network Manager includes optimized CD-ROM Server software with caching to give industry-leading performance. Also includes support for multi-session and Kodak Photo CD formats, as well as device drivers for the Pioneer multi-disc unit.

**Capacity!**

Advanced Jukebox Support

Users will find increased storage capacities and enhanced performance as CorelSCSI Network Manager transparently integrates optical jukeboxes with NetWare file servers.

**Security!**

RAID Levels 4 and 5 Software

CorelSCSI Network Manager also includes CorelRAID, which allows users to customize RAID level 4 and 5 arrays with any supported ASPI-compatible SCSI controller(s) and 3 or more SCSI hard drives. Status screens allow the system administrator to easily troubleshoot any potential problems. CorelRAID lets users build arrays that provide high fault tolerance while improving performance. With CorelRAID there is no down time. By using hot-swap or hot-standby features, server down-time is eliminated.

**Compatibility!**

Compatible with Leading Host Adapters

CorelSCSI Network Manager includes ASPI Managers for Always Technology, Future Domain, and DPT, and supports a variety of host adapters including various models from:

CorelSCSI works with hundreds of leading manufacturers' SCSI devices. Corel ensures this with our in-house CorelSCSI Product Certification Program. Our listing of supported devices is updated monthly and is available through our fax back system, BBS, and customer service department.

For upgrade information or to order, call Corel: ext. 28

**$595 AS A BULK ORDER**

1-800-772-6735

OEM Sales (613) 728-0826 ext.1051

CorelSCSI works with hundreds of leading manufacturers' SCSI devices. Corel ensures this with our in-house CorelSCSI Product Certification Program. Our listing of supported devices is updated monthly and is available through our fax back system, BBS, and customer service department.

For upgrade information or to order, call Corel: ext. 28

1-800-772-6735

OEM Sales (613) 728-0826 ext.1051

Circle 73 on Inquiry Card.
ANY PORT IN

- Stereoscopic glasses for an even more virtually realistic 3D look.
- Get the best graphics on the planet with up to 19" 1280 x 1024 monitors.
- Roomy enough for two cards. ATM, FDDI, and/or video out. Print to video.
- StereoView
- StereoExpandability
- Pipe in video from VHS, Laser-disc, etc.
- Zoom ideas around your office, building, or campus at high-speed.
- ETHERNET AUTO
- The way this puppy reacts to a Silicon Graphics mouse is startling.
- Mouse
- MAC-compatible.
- Talk to anything from modems to midi to your digitizer.
- Dual Serial
- Don't forget printing and all that. Indy didn't.
- Parallel

- Headphones
- Slip 'em on and play to your department's content.
- Microphone
- Add a voice note to your model or drawing.
- Analog Stereo In
- Jazz up presentations with music, effects, & audio samples.
- Analog Stereo Out
- Amplify your creations. Your design review will blow them away.
- Digital Stereo In/Out
- Record and playback CD-quality sound. Sweet.
- IndyCam™ Port
- For the digital IndyCam color video camera. Meet face-to-face without using your feet. Or send video-mail.
- ISDN
- Two 64Kbit channels. Network with the factory down the block or a continent away.
- ETHERNET T10BASE-T
- A twisted-pair connection to share, deliver, or just play with ideas.
- Keyboard
- The 101-keyboard is PS/2™ compatible, just like the mouse.
- SCSI-II
- External disk and tape drives, CD-ROM, scanners, Photo CD, printers, plotters, you name it!

Motif® 1.2 © 1993 Silicon Graphics, Inc. Indigo is a registered trademark, and Indy is a trademark of Silicon Graphics. All other trademarks, registered and unregistered, are properties of their respective holders.
Introducing INDY™ from Silicon Graphics.

Welcome to Indy, the world processor. The newest Indigo®. The most affordable. And the first computer with its own digital color camera.

The intuitive user interface is a pleasure zone. Capture, create, communicate, and collaborate with the power of a 100MHz MIPS® R4000® 64-bit RISC processor. Now you can show the whole world exactly what you’re thinking. Want one?

Call 1-800-431-4331 Department B22 for the cool brochure.

INDY
Starting under $5000.*

* The $4995 Indy workstation includes all the features above, plus: 16MB of RAM (expandable to 256MB); digital IndyCam™ color camera; microphone; 3 juggling balls. 8-bit graphics w/ Virtual...
Graphics Gets Down to Basics

Give the people what they need. That's the philosophy behind several new Windows drawing programs designed for people whose artistic capabilities are nil, yet who still need to quickly create professional-looking diagrams and charts. You won't find some of the high-end features (e.g., support for Bézier curves, gradient fills, or special text effects) in ShapeWare's Visio 2.0 or Micrografx's SnapGrafx that you find in free-form, professional drawing programs. Instead, these programs are for business users who are often called on to create network diagrams, flowcharts, project time lines, and organizational charts for internal use. But they are designed to help in speeding the process along. You can use either of these programs to create respectable drawings in just 5 minutes.

While the two programs were developed to fulfill the need for quick-and-clean graphics, Visio 2.0 is more extendable than SnapGrafx. Visio 2.0 is an OLE 2.0 object and a container that also supports OLE 2.0 automation. In addition, ShapeWare has developed a catalog of optional symbol libraries for specific industries or themes. However, because of SnapGrafx's template gallery, which shows up each time you start the program, SnapGrafx makes it easier for you to get started on your drawing.

Both Visio and SnapGrafx use templates to jump-start you into the graphics creation process. Instead of having to create and link the arrows, symbols, and text boxes that you will use in an organizational chart or network diagram, the templates do much of that work for you. Each template provides a library of predrawn shapes and a framework for performing a specific task so that objects interact as you would expect them to. For example, in the creation of a flowchart, when you move a box, the link moves with it; when you select a shape and begin typing, the text is automatically inserted. Although these hand-holding features are not as dazzling as those that you might find in a 24-bit color paint program, they also include predesigned templates to minimize repetitive tasks. Intellidraw 2.0, Aldus's full-featured drawing program for the Mac and Windows, offers predefined templates and collections of smart objects. Microsoft has acknowledged that a number of people use presentation programs to create organizational charts. The company is including a special version of Banner Blue's Org Plus as a standard feature in PowerPoint 4.0 for Windows, which is expected to ship this month.

—Dave Andrews
Introducing Project Scheduler 6 for Windows:
Easy-to-use project management software with the advanced features you've been missing.

Now you can easily analyze and report rapidly changing schedules and resource availability with greater accuracy and speed.

Sophisticated modeling features like the Advanced Resource Tracking Spreadsheet (ARTS™) make Project Scheduler 6 the only Windows-based product to let you enter and evaluate resource costs and usage on a period by period basis. Performing multiple "what-if" scenarios is also a breeze with its ability to do multiple undo/redo in seconds.

You can manage multiple projects from a single resource base and rearrange activity information by function (WBS), organization (OBS) or resource (skill codes)—making it easy to view and present data in the most meaningful way. And with Project Scheduler 6's unique ability to build an ODBC project repository, spreadsheet and database users from other departments can access and update project data for added efficiency.

Project Scheduler 6 lets you build standardized screens and reports for consistency across your entire organization, or create custom formats on the fly for ultimate flexibility and impact.

Our object-oriented report writer offers outstanding layout versatility not usually found in project management software. It allows you to select and precisely place data fields, change fonts on-screen, and even incorporate colorful logos for sensational-looking reports.

All of our software comes with free telephone support that won't keep you waiting in an electronic queue and includes access to the project management experts who developed the entire Project Scheduler series of multi-platform software. Scitor also offers the most comprehensive training and consulting programs in the industry.

If you're looking for project management software that offers both powerful features and true ease-of-use, then take a closer look at the new Project Scheduler 6 for Windows today!
For the best in electronic forms, this choice is easy.

Just click here to let it ride on your e-mail or messaging system.

Use any of 22 drawing tools to create your form.

The electronic signature lets you tamperseal the data on your form.

Import or create your logo. Then store it in the object library to use over and over.

With 120 spreadsheet functions at its disposal, WordPerfect InForms will calculate the total. And then decide where to route the form for proper authorization.

You've decided to streamline and cut costs with an electronic forms package. But which package should you choose? • First, look for one that's easy to manage. With graphics and spreadsheet capabilities, to make your forms look and act exactly the way you want them to. And with design tools that let you get up and running right away. • Second, look for the one that will get you the most out of your databases. That will let
For the easiest in multiple database access, this choice is best.

Pick up your vendor address from dBase, and your billing address from Oracle.

Simultaneously update any of 19 popular database programs with your sales order, manufacturing or shipping information.

Any current backorders from this vendor? Query your Paradox database in plain English or by example and get a custom report.

Automatically update your Sybase SQL inventory database.

You access, update or query multiple databases from a single form. Now that you know what you're looking for, the best choice is easy: WordPerfect® InForms. No electronic forms package is easier to handle and supports nearly as many databases (19 of the most popular). Take a look at the next generation in electronic forms. Call (800) 526-4806 for a FREE WordPerfect InForms demo disk, or (801) 225-4414 to download from our BBS.
A Giant Leap for Borland C++, a Small Step Past Visual C++

When Borland C++ for Windows 4.0 makes its debut, it will be the best Windows development system on the planet—but just by a hair. BCW 4.0 inherits and improves on the best features of its predecessor, its OS/2 sibling, and archrival Visual C++ to create an unsurpassed environment for building 16- and 32-bit Windows applications. But while the innovations are great, the end result is a tool that’s only marginally better than Visual C++. Also, given the similar capabilities and great complexity of both packages, the advancements in BCW 4.0 will prove a boon primarily to those already committed to Borland C++ and OWL (Object Windows Library) development.

The most obvious enhancements to BCW 4.0 are Experts, high-level, rapid application-development utilities that are similar to the Wizards of Visual C++. The AppExpert generates a complete framework for an OWL-based application (or DLL) given only a few selections in a small set of dialog boxes. The resulting application can be incredibly sophisticated, optionally including a ready-to-run MDI (Multiple Document Interface), a toolbar, a status line, print previews, and built-in help.

The ClassExpert is a combination browser and editor that works with AppExpert applications, letting you quickly derive new classes from OWL’s comprehensive set and easily define new member functions. The ClassExpert is fully integrated with Borland’s Resource Workshop, so deriving a new class from OWL’s TDialog instantly pops you into the resource editor, where you build the dialog-box template. Changes you make in the resource editor are reflected in the source files you edit within the ClassExpert.

Underlying the Expert technology is OWL 2.0, a heavily revamped version of Borland’s high-level class library. OWL 2.0 adds Doc/View support, VBX control classes, and a host of new high-level classes (e.g., print and print preview). But OWL’s most significant change is that it no longer requires the Borland-specific dynamic-dispatch virtual tables that formed the heart of OWL 1.0. That makes OWL 2.0 potentially portable to any C++ compiler and opens the door for OWL on platforms beyond Windows, making it an attractive target for those building cross-platform applications.

OWL’s first step outside Windows will be to Novell’s AppWare Foundation, a move that should be realized by this summer. Compared to other Windows C++ implementations, BCW 4.0’s compiler is the most advanced. It supports the most recent recommendations of the ANSI C++ committee. New language features in BCW 4.0 include ANSI C++ exceptions and string classes, and run-time type information support.

BCW 4.0 targets both Win16 and Win32, includes Win32s, and can run (minus the IDE) on Windows NT. For the moment, it better Visual C++ 1.0 with more advanced C++ features and a slightly better IDE; it also nicely fills the gap between the 16-bit and NT-hosted 32-bit versions of Visual C++. But its real challenge will come when Microsoft fills that gap on its own with Visual C++ 1.5, which will include Microsoft Foundation Classes 2.5 and its attendant high-level ODBC (Open Database Connectivity) and OLE 2.0 classes. At that point, OWL’s potential as a GUI-independent platform may be the only quality that really sets BCW 4.0 apart.

—Steve Apiki

Borland C++ 4.0, $499, Borland International, Inc., P.O. Box 660001, Scotts Valley, CA 95067, (408) 431-1000.

LAPLINK CUTS THE CABLE

Traveling Software and National Semiconductor have developed a wireless product that uses radio-transmission technology and intelligent software to let you automatically connect two computers and synchronize their files before you’ve even taken off your coat. Called LapLink Wireless with AirShare, the hardware/software package lets you link portable and desktop PCs without having to physically connect them.

Due to the package’s on-connect option, you can configure the AirShare software to automatically begin synchronizing files at speeds of 115 Kbps once you walk within the range (about 30 feet indoors) of the target PC. Thus, you can begin sharing files simply by walking near the target computer. You can also use the package to print documents directly from your portable to a local or network printer.

LapLink Wireless includes two AirShare radio modules that weigh about 3 ounces each. The package is slated to ship in the first quarter and will cost $299.95.

—Dave Andrews
Don’t let the next generation of high-performance graphics cards pass you by.

Introducing Pro Graphics™ 1024. Driving a stunning 16.7 million colors at 1024 x 768 resolution, it delivers the best performance in the field. Now, that’s True Color. And it’s from Media Vision, the leader in innovative PC graphics. With a refresh rate of 76 Hz for a crisp flicker-free display, Pro Graphics 1024 delivers the speed you’re looking for. At a price that won’t blow you away.

Why not test drive a Pro Graphics 1024 at your local computer retailer? And see what 16.7 million colors at 1024 x 768 looks like at this speed. For more information on the whole Media Vision family of Pro Graphics accelerators call 1-800-845-5870 dept. 630.

Tests performed using Ziff Davis Labs' WinBench™ V.3.11 without independent certification by Ziff. Media Vision conducted all tests based on Diamond motherboard with Intel 486DX2/66 CPU, 16MB RAM, 256K cache, 340MB IDE hard drive, MS-DOS Version 5.00. ©1993 Media Vision, Inc., 3185 Laurelview Court, Fremont, CA 94538. (510) 770 9592. Pro Graphics 1024 is a trademark of Media Vision, Inc. Any other trademarks and registered trademarks are owned by their respective holders.

Circle 130 on Inquiry Card.
Why is this perpetual power-seeker pleased?

He just bought an AMBRA and got the max without spending megabucks.
OPEN-THROTTLE THROUGHPUT

PCI local bus
Say goodbye to I/O jams and hello to a jumperless future—at AMBRA, the PCI local bus has arrived!
In our Pentium processor-based ISA desktops, this heavy-load CPU-to-peripheral data carrier:
- Increases throughput
- Autocconfigures PCI adapter cards
- Provides a strong expansion base for high-performance peripherals

Networks
Multimedia
Disk drives

VESLA local bus
Prefer VESA over PCI? AMBRA's selection of Pentium technology systems includes towers and desktops to suit.
Step up to Pentium processor power while protecting your investment in VESA option cards you may already have.

WARP-SPEED GRAPHICS. If you're talking accelerated graphics, AMBRA's talking 81 million Winmarks! with the Diamond Viper PCI video card! This high-powered PCI graphics board provides 24-bit True Color (up to 16 million hues!), fast and flicker-free refresh rates, and super-rapid screen redraws. For VESA fans, AMBRA also has the Viper in a VL version. In addition, we offer the popular ATI® Mach 32 VL graphics accelerator.
EXPONENTIAL GROWTH

MAYBE YOU NEED A SYSTEM THAT’S BIG, BIG—AS WELL AS FAST, FAST. WE’VE DESIGNED A DUAL PENTIUM PROCESSOR COMPLEX THAT ALLOWS YOU TO DOUBLE YOUR COMPUTING POWER WHENEVER YOU CHOOSE.

We build TO YOUR SPECS for memory, storage, and more. And if one Pentium processor isn’t enough, take TWO!

POWER

Our dual complex is available in EISA towers that offer 8 slots and 12 bays to build upon.

You can begin with one Pentium processor, then add another later. Say, when you’re ready to tap the multi-processor support in an operating system like UNIX or Windows NT™. If you’re ready now, we’ll create a dual-powered system for you without delay.

open-ended expansion. Require big-byte storage? We’ve got hard disks ranging up to 1GB! Need to run a dozen high-speed peripherals? You can support as many as 14 drives and devices on a single slot, thanks to

Firm confidence.

AMBRa covers every computer with a 30-day money-back guarantee and a one-year limited warranty. An optional IBM® one-year onsite warranty is also available to you. With either warranty, you can rely on toll-free technical support 24 hours a day. 7 days a week.

FREE CUSTOMIZATION. The systems you see here are just some of your choices. AMBRA custom-configures to your exact specs—preinstalling and/or preloading your pick of memory sizes, hard disks, option cards, and more—without extra service charge and no delay.

Full convenience.

To place an order or get more information, just call AMBRA's lines are open every weekday 8 am to 9 pm, and Saturday 10 am to 6 pm (ET). We accept VISA®, MasterCard®, and American Express®—as well as purchase orders from qualifying businesses. So pick up the phone, and get a direct line to Pentium processing power today.

In Canada, call 1-800-363-0066, Ext. 4911.

---

1. **Model DP60/PCI**
   - Pentium processor, 60 MHz
   - 64-bit data path
   - 8MB RAM, max: 128MB
   - 256KB processor cache
   - 3.5" 1.44MB diskette drive
   - 340MB (12ms) hard disk
   - 4 ISA, 2 PCI, 1 PCVISA slot
   - 6 storage bays
   - PCI graphics accelerator, 2MB DRAM
   - 14" SVGA color monitor, LR
   - Desktop casing
   - 200-watt power supply
   - MS-DOS® 6.0, Windows 3.1, mouse
   - $2,799

2. **Model DP60/PCI to the max, with:**
   - 440MB (12ms) hard disk
   - Diamond Viper PCI, 2MB VRAM
   - 2X CD-ROM drive
   - 15" Flat Square color monitor, LR, NI
   - Desktop casing (convertible to mini-tower)
   - 200-watt power supply
   - MS-DOS® 6.0, Windows 3.1, mouse
   - $3,999

3. **Model DP60E/V/L**
   - Pentium processor, 60 MHz
   - 64-bit processor complex
   - 8MB RAM, max: 64MB
   - 256KB processor cache
   - 3.5" 1.44MB diskette drive
   - 540MB (10.6ms) Fast SCSI-2 hard disk
   - Onboard dual-channel Fast SCSI-2
   - 8 EISA slots (2 VESA)
   - 6 storage bays
   - L45 ATI® Mach 32, 2MB VRAM
   - Desktop casing (convertible to mini-tower)
   - 200-watt power supply
   - MS-DOS® 6.0, Windows 3.1, mouse
   - $3,999

4. **Model TP60E/V/L**
   - Pentium processor, 60 MHz, upgradeable to dual processors
   - Dual 64-bit processor complex
   - 8MB RAM, max: 128MB
   - 512KB processor cache
   - 3.5" 1.44MB diskette drive
   - 540MB (10.6ms) Fast SCSI-2 hard disk
   - Onboard dual-channel Fast SCSI-2
   - 8 EISA slots (2 VESA)
   - 12 storage bays
   - L25 S3 386 graphics accelerator, 1MB DRAM
   - 2X CD-ROM drive
   - 15" Flat Square color monitor, LR, NI
   - Tower casing
   - 350-watt power supply
   - MS-DOS® 6.0, Windows 3.1, mouse
   - $4,719
Where is everyone going these days? They’re going mobile. And your next computing or communications device can go with them when you design-in AMD technology.

Take advantage of AMD’s vast exper-
tise in process, packaging and design technologies — optimized for mobile computing and communications applications. So your next design can have more features, more speed, a smaller and lighter form factor, and longer bat-

Our new CT2 PhoX™ controller — the core technology in the newest CT2 digital cordless phone systems — is the latest expression of the DSP technology that makes us a leading supplier of telecommunications ICs in the world today.

Our 5.0 Volt-only Flash memories play a critical role in today’s advanced digital cellular phones. While our low-voltage EPROMs play an equally important role in analog cellular designs. Both non-volatile memory families offer the right combination of packaging and speed that mobile communications applications demand.

AMD’s 5.0 Volt-only Flash memory cards are instrumental in providing portable storage in state-of-the-art hand-held personal electronic devices — like personal digital assistants, schedulers, electronic notepads, personal communicators, pocket computers, and even electronic maps.
tery life than ever before. Ideal for today's demanding mobile professional.

See for yourself why AMD is the way to go in mobile computing and communications. For a free brochure on all our mobile products, contact AMD today.

800-222-9323

Advanced Micro Devices

Circle 288 on Inquiry Card.


CD-ROM DRIVES

Speedy CDs Improve Video Performance

When it comes to moving data from disc to screen, CD-ROM drives have never been fleet-footed performers. However, CD-ROM may finally be finding its legs. Faster double-speed CD-ROM drives are now the norm, even among low-cost models. And Pioneer, NEC Technologies, and Plextor (formerly Texel), are upping the ante again with triple- and even quadruple-speed CD-ROM readers.

Pioneer already sells its external DRM-604X quadruple-speed CD-ROM reader. NEC has announced 3X and 4X drives. The new MultiSpin 3X drives ($455 to $600) transfer data at 450 Kbps, compared to the 150-Kbps rate of the first CD-ROM readers. The MultiSpin 4X Pro ($995), which NEC says it is targeting at software developers and power users, bumps the data transfer rate to 600 Kbps, or fully twice the throughput of today’s double-speed CD-ROM drives.

The higher transfer rates of these new models mean that the drives can more quickly read into memory large blocks of data—the kind needed for showing photo-realistic pictures, full-motion video clips, and crisper animation sequences. Plextor’s quadruple-speed drive should be available by the middle of 1994.

While any CD-ROM title with such multimedia elements should run noticeably smoother, NEC is working with a host of publishers to produce new discs or updated versions of earlier titles that take particular advantage of the higher data transfer rates. Companies participating in NEC’s Strategic Software Partnership program include Broderbund, Corel, Grolier, Knowledge Adventure, Macromedia, Spectrtrum HoloByte, and Time Warner Interactive.

Not all CD-ROM applications will benefit from the boost in data transfer rates, however. Searching through a disc full of text information (e.g., a Yellow Pages directory or a database of magazine articles) won’t be much faster on a triple-speed drive. That’s because finding data on the disc to begin with remains a relatively leisurely process. Both the MultiSpin 3Xe (external) and 3Xi (internal) drives have access times of 195 milliseconds, as does the 4X Pro model.

A fourth model, the 3Xp (personal), has an access time of 230 ms. That’s roughly 10 times slower than the access times of typical hard drives.

Still, for the sort of glitzy titles that dominate the CD-ROM field, triple- and quadruple-speed readers are a boon. And there may be higher speeds ahead. “There’s no limit to how fast you can spin the disc,” notes Dan Johnson, a MultiSpin product manager at NEC. The challenge, he says, is in developing a faster spindle motor and better error-correcting code (in the drive’s firmware) and then dispersing the extra heat it produces.

NEC has been experimenting with CD-ROM drives running at six to eight times the original speed. But at some point, says Johnson, CD-ROM capacity may become a bigger issue than transfer speed.

—Christopher O’Malley

OPEN SYSTEMS

Novell Opens Unix

LONDON—Novell has transferred the Unix trademark to the international X/Open standards organization. The transfer, which was announced last October, when combined with other standards efforts, may yet result in multiple implementations of Unix that conform to a single specification.

Novell’s transfer of the Unix trademark to X/Open is, said Kanwal Rekhi, executive vice president of Novell’s Unix Systems Group, the next logical step for Unix. (In September, over 75 companies, including Sun, Hewlett-Packard, DEC, IBM, Novell, and SCO, agreed to adopt a single set of 1170 API calls.) X/Open will be responsible for certifying that vendors’ operating systems meet the Spec 1170 definition of Unix.

The idea behind the common API is to let developers write to a single set of memory, file-system, and other kernel-level calls so that they need to do only a source-level recompilation to support another Unix platform. With multiple compatible implementations of Unix, vendors will then compete on the basis of price, quality, service, and reliability, or as X/Open’s president and CEO Geoff Morris said, “a single specification, a single brand, and as much innovation as the industry can deliver.”

The movement toward a unified Unix will continue throughout this year. SunSoft, IBM, and SCO officials say they expect to have versions of Unix that comply with Spec 1170 this year. But Morris said that the suite of software tests to verify Spec 1170 compliance will likely not be available until the end of the year. Until then, there is an interim specification that says companies must use USL operating-systems technology, conform to SVID (System V Interface Definition), and conform to XPG3 (X/Open Portability Guide) or XPG4.

Novell will not give up its right to license Unix System V source code to other vendors, but once the test suites are available, Unix vendors will no longer be required to use Unix code developed at USL/Novell.

—Dom Pancucci
WATCOM SQL for Windows is a high-performance SQL database engine for Windows applications. The package includes everything required to begin using WATCOM SQL immediately from many popular Windows applications, supporting interfaces ranging from ODBC and DDE to the Windows clipboard. Everything necessary for application development in C/C++ (using compilers from WATCOM, Microsoft or Borland) is also included.

Installation in Under 10 Minutes The easy installation and setup reduce the time and expense traditionally required by client/server technology. Further, WATCOM SQL lets you achieve high performance results right out of the package without the need for performance setup and tuning by expert personnel.

Performance and Reliability WATCOM SQL's cost-based query optimizer and efficient data representation combine to deliver high performance. Transaction processing and declarative referential integrity protect the consistency of your data. The client/server architecture reduces network traffic, resulting in increased performance for your multi-user applications.

Scalable SQL for Now and the Future WATCOM SQL applications can be designed to run without change in environments ranging from standalone PCs to large multi-user networks. The 32-bit WATCOM SQL Network Server Edition unleashes the power of 386/486 PC's to deliver high performance for large networks with many clients.

The Best Value in SQL Database Engines WATCOM SQL for Windows 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 WATCOM SQL you'll be able to get a copy of the 6-user Network Server Edition for only $99* (Suggested retail price: $795*).

Royalty-Free Runtime for only $99* As a registered user you can get royalty-free runtime support for just $99*, enabling you to distribute our standalone single-user runtime SQL database engine with your applications royalty-free.

WATCOM SQL for Windows 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 WATCOM SQL you'll be able to get a copy of the 6-user Network Server Edition for only $99* (Suggested retail price: $795*).

WATCOM SQL Network Server Edition

High-performance Multi-user SQL Database Server for PC LANs, Supports multiple concurrent DOS or Windows clients in a network environment.

WATCOM, 415 Phillip Street, Waterloo, Ontario, Canada, N2L 3X2. Telephone: (519) 886-3700, Fax: (519) 747-4971. *Prices do not include freight and taxes where applicable. Authorized dealers may sell for less.

WATCOM and the Lightning Device are trademarks of WATCOM International Corporation. Other trademarks are the properties of their respective owners. Copyright (1993) WATCOM International Corporation.
<table>
<thead>
<tr>
<th>State</th>
<th>Location</th>
<th>Address</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>Phoenix</td>
<td>Keyboard City</td>
<td>602-320-2206</td>
</tr>
<tr>
<td>California</td>
<td>Berkeley</td>
<td>Guitar Center</td>
<td>510-652-6104</td>
</tr>
<tr>
<td></td>
<td>Covina</td>
<td></td>
<td>818-967-7911</td>
</tr>
<tr>
<td></td>
<td>Hollywood</td>
<td></td>
<td>213-874-1060</td>
</tr>
<tr>
<td></td>
<td>Lawndale</td>
<td></td>
<td>310-542-9444</td>
</tr>
<tr>
<td></td>
<td>West L.A. Music</td>
<td></td>
<td>310-077-1945</td>
</tr>
<tr>
<td></td>
<td>Menlo Park</td>
<td></td>
<td>415-328-1945</td>
</tr>
<tr>
<td></td>
<td>Mountain View</td>
<td></td>
<td>415-694-3021</td>
</tr>
<tr>
<td></td>
<td>Orange Park</td>
<td></td>
<td>415-328-5773</td>
</tr>
<tr>
<td></td>
<td>Rockley Music</td>
<td></td>
<td>303-233-4444</td>
</tr>
<tr>
<td></td>
<td>Music Education</td>
<td></td>
<td>310-477-1945</td>
</tr>
<tr>
<td></td>
<td>Ascend</td>
<td></td>
<td>813-725-2062</td>
</tr>
<tr>
<td></td>
<td>Cory</td>
<td></td>
<td>918-742-5541</td>
</tr>
<tr>
<td></td>
<td>CCLI</td>
<td></td>
<td>503-257-2230</td>
</tr>
<tr>
<td></td>
<td>Guitar Center</td>
<td></td>
<td>503-226-3719</td>
</tr>
<tr>
<td></td>
<td>Mesa</td>
<td></td>
<td>503-253-2866</td>
</tr>
<tr>
<td></td>
<td>Sam's Music</td>
<td></td>
<td>615-371-5000</td>
</tr>
<tr>
<td></td>
<td>Music Center</td>
<td></td>
<td>817-227-3510</td>
</tr>
<tr>
<td></td>
<td>Buddy Rogers Music</td>
<td></td>
<td>214-392-3490</td>
</tr>
<tr>
<td></td>
<td>Keyboard Superstore</td>
<td></td>
<td>214-631-0923</td>
</tr>
<tr>
<td></td>
<td>Sam's Music</td>
<td></td>
<td>214-960-0011</td>
</tr>
<tr>
<td></td>
<td>Guitar Center</td>
<td></td>
<td>713-952-5070</td>
</tr>
<tr>
<td></td>
<td>Sam's Music</td>
<td></td>
<td>713-531-9227</td>
</tr>
<tr>
<td></td>
<td>Musicware</td>
<td></td>
<td>801-261-4555</td>
</tr>
<tr>
<td></td>
<td>American Music</td>
<td></td>
<td>206-633-1774</td>
</tr>
<tr>
<td></td>
<td>Evans Music</td>
<td></td>
<td>206-363-6851</td>
</tr>
<tr>
<td></td>
<td>Music City</td>
<td></td>
<td>509-482-0671</td>
</tr>
<tr>
<td></td>
<td>Cascio Music</td>
<td></td>
<td>414-786-6249</td>
</tr>
<tr>
<td></td>
<td>Musicware</td>
<td></td>
<td>416-785-3311</td>
</tr>
</tbody>
</table>

Get MusicTime today at one of these fine Passport Dealers.
With MusicTime™
Your Sound Card Plays More Than Games.

Create Songs on Your Sound Card with MusicTime.
Whatever your musical ability, MusicTime will inspire you to create your own breathy love songs, foot-tapping jazz or head-slammin' rock 'n' roll. With MusicTime and either a sound card or a MIDI instrument, you can compose, edit, play back and print sheet music on your PC.

Bring Your Music to Life.
Use your mouse-to-click musical notes and symbols onto a staff sheet. If you've got a Miracle® or MIDI keyboard, MusicTime will record and transcribe your live performance into music notation in real time—right before your eyes!

Easy to Play Back, Edit and Print.
Play back instantly through your sound card or MIDI gear. Editing is easy with MusicTime's cut, copy and paste commands. Automatically transpose notes into any key. Add guitar chords. Write beautiful lyrics. Print out publishing-quality sheet music.

MusicTime couldn't be easier to use.
Windows, Mac and MIDI Compatible.
MusicTime is available for PC's with Windows® or the Macintosh®, and is compatible with The Miracle Keyboard, Sound Blaster Pro®, Media Vision Pro Audio Spectrum® and Thunder Board®, AdLib Gold® and most popular PC sound cards.

For your copy of MusicTime, call Passport or visit your nearest computer or music store. If you're tired of just playing games with your sound card, get MusicTime and turn your beeps and blasts into be-bop and hip-hop.

MusicTime
Passport Designs, Inc. • 100 Stone Pine Rd. • Half Moon Bay, CA 94019 USA • Phone: (415) 726-0280 • Fax: (415) 726-2254
Passport MusicTime is a trademark of Passport Designs, Inc. All other products and brands are trademarks or registered trademarks of their respective holders.
Circle 99 on Inquiry Card.
REMOTE ACCESS

Remote Control Gets Redirected

Mobile workers who want to access data that resides on a remote PC or LAN now have a wide variety of solutions for their communications needs, thanks to new programs that combine several functions in one package. Companies like Ocean Isle Software (Vero Beach, FL) and Triton Technologies (Iselin, NJ) that sell remote-control packages are adding LAN-redirection capabilities to their packages, giving you the ability to dial into your PC on the LAN and access its network services at a cost of $250 or less.

Such packages don’t offer the full range of security or simultaneous multiuser access as dedicated products like Shiva’s $1699 NetModem/E (see “Network Modems Dial in, Dial out, and Route Packets,” November 1992 BYTE). But they offer an inexpensive communications solution for the user who wants to update and transfer files from one system to another.

One common solution for connecting nonnetworked users has been remote-control products like Norton-Lambert’s Close-Up or Symantec’s Norton PC Anywhere. With remote-control software, you take over a remote PC system as if you were sitting at its keyboard. You can view the remote PC’s screen from your own PC, and your keystrokes and mouse actions can control the remote PC’s applications, which is why remote-control programs are often used for technical support and LAN troubleshooting.

Remote-node products take a different approach. In products like the NetModem/E, USRobotics’ Communication Server 386, and DCA’s Remote LAN Node software, a remote-access server attached to the LAN captures network packets and forwards them to the remote system. There, a network driver presents the network packets to the system as if they had been received directly from a LAN. This permits the remote system to perform any network operation (e.g., disk, printer, or E-mail) that is possible when attached locally. But remote network operations are somewhat slower than a LAN-attached node because modems usually operate at less than 5 percent of the speed of an Ethernet network.

A third category of software is typified by the LAN-redirection portions of Triton’s Co/Session, Ocean Isle’s ReachOut, and Traveling Software’s CommWorks communications package. These software packages provide remote access without directly giving full access to a remote LAN. Steve Dulaney, product manager of CommWorks, says that unlike products like the NetModem/E, which can support multiple simultaneous users, the LAN-redirection portion of CommWorks is more for making one-to-one connections. But, once you’re connected to your PC on the LAN, he says, “Every drive is available, even if it happens to be a network drive.” For small workgroups, products in this category provide an inexpensive alternative to more expensive dedicated solutions.

Increasing modem speeds coupled with decreasing costs should improve the usefulness of remote-node products. Inexpensive integration with operating-system software will increase the acceptance of remote-node technology among users. Remote control still is the number-one choice for applications such as remote technical support and training.

—Matt Trask

EUROPEAN COMMUNICATIONS

Falling Prices Boost ISDN

MUNICH—Businesses in Germany are increasingly turning to ISDN for their telecommuting needs. ISDN’s ability to establish connections in about 1 second, combined with compression and bridges that can harness many 64-Kbps lines into one channel, make it an attractive LAN-to-LAN networking solution. “Telecommuting applications are, for the moment, the killer applications for ISDN,” says Christian Luhrs, director of marketing for CPV-Stollmann (Hamburg).

One segment of the market ISDN has not yet widely penetrated is the home-to-office arena, partly because ISDN is too expensive for many users. But Telekom, a German phone company, is expected to reduce the cost of ISDN access this year.

Acotec (Berlin) offers ISDN for Windows, a program that lets Windows for Workgroups users establish LAN-to-LAN and PC-to-LAN connections over ISDN. Christian Zillich, Acotec’s director of marketing, reckons that Telekom is activating 15,000 ISDN accesses a month. He says, “Five years ago, when ISDN started, people asked, ‘Where are the ISDN end terminals?’ There are 35 million PCs in Europe. These are the engines.”

—Dave Andrews

Advancements in full-motion data compression continue to improve the performance of videoconferencing programs that run over 64-Kbps ISDN lines. For example, Teles (Berlin) has developed TelesVision, a videoconferencing program for Unix that lets you view up to four participants (out of a total of 20) simultaneously and share documents over ISDN. However, differing national ISDN standards in Europe often make it difficult to set up a videoconference involving several countries. For this reason, 26 public network operators from 20 European countries have agreed to a common ISDN called Euro-ISDN. The first products and services to support Euro-ISDN will appear this year.
PERFORMANCE MEASUREMENT
TRUE TESTS OF SPEED
PUTTING PCs TO THE TEST.

At Intel, we’ve become experts at measuring PC performance. The reason for this is quite simple. We need ways to accurately measure performance in order for our engineers to develop faster processors. That’s why we’ve worked with other companies in the industry to develop measurement tools. You can use these same tools to choose the right PC.

MegaHertz. Like RPMs?

One common misconception is that you can compare PC performance by comparing megahertz ratings or clock speeds. This is like comparing the performance of engines with RPMs instead of horsepower. For example, although a small 4-cylinder engine may operate at high RPMs, it isn’t as powerful as a big V-8 at lower RPMs. That’s why the industry created benchmarks.

Performance Basics.

There are four different types of benchmarks.

You should be sure you’re comparing the same types of benchmarks when comparing PCs. One kind measures the performance of an entire system. Another only measures subsystems.

In addition, benchmarks can be built two different ways—using commercial software applications or synthetically with code that’s written to represent applications. While most applications are several megabytes in size, some synthetic benchmarks are only a few kilobytes. This allows them to fit in internal processor caches. So they exaggerate processor performance and don’t reflect real-world results.

System Benchmarks.

To compare the performance of an entire computer, you should use a system benchmark. This type of benchmark demonstrates how the individual subsystems in a PC work together to achieve overall performance for your applications.

One example of a benchmark that does this accurately is BAPCo’s SYSmark93™ for Windows. It’s an applications-based benchmark made up of best-selling Windows applications including word processing, spreadsheets, databases, software development, graphics and desktop publishing.

BAPCo is a non-profit organization comprised of 21 hardware and software member companies throughout the industry, including Intel. To ensure real-world performance results, BAPCo surveyed users about how they are actually using these applications and incorporated these results into their benchmarks. (See the charts on back.)

Subsystem Benchmarks.

These benchmarks stress a single aspect of a PC’s performance. They help manufacturers “tune” each subsystem in a PC to work together and achieve the fastest overall speed. Viewed alone, however, they are not an accurate measure of how a computer will perform overall.

Because the microprocessor is the subsystem most responsible for a PC’s performance, you should choose it first using a tool like the iCOMP™ index. The other subsystems should then be chosen based upon your software’s needs. (See the diagram this page.)
**MEMORY SUBSYSTEM**

Memory performance is dependent on cache size and architecture which determine wait states. Because it is linked to the microprocessor, it is best measured by a good CPU benchmark like SPECint92, Landmark 3.0 or ZD Labs' PC Bench 7.

**VIDEO**

Video performance is determined by the graphics chip set and whether or not it's on a local bus. Ziff Davis Labs' WinMark test is a good measure of this PC subsystem.

**BUS**

The ability to transfer information quickly between the processor and other subsystems is vital to overall system performance. This is measured by bus throughput. Advanced buses like the PCI bus can transfer information at 132MBytes/sec as compared to 5MB/sec for the ISA bus.

**DISK DRIVES**

Many of today's hard disks incorporate disk caches which increase throughput. You can simply compare access times or use most PC utility programs to accurately test disk drive performance.

**THE iCOMP™ INDEX. COMPARING INTEL MICROPROCESSORS.**

Megahertz ratings are not an accurate measure of microprocessor performance. Other elements have an effect on speed. For example, an Intel 386™ processor has larger caches, floating point operations and the ability to execute one instruction in a single clock cycle. These advancements make it run faster than an Intel 486™ processor. Even if both processors are running at 33MHz, that's why Intel developed the iCOMP™ index. It's an easy, reliable way to compare the relative performance of Intel processors.

iCOMP stands for the Intel Comparative Microprocessor Performance Index. It is not an industry benchmark. Rather, it's an Intel-developed tool for comparing the performance of our microprocessors.

The iCOMP index represents Intel processor performance on typical desktop applications, saving you the time of reading and understanding multiple benchmarks. It's a "forwards looking." It weighs 16-bit performance 70 percent and 32-bit performance 30 percent. Thus, it represents typical usage during the next three to five years.

**COMPOSITION**

The iCOMP index is a weighted average of several well-accepted industry-standard benchmarks, each measuring a specific aspect of processor performance.
IN GENERAL, THE FASTER THE PROCESSOR, THE FASTER THE COMPUTER...

BAPCo's SYSmark92 results for different Intel processors!

400
350
300
250
200
150
100
50
0

Pentium™ Processor

486™ DX2-66
486 DX-50
486 DX-33
486™ DX-33

AS YOU CAN SEE, THESE BUS SYSTEM BENCHMARK RESULTS ARE SIMILAR TO THE iCOMP™ INDEX RESULTS INSIDE. THIS SHOWS HOW THE iCOMP INDEX CAN BE USED TO EASILY COMPARE THE PERFORMANCE OF COMPUTERS WITH DIFFERENT PROCESSORS.

HOWEVER, PCs WITH THE SAME PROCESSOR DON'T ALL PERFORM THE SAME.

250
200
150
100
50
0

All Intel486™ DX2-66 processor-based systems.

SYSmark92 results for Intel486™ DX2-66 processor-based systems!

THE OVERALL PERFORMANCE OF A PC DEPENDS UPON THE ENTIRE SYSTEM—NOT JUST THE MICROPROCESSOR. THAT'S WHY IT'S IMPORTANT TO CHOOSE A PC WITH WELL-TUNED SUBSYSTEMS.

NOT ALL PCS ARE CREATED EQUAL.

It has been said that a chain is only as strong as its weakest link. Although the processor is the vital component in a computer, other subsystems can have a dramatic effect on overall performance. In fact, depending upon subsystems like disks, memory and video, the performance of PCs with the same processor can vary by up to 100 percent. Even with the same components, system performance can be enhanced through disk caching software and BIOS enhancements.

Subsystems should be chosen based upon your software:
• Video—Better video subsystems will boost the performance of Windows and graphic-intensive applications.
• Disk—Faster disk drives will boost the performance of applications like databases.
• Memory—A better memory subsystem, a more efficient cache and faster RAM speed increases the performance of all applications, especially calculation-intensive ones like spreadsheets.

FOR MORE INFORMATION ON THE iCOMP™ INDEX AND PERFORMANCE MEASUREMENT, CALL 1-800-955-5599.

We've prepared a detailed package including more information on the iCOMP index, the different kinds of benchmarks, and even specific benchmark results. Simply call us today and ask for literature pack #73.

We'll send it all to you absolutely free.
Low-Cost Data Acquisition

HOWARD EGLOWSTEIN

One of the most frequently asked questions in the Internet PC newsgroups is, "How do I get access to the serial/parallel ports on my PC?" Products such as LapLink and the many parallel-port tape/disk drives on the market make using these ports look easy. But building your own data acquisition interfaces is far from trivial, unless you have a good reference like Jeffrey Hirst Johnson's Build Your Own Low-Cost Data Acquisition and Display Devices. Johnson starts at the beginner's level, explaining the basics of data transmission and exposing the inner secrets of your PC's serial and parallel ports.

Along the way, you'll learn how the PC's interrupt system works and that the standard, yucky old parallel port on the original IBM PC is capable of 8-bit bidirectional data transfer without any modifications. Several different approaches to using the printer port come up in discussion. I've seen some of these used in commercial products but have never seen such a thorough discussion of all of them in one place. Plenty of working code is provided in assembly language and Turbo Pascal.

You'll also learn about ADCs (A/D converters) and the complementary D/A conversion process and put them to use building your own digital multimeter. The design includes remote control of and acquisition from the multimeter through your (you guessed it) serial and parallel ports. Perhaps you don't need to build a PC-controlled mousetrap but simply want to know how those LapLink guys can move data so quickly. This book will tell you all you want to know and more.

BYTE Lab testing editor Howard Eglowstein has built a notebook battery-testing device—affectionately called Thumper—for the BYTE Lab. You can reach him on the Internet or BIX at heglowstein@bix.com.

WHAT ARE OPEN SYSTEMS?

OPEN SYSTEMS: THE REALITY by Terry A. Critchley and K. C. Batty

As Critchley and Batty demonstrate at the beginning of their book Open Systems: The Reality, the one thing that seems too open is the definition of the phrase open systems. The definition that you receive may be nothing more than a rephrasing of "Buy our system; we are open for business." But as the authors point out, actual standards have been written that specify what open systems can mean in a valuable way.

This book traces the history of each standard and organization. It also gives an overview of what each standard involves. Of particular note is the history and charter of X/Open and the OSF (Open Software Foundation). Now that the Unix trademark is controlled by X/Open, there will be more pressure to move to Unix certification rather than just being satisfied with Posix compliance. Open Systems: The Reality is written for information systems managers as well as the technical people who plan on implementing edicts for open systems. It provides an overview of the subject while still providing enough technical content that you can understand the differences between competing standards.

—Ben Smith

AN IMPROVED ENCARTA

MICROSOFT ENCARTA 94, $395

Last year, the Encarta electronic encyclopedia set a standard for multimedia CD-ROM. Now, Microsoft has topped itself with Encarta 94, a significant improvement of an already-great Windows product.

Encarta is based on the full text of the 29-volume Funk & Wagnalls New Encyclopedia, but this is just the starting point. Microsoft has added video and audio clips, animations, photos, interactive maps, and more around an easy-to-use interface. You can find any of the 25,000 articles using keyword searches or by browsing through category lists.

The real power of the product, however, lies with its interactive nature. Visual cues such as highlighted text, menu buttons, and icons lead you through the components of a given topic (e.g., text, video, and map) or through various levels of related topics. Exporting text is a simple matter of copying it to the Clipboard.

With many multimedia CD-ROM titles, the various elements seem to have been put together with baling wire and chewing gum. Transitions are choppy, and the interfaces are often confusing. This is not the case with Encarta 94. You can navigate smoothly and logically from text to video to other hyperlinked references and back again without getting lost.

The material is up to date, as you would expect with an electronic medium. The ever-changing boundaries of Eastern Europe and the former Soviet empire are mostly current, for example.

To get the most out of Encarta, you need an MPC 2-compatible system (although it will run on MPC 1 systems). This means you need at least a 486SX CPU, a double-speed CD-ROM drive, and a good sound board and speakers.

As a general reference for the home or small business, Encarta 94 is a great value. It is not, nor is it intended to be, the last word on any given topic it covers, but you will be entertained by the way in which the information is presented.

—Michael Nadeau
DON'T PROGRAM WITHOUT IT

PC Intern is a literal encyclopedia of DOS knowledge. This book has been read and valued by more than 250,000 programmers worldwide. Whether programming in Assembly language, C, Pascal or BASIC, you'll find dozens of practical, parallel working examples in the pages of PC Intern.

This book clearly describes the technical aspects of programming under DOS, through version 6.2, and also includes updated information on programming for the Pentium™ processor.

Many PC Intern readers say this book is worth its weight in gold, which, at 1300 pages, makes it very valuable, indeed!

Available at your bookseller or Order Toll Free at 1-800-451-4319 Ext 21 $59.95

Abacus
5370 52nd Street SE • Grand Rapids, MI 49512, Dept. B1 Includes Companion diskette

DUELING DICTIONARIES


You can judge a book by its cover. The IBM Dictionary of Computing is just what you'd expect: a serious, "just the facts, ma'am" reference on computer terms. The second edition (which adds 250 definitions and updates another 150) of The New Hacker's Dictionary, however, knows how to have fun with the language.

The two, in fact, have little in common except the word dictionary in their titles. That's OK, though, because each serves a different purpose. The 18,000-definition IBM Dictionary is as solid and up-to-date a reference on the vocabulary of computing as I've seen. It does cater to IBM-specific terminology, as you would expect from the title, but not at the expense of jargon at large. The New Hacker's Dictionary is a colorful celebration of hacker slang and contains few of the terms in the IBM Dictionary.

One word you do find in both is bug. The IBM Dictionary defines it as "an error in a program." The New Hacker's Dictionary devotes over a page to it, describing not only its roots in hackerdom, but also pointing out that a bug was considered a flaw in something prior to the age of computers. This historical perspective exists throughout the book and makes The New Hacker's Dictionary both a good recreational read and a reference.

Anyone who deals with technical literature will find the IBM Dictionary of Computing indispensable. Anyone interested in hacker culture will enjoy browsing through The New Hacker's Dictionary. I intend to hang onto both.

—Michael Nadeau

FOR FIRE WALKERS ONLY


It all started as a student's programming project in the early 1980s at the University of California at Berkeley; it ended up being the worldwide standard for Internet mail routing. The program is called sendmail. At last, there is comprehensive documentation on how to administer it—Sendmail, the book.

The program and its rule description file, sendmail.cf, have long been regarded as the pit of coals that separated the mild Unix system administrators from the real fire walkers. Now, sendmail syntax, testing, hidden rules, and other mysteries are revealed. Costales, Allman, and Rickert are the indisputable authorities to do the text.

—Ben Smith
Colorado Tape Backup vs. floppy disk stackup.

May We Suggest
The Stack on the Right.

You need to protect your data. With today's hard disk capacities backing up on floppy could take 80, 100, even 200 or more diskettes and several hours. Colorado Memory Systems has a better way. Colorado Tape Backup. Your data is your most valuable asset. Independent studies show that recovering lost data can take as long as 42 days, costing as much as $98,000. And only 63% of businesses survive more than two years after major data loss. Colorado tape backup is the easiest and most reliable way to protect your data. With dozens of awards and more recommendations by users, resellers, and editors than all other backup systems combined, nothing else stacks up to Colorado. Explore Colorado Tape Backup Solutions today. Visit your dealer or call 1-800-451-0897, extension 727 for details.

Capacities from 120 MB to 4 GB*
Why is this two-fisted tightwad smiling?

He just bought an Ambra and saved big money.
NOTEBOOKS

MODEL SN425C
- 486SX, 25 MHz, SL-Enhanced
- 4MB RAM
- 170MB hard disk
- 7.6" STN color screen
- 1 PCMCIA slot, Type II
- Parallel and serial ports; external keyboard, monitor and diskette drive ports
- 86-key keyboard
- Integrated 16mm trackball
- SUSP/Resume
- NiCad battery
- MS-DOS 6.0, Windows 3.1
- 6.6 lbs, including battery
$1,899

MODEL SN450C
- 486DX2, 50 MHz
- 4MB RAM
- 3.5" 1.44MB diskette drive
- 200MB hard disk
- 9.5" STN dual-scan color screen
- 1 PCMCIA slot, Type III
- Parallel and serial ports; external keyboard and monitor ports
- 86-key keyboard
- Integrated 16mm trackball
- SUSP/Resume
- NiCad battery
- MS-DOS 6.0, Windows 3.1
- 6.6 lbs, including battery
$2,699

NOTEBOOKS

MODEL D466BL
- 486 Blue Lightning™66 MHz
- Upgradable to Intel® Pentium™ technology
- 4MB RAM
- 256KB processor cache
- 3.5" 1.44MB diskette drive
- 340MB hard disk
- Onboard SCSI
- 5 16-bit ISA slots (2 VESA on local bus)
- Windows accelerator, 1MB video memory
- 15" Flat Square-color monitor, LR, NI
- Network-ready (Ethernet 10BaseT)
- MS-DOS 6.0, Windows 3.1, mouse
$1,899
(For 8x6 minitower, add $75.)

DESKTOPS

Model D466DX
- 486DX2, 66 MHz
- 8MB RAM
- 256KB processor cache
- 3.5" 1.44MB diskette drive
- 340MB hard disk
- 8 ISA slots
- 6 storage bays
- Windows accelerator, 1MB video memory
- 2X CD-ROM drive
- 15" Flat Square color monitor, LR, NI
- MS-DOS 6.0, Windows 3.1, mouse
$2,495

Model D466OS
- Intel Pentium, 60 MHz
- 8-bit data path
- 8MB RAM
- 256KB processor cache
- 3.5" 1.44MB diskette drive
- 340MB hard disk
- 4 ISA, 2 PCI, 1 PCI/ISA slot
- 6 storage bays
- PCI graphics accelerator, 2MB DRAM
- 14" SVGA color monitor, LR
- MS-DOS 6.0, Windows 3.1, mouse
$2,799

Free customization.
AMBRA custom-configures to your exact specs—with no extra service charge and no delay.

More systems to choose among! Call soon!

Firm confidence.
Every AMBRA comes with a 30-day money-back guarantee and a one-year limited warranty. An optional IBM® one-year onsite warranty is also available! With either warranty, you can rely on toll-free technical support around the clock.

Full convenience.
To place an order or get more information, just call any weekday 8 am to 9 pm, or Saturday 10 am to 6 pm (ET). We accept Visa®, MasterCard® and American Express®—as well as purchase orders from qualifying businesses. Pick up the phone today!
Of the many computer-related products and technologies that debuted in 1993, only 71 earned BYTE Awards. These winners set the standards for innovation and price/performance, and a few are harbingers of things to come.

Every year, thousands of new products and technologies appear. Some fade into obscurity while others become commercial successes, but only a very few represent important breakthroughs in innovation. These latter products and technologies often serve as industry catalysts; they point the way for other innovative products.

BYTE editors are in a unique position to observe and evaluate these breakthrough products. Multiplatform in nature, BYTE has no inherent biases toward any one operating system or CPU. We rate the products, using a nomination and voting process, based on their level of innovation and market impact. (For a full description of the selection process, see the text box “How BYTE Selected the Best” on page 48.)

BYTE Awards are three-tiered. The Award of Excellence is the highest honor, followed by the Award of Distinction and the Award of Merit.

Reading the Tea Leaves
There are three strong trends reflected by this year’s voting: a platform shift in terms of both CPU and operating system, CD-ROM’s coming of age, and the changing face of communications. The latter includes both wireless connections and videoconferencing.

By far, 32-bit processors and operating systems dominated the voting. The three top vote-getters were the IBM/Apple/Motorola PowerPC 601, IBM’s OS/2 2.1, and Intel’s Pentium processor. Microsoft’s Windows NT was not far behind. Furthermore, other products and technology for supporting a 32-bit environment—Microsoft’s OLE 2.0 and the PCI 2.0 bus standard—were Award of Excellence winners. The Silicon Graphics Indy, a 64-bit Unix workstation, was also ranked highly.

Companies considering a platform shift want to do so with minimal expense and stress. This means maintaining the ability
to run important in-house and commercial applications that are already developed and owned. NT and OS/2 offer compatibility with Windows and DOS applications, and the Pentium and PowerPC processors provide the horsepower to drive the new 32-bit applications in addition to existing applications.

Eventually, though, existing applications need to move to new hardware and operating-system platforms. The tools to do the job are also among our award winners: They include Watcom C/C++ 32, Borland C++ 3.1, Microsoft Visual C++ for Windows 1.0, and Symantec’s C/C++ 6.0.

This trend was very predictable. Processor-performance improvements are outpacing price increases by a wide margin, and today’s graphical applications always find a way to use the extra power. Couple a Pentium or PowerPC with OS12 or Windows NT, and you have an extremely powerful multitasking system that has the ability to run non-native applications at a respectable speed.

**CD-ROM Shows Its Stuff**

CD-ROM has been around since the mid-1980s, but until recently its use has been relegated to niche applications. Two events have helped to change this: the advent of recordable CDs and a quantum leap in the quality of consumer and business titles. You can now expect, for example, tightly integrated and intelligently designed multimedia software. Four award winners exemplify why CD-ROM is becoming so popular.

Two software titles, Voyager’s A Hard Day’s Night and Microsoft’s Encarta 1994 Edition, show off the potential of CD-ROM as an ideal multimedia medium. This is not just due to the inherent ability of CD-ROM drives to play multiple data types; a great deal of credit goes to the developers at Voyager and Microsoft for creatively putting those abilities to use. Both effectively use audio, video, hypertext, and more to significantly enhance the delivery of information.

We also gave awards to two CD-ROM drive products. The JVC Personal RomMaker is an affordable CD-R (compact disc recordable) drive. The product brings greater ease of use and reliability to the medium—qualities badly needed for CD-R to gain wide acceptance. Affordable recordable drives open up a lot of possibilities for corporate in-house publishers. For them, CD-ROM is now a viable medium for internal or external data distribution.

Speaking of getting data out to the troops, Pioneer’s Award of Merit–winning DRM 604X is a slick six-CD-ROM minichanger designed for network use. Featuring a 600-Kbps transfer rate, this product is a fast means of sharing CD-based data among a staff’s members.

**New Ways to Communicate**

The way in which people use computers to communicate is changing in two ways. "Anytime, anywhere" communications is here, enabled by small, wireless devices such as the new PDAs (personal digital assistants) that were announced in 1993. These devices are designed to act as mobile nodes for faxing, E-mail, and paging.

From a product standpoint, we thought that the current crop of PDAs were seriously flawed. However, we did give Apple an Award of Excellence for some of the technology embedded in its Newton MessagePad. Specifically, its Newton Intelligence operating system is a strong backbone on which to build a powerful communications and computing device.

Though not technically a PDA, the Award of Merit winner Eo Personal Communicator 440 is an impressive example of what a small communications device can do today. It serves as your own personal cellular phone, portable fax machine, and daily organizer, all wrapped in an easy-to-use package.
How BYTE Selected the Best

The BYTE Award winners were selected through a democratic process. All BYTE editors, including staff, consulting, and contributing editors, participated. BYTE licensees around the world (who reprint BYTE editorial material in the native languages of their respective countries) also participated.

The process begins with nominations. To be eligible, a product or technology must have been introduced since the previous year's award process ended (i.e., early October) and be likely to ship to users by the end of the current calendar year. We judge the likelihood of a nominee's shipping based on the vendor's announced shipping date and the apparent maturity of the product or technology. Nominated products must have been covered or have planned coverage in BYTE.

A nominated product should be one that breaks new ground in terms of new technology, performance, price, or innovative use of existing technology. An editor can nominate only products that he or she has had hands-on experience with and is reasonably sure will perform as advertised.

After the nomination process, every editor and licensee receives a ballot listing all the nominated products and technologies. Each voter then selects what he or she believes to be the 10 most significant products of 1993; a voter may pick fewer than 10 if he or she chooses.

Awards of Excellence, Distinction, and Merit are assigned based on the number of votes received. Cut-off points for each award are determined according to how the votes are distributed along a curve.

Powering the Eo is AT&T's ATT92010 Hobbit processor, an Award of Distinction winner. The Hobbit is a powerful RISC processor designed specifically for small communications devices such as the Eo. It can crank out 13 MIPS or more, yet run comfortably for an hour or more on battery power.

The other side of the communications trend is visual. Thanks to Apple and Silicon Graphics, you can now buy a PC with built-in videoconferencing capability. Videoconferencing is not for everyone—yet. We believe, however, that the Silicon Graphics Indy and the Mac Quadra 840AV, along with the Mac Centris 660AV, are milestone products. People will look back on them as the beginning of a trend to integrate video capabilities on the desktop.

The Biggest Innovators

A few companies stood out as leaders in innovation for 1993. At the top, Microsoft tied with Apple for the highest number of awards: seven. All of Microsoft's awards were for software products—three for operating systems, and two each for applications and development tools. Four of Apple's awards were for systems.

IBM made a strong showing with five awards, for products ranging from its Continuous Speech Series speech-recognition technology to its OS/2 2.1 operating system. The company continues to show leadership in notebook PCs, winning awards for the ThinkPad 750C and ThinkPad 500. The PowerPC 601, which IBM co-developed with Motorola and Apple, was the biggest overall vote-getter by a wide margin.

Also making strong showings were Adobe, Silicon Graphics, and Hewlett-Packard. Adobe shines in the area of graphics software, winning awards for Photoshop 2.5 for Windows and Macintosh and Premiere 3.0 for Macintosh. Its Award of Excellence—winning cross-platform document-interchange software, Acrobat, promises to revolutionize electronic publishing.

Silicon Graphics is also known for graphics, but from the hardware side. Videoconferencing capability aside, its Indy is a powerful, inexpensive graphics workstation. The RealityEngine is very expensive at about $80,000, but nothing else comes close to delivering its graphics and video capabilities on a workstation-class system.

Hewlett-Packard won three awards, all Awards of Excellence. As you would expect, two of those winners were printers: the LaserJet 4L and the DeskJet 1200C. HP's innovative OmniBook 300 subnotebook was the company's other winner.

Past and Future Predictions

Last year, we predicted that Mac software would rebound in the award standings but still not overtake Windows. Windows applications garnered more than three times the number of Mac awards last year. This year, Windows applications received less than twice as many awards as Macintosh applications. As we said then, Windows had a lot of momentum—and it still does—but the Mac hardware and operating system offered some technological advantages to software developers.

We also told you to look for the next-generation notebooks and subnotebooks. This year, twice as many portable systems as desktop systems won awards. Most of them were notebooks or subnotebooks. This generation of award winners is more powerful than the previous generation and is easier to use.

What do we predict for next year? Look for powerful new portable and desktop systems based on this year's award-winning processors. At this writing, the first PowerPC systems have been announced. System vendors should soon start taking full advantage of Intel's Pentium as well. Low-power versions of these processors will inspire a new generation of notebook PCs.

We also expect to see new applications (as well as ports of old ones) for Windows NT, OS/2 2.1, and other 32-bit operating systems running on RISC-based processors. These applications could create new performance standards, especially for graphics-related functions.

Wireless communications is another area to watch. Wireless technology is advancing rapidly, and some of the regulatory and structural barriers to using it are beginning to fall. In 1994, you might see the first wireless products and services that are practical for everyone to use.

—Compiled by Michael Nadeau

---Continued
BECAUSE WHEN THE POWER DIPS, ITS NOT WHAT YOU PAID FOR YOUR UPS THAT'S IMPORTANT, ITS WHAT IT DOES

SO LET'S TALK ABOUT FEATURES...

The MINUTEMAN ALLIANCE A500 keeps your network safe from brownouts, the most common power problem. Our line-interactive technology continuously monitors and provides an automatic boost whenever power dips. This important feature prevents frequent battery usage, saving the battery for more severe power problems.

Other important features that make the MINUTEMAN A500 stand out are a 500 VA rating, extensive status indicators and a Test button so you can confirm that the UPS is doing its job. A Site Wiring Fault Indicator is included to let you know if there is a problem with grounding or other on-site electrical wiring problems that could be catastrophic.

The Alliance A500 is compatible with MINUTEMAN's LanMaster unattended shutdown software for all operating systems to further protect your network, even when you're not there.

If all UPSs were priced the same, the choice would be easy based only on features. But when you compare prices, the choice becomes even more obvious.

We don't believe you'll pay 25% more for a product that gives you less. Call our POWER HOTLINE now and find out how to get more UPS for less.

<table>
<thead>
<tr>
<th>Model</th>
<th>Minuteman A500</th>
<th>APC BK600</th>
<th>Tripp Lite Omni 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRICE</td>
<td>$299</td>
<td>$399</td>
<td>$379</td>
</tr>
<tr>
<td>Price per Watt</td>
<td>.92</td>
<td>1.00</td>
<td>1.08</td>
</tr>
<tr>
<td>VA Rating</td>
<td>500</td>
<td>600</td>
<td>500</td>
</tr>
<tr>
<td>Line-Interactive</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Waveform Output</td>
<td>Simulated Sinewave</td>
<td>Simulated Sinewave</td>
<td>Simulated Sinewave</td>
</tr>
<tr>
<td>LED Status Indicators</td>
<td>YES 4-LED's</td>
<td>NO</td>
<td>YES 4-LED's</td>
</tr>
<tr>
<td>Site Wiring Fault Indicator</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Test Button</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

Product and company names mentioned herein may be trademarks or registered trademarks of their respective companies.

MINUTE•MAN
UNINTERRUPTIBLE POWER SUPPLIES
1-800-238-7272

Minuteman's product line includes UPSs and Voltage Regulators ranging from 300VA to 10 KVA. International models are available.

1455 LeMay Drive
Carrollton, Texas 75007
214/486-7363 Voice
214/486-9011 Fax
Circle 98 on Inquiry Card.
Adobe Acrobat
Adobe Systems
Adobe's PostScript PDL (page-description language) has become the lingua franca of the printer world. That is, numerous applications on a variety of platforms can obtain consistent output on a PostScript printer. With Acrobat, Adobe strives for the same grand unification for electronic documents. Acrobat accomplishes this by leveraging off proven technologies such as EPS (Encapsulated PostScript) and Multiple Masters fonts.

Getting your electronic documents into Acrobat format requires no rocket science. Just print your document into an EPS file, run an Acrobat Distiller application to compress the data, and tack on a Reader application. Versions for DOS, Windows, and the Mac are available.

If your computer system lacks the fonts that were used to create the original document, the Reader's Multiple Masters technology will render an approximation of the missing font with appropriate weight and spacing. Acrobat provides text searching and hypertext linking to assist users looking for information in large documents.

Compression is outstanding, shrinking a 20-MB PageMaker file down to under 4 MB. Creating thumbnail pages, hypertext links, indexes, and text annotations with Acrobat is a no-brainer.

Adobe Photoshop 2.5 for Windows and Macintosh
Adobe Systems
Adobe Photoshop, long the leading Mac application for professional image editing, is now available for Windows. Both versions boast significant improvements over release 2.0. Experienced darkroom workers as well as neophytes will appreciate the new dodge-and-burn tool, which simulates the traditional lightening and darkening manipulations employed when enlarging. Brushes can be modified with any selected shape, and the new pen tool gives more precise control over the shapes you select.

A quick-mask mode lets you work with a semitransparent film overlaid on your image and then quickly change the mask into a selection. A new preview window makes it easier to tinker with color corrections and other variables. Photoshop's open architecture allows plug-in software to augment existing features, such as accessing a digital signal processor to speed up image processing. And a host of special-effects filters let you add pizzazz to a lackluster image. The new Photoshop will definitely be welcomed by Windows users.

HP DeskJet 1200C
Hewlett-Packard
With a good balance between price and output quality, HP's reliable and flexible DeskJet 1200C ink-jet printer is the best package for bringing affordable color printing to most offices. The 300-dot-per-inch color ink-jet prints on a variety of media,
YOU CAN'T CONTROL YOUR BOSS, YOUR WORKLOAD, YOUR WEIGHT, YOUR BACKHAND, YOUR WEEDS, YOUR DOG, YOUR LIFE. AT LEAST NOW YOU CAN CONTROL YOUR CURSOR.

At Microsoft, we feel there are enough things in the world that follow their own unpredictable path. So we redesigned just about every aspect of the new Microsoft* BallPoint* mouse to let you regain control of your portable computer.

We started by changing the weight of the ball. We improved the smoothness of the tracking mechanism. We reshaped our mouse to fit your hand better. We even added software features that make it easier to find and control your cursor.

All of which means, in simple terms, that the cursor will now do what you want it to do.

And which is why, in independent tests, people worked 35% faster with the BallPoint mouse than with other leading portable and built-in pointing devices.

Of course, you should try it yourself. So pick up a BallPoint mouse at a computer store today.

And have one aspect of your life firmly, and comfortably, in the palm of your hand.

Microsoft®
Making it easier
from plain paper to color transparencies, with an image quality that
is hard to beat at a cost per page of as little as 8 cents. With a built-
in RISC processor, the 1200C also offers decent performance.

The unit looks more like a small refrigerator than a printer.
But you can’t argue with the DeskJet 1200C’s sumptuous output,
especially on coated paper. It’s easily expandable in terms of
memory, PDLs, and network connections. This is a printer
designed to grow along with your office.

HP OmniBook 300
Hewlett-Packard

The OmniBook 300 is
equally suitable for a trip
to the company cafeteria
or a trip across the coun-
try, thanks to its sub-3-
pound size and extra-long
battery life (over 12 hours,
according to our tests).

Other features, such as the mechanical-arm-like mouse that
pops out from the side of the machine, Windows 3.1 in ROM, and
the complete lack of traditional (and power-consuming) rotat-
ing hard drives, put this machine a notch above the competition.

Bummers include the lack of support for enhanced-mode op-
eration in Windows, which means no support for virtual memory
or running DOS applications in a resizeable window alongside
other program windows. Nevertheless, the OmniBook 300 does
a fine balancing act between cutting-edge technology and main-
stream usability.

“I literally take my OmniBook everywhere I go. It is perfectly
designed for use on those small tray tables on airplanes. Its 12-
volt external power supply makes it easy to tie into a car’s or a
boat’s electrical system. The OmniBook 300 is so robust that I
took it to sea with me on my three-week sailing vacation. Windows
and the applications software that comes bundled with the Om-
niBook make it an exceptional value.”—Ben Smith

HP LaserJet 4L
Hewlett-Packard

It’s hard to beat the 300-dpi HP Laser-
Jet 4L in price/performance for the
home or small office—or as the low-
end executive model you choose not
to share with other network users.
You get plenty for the $849 list price:
a small footprint and a weight of under 16 pounds, HP’s RET
(Resolution Enhancement Technology), a variant of PCL5 called
PCL5e, and, for stretching the standard 1 MB of memory, MET
(Memory Enhancement Technology).

MET conserves memory by compressing fonts before down-
loading them. In addition, Explorer TSR control software re-
places front-panel controls and uses HP’s Bi-Tronic technology
to have messages such as paper-out signals break into your DOS
application when appropriate. Output quality was excellent in
our tests, and the printer’s new Canon engine has no corona wire
and fewer parts to clean than traditional laser printers.

Indy
Silicon Graphics

The latest descendant of the Silicon
Graphics Indigo architecture is the entry-
level Indy, whose $5000 price tag belies
its sizzling processor and graphics per-
fomance. The real story of the Mips
R4000-based Indy is media integra-
tion: It supports analog and dig-
tal audio and video right out of
the box, and it even comes stan-
dard with a small digital-video camera.

The Indy is packed with features—for in-
stance, ports for 10Base-T, Fast SCSI, and ISDN are
built in—and Silicon Graphics continues to innovate with op-
tions such as a 20-GB floptical drive. To cap it off, the system
includes a new media-centric Indigo Magic user interface on top of
Motif that eases the use of desktop video conferencing and speech
recognition.

While the Indy may not become a mass-market sys-
tem, it blazes a path in multimedia computing.

“The Indy has exceptionally fast and inexpensive 2-D graph-
ics. It is also very fast at general computing. I found that it’s
very easy to use despite the incredible sophistication of its per-
ipherals, utilities, and operating-system interface. The new op-
erating system synergistically brings together my two favorite
computing environments, Unix and the Macintosh. It lives up to
its slogan: Serious Fun.”—Ben Smith

Lotus Notes 3.0
Lotus Development

Notes has always offered a unique and powerful blend of E-mail,
conferencing, and client/server database technology. Version 3.0
adds X.500-style hierarchical naming, Macintosh client support,
full-text indexing, native IPX/SPX support, smarter database
replication, and a host of new macro-language functions. These
new features aren’t just tacked on, either; they’re deeply and
sometimes surprisingly integrated.

When a Notes 3.0 Macintosh client subscribes from within a
shared Notes database to an edition published by a System 7
Macintosh, the edition becomes visible not only to other Macin-
tosh clients but to Windows and Presen-
tation Manager clients as well. The
full-text indexing and retrieval capabilities also integrate intelli-
gently with Notes.

Data-entry forms double as search tem-
plates; the multi-
threaded OS/2 server handles incremen-
tal reindexing gracefully as a background task. Background repli-
cation on the client side refines what was already an excellent
mechanism for distributing information to users who are some-
times LAN-connected and at other times modem-connected.

You
Most of the time all mice are nice and fine for pointing around. But when it comes to inputting graphics or logos into any application or any CAD package, they are hopeless. They just can't — and so you can't. No way. Problem? Yes and no. It depends — you may shrug your shoulders and say "Well, I'll never do CAD and I just never want to input any sketches, logos, or photos into my computer anyway." Or — you feel that isn't good enough after all the money you have invested and all the nice things you know you could do today with your own graphics once they were in the computer.

**PROBLEM SOLVED.**

Here comes the mouse that lets you input all your graphics as well. How?: That's what they all want to know, but we're not telling. Its a new invention. It's a universal combination of a true mouse and an independent manual drawing board that becomes a precision full-featured digitizer tablet once you just place the mouse onto the board. It's all in one or all separate as required. Simply unplug your poor old mouse, plug in our mouse and have the real all purpose input device to your PC always at hand. At a price poor mice can afford too.
won't find a more complete communication tool for business.

"Dialed into a Notes server from a remote laptop, automatically replicating mail and discussion databases, I began to appreciate the remarkable feats of engineering that sustain this one-of-a-kind product. Although the reach of Lotus's vision of business process automation does exceed the grasp of the current incarnation of Notes, no other product so boldly and effectively empowers users to manage distributed data." —Jon Udell

**Macintosh Quadra 840AV**
**Apple Computer**

Apple's Quadra 840AV is more than just the highest-performance Macintosh; it's also the most fully featured personal computer ever made. To supplement the system's 40-MHz Motorola 68040 CPU, Apple added a 66-MHz AT&T 3210 DSP (digital signal processor). This makes the 840AV ideal for advanced audio, video, and telephony applications, with little or no additional hardware. Full-motion video digitizing is built in, including support for NTSC, PAL, and SECAM. Composite and S-video outputs make it easy to record digitized video on a VCR. The 840AV's audio capabilities are equally impressive, and Apple's new PlainTalk speech technology provides speaker-independent continuous voice recognition for short commands.

The new GeoPort, a plug-and-play interface, allows easy connections to analog and digital phone lines for voice, fax, and data communications. Other standard features include built-in Ethernet and AppleTalk networking, 24-bit color video, and numerous expansion slots and bays. All this makes the Quadra 840AV the premier personal computer for multimedia authors, graphic designers, and power users. It's the fastest Mac on the block. Software compatibility is excellent, especially considering that the system architecture is loaded with new hardware such as DMA channels, a new video bus, and a DSP. The PlainTalk voice-recognition and video-processing features—within limits—allow this Mac to do things no other computer can do.

**Microsoft Excel 5.0 for Windows**
**Microsoft**

After 1-2-3 release 4 gave Lotus some momentum, Microsoft has reclaimed its preeminence in the spreadsheet market. Excel 5.0 unveils new technologies that represent the future of Microsoft applications. Microsoft's new application macro language, Visual Basic for Applications, appears for the first time in Excel 5.0. OLE 2.0 automation will work with VBA to enable a powerful environment for cross-application development.

A consistent interface will further integrate Microsoft applications; Excel's menu structure will be closely mimicked by Word for Windows 6.0 and PowerPoint. IntelliSense, another new Excel feature that will soon find its way into other Microsoft applications, makes intelligent assumptions to help automate actions such as adding a closing parenthesis to a function. Excel will also analyze your work and offer pop-up tips on how to perform operations more efficiently. Excel 5.0 fills some conspicuous gaps in the features matrix by adding true 3-D worksheets (with page tabs), in-cell editing, and custom AutoFill (for creating custom series that will automatically flow into selected blocks when appropriate). A few key improvements and promising new technologies combine to make Excel 5.0 one of the most powerful Windows applications around.

**Pentium processor**
**Intel**

Intel has the best track record of any company in the personal computer industry. No one can match its record of consistent progress and performance.

The Pentium, with its two integer pipelines, advanced branch-prediction hardware, and sophisticated cache design, doubles the performance of the 486DX-2-66 for integer operations, while its phenomenal FPU outdoes a 486's FPU by a factor of 4. More important, the Pentium reached this performance level without sacrificing compatibility with its immense software base.

Pentium gives pause to those who say that the 80x86 architecture can't compete against pure RISC designs. Intel has shown what you can do with intelligent design and hard work. The Pentium designers didn't have the luxury of starting from scratch, which makes their achievement all the more noteworthy. And despite all the hoopla about RISC performance, do you think for a moment that, given the chance, any of the RISC vendors would fail to trade places with Intel?

**Microsoft Windows NT**
**Microsoft**

If you were given the job of designing the ultimate desktop operating system, you just couldn't do much better than simply listing the features of Windows NT. Preemptive multitasking, multiprocessing support, the ability to run industry-standard software, built-in networking support, portability across hardware platforms, support for multiple interfaces—the
Power Packed Upgrades.

POWER SUPPLIES

"The premier power-supply maker"
John Dvorak, PC Magazine, March 30, 1993
"The only company to go to for a power supply"
Jerry Pournelle, Byte, April 1993

STANDARD UNITS

These UL/CSA approved, fully tested power supplies are the best basic units available.

STANDARD 205 SLIM ............................ $89
STANDARD 220 DESK/TOWER ........... $99
STANDARD 270 DESK/TOWER ........... $129
STANDARD 220 DESK/TOWER ........... $129
STANDARD 270 DESK/TOWER ........... $179

ULTRA-QUIET UNITS

Unrattled your nerves with an ultra-quiet Silencer power supply. Appreciated by users since 1986, their high-efficiency fans and low-turbulence circuitry reduce noise by up to 84%!

A must for home office or multimedia applications.

SILENCER 205 SLIM ........................ $119
SILENCER 220 DESK/TOWER .......... $129
SILENCER 270 DESK/TOWER .......... $179

HIGH-PERFORMANCE UNITS

Upgrade your computer with one of our premium Turbo-Cool power supplies—the choice of PC professionals. You'll get 50% - 100% more power, built-in line conditioning, super-tight regulation, ultra-clean output, a high-capacity cooling fan, UL/CSA/TUV, a 2-year warranty for 300W models, and a 5-year warranty for the 450! Ideal for high-end workstations and network file servers.

TURBO-COOL 300 SLIM/BABY ........ $169
TURBO-COOL 300 DESK/TOWER .... $189
TURBO-COOL 450 DESK/TOWER .... $349

SOLID-STEEL CASES

Give your computer a professional, high-tech look with one of our premium-quality, USA-made, all-steel cases. They're rigid— unlike light-weight imports—so the PC's components are always properly aligned and grounded.

You'll enjoy easy system access, and with room for up to 18 drives, there's real expandability!

Desktop Tower Monster
Exposed Drive Bays: 5 6 13
Total Drive Bays: 7 8 18
Motherboard Capacity: 1 1 2
Power Supply Capacity: 1 1 2
Cooling Fan Capacity: 2 3 6
Filtered Air Inlet: Yes Yes Yes
Lockable Front Door: Yes No Yes
Beige or Black Finish: Yes Yes Yes
Made in USA: Yes Yes Yes

SOLID-STEEL DESKTOP CASE $175
SOLID-STEEL TOWER CASE $295
SOLID-STEEL MONSTER CASE $895

REDUNDANT POWER

Eliminate the risk of network downtime or data loss due to power supply failure with the TwinPower 900 redundant power system. It delivers high-capacity, fault-tolerant power to your entire network server. Consists of two Turbo-Cool 450 power supplies in parallel, utilizing a special power-management interface module. A must for mission-critical LANs.

- 900 watts peak power
- 100X more reliable than a single-unit
- load-sharing design
- hot-swap capability
- 5-year warranty
- monster-case compatible

TWIN-POWER 900 $995

OVER-TEMP ALARM

Don't wait for the acrid smell of burnt components! With our new 110 Alert, you'll know if your PC is overheating before damage occurs. Should the computer's temperature reach 110°F, a loud alarm warns you that a fan has failed or that the cooling system is inadequate to handle that extra hard drive or other peripheral you may have added. Compatible with any computer, the inexpensive 110 Alert is compact, easy to install, and so reliable, it carries a lifetime warranty.

110 ALERT $29

CPU COOLERS

It's a fact. 486 chips run hot, often exceeding 185°F!

Now, you can cool your 486 to a safe 85°-95°F with our popular CPU-Cool. It prevents random system errors and other heat-related problems. Consists of a mini-fan embedded in a die-cast heat sink that easily mounts on the CPU. Powered by a spare drive connector. Effective, inexpensive insurance!

- cools CPU 70° - 100°F
- prevents system errors
- adds years to CPU life
- thinner, quieter, and better-built than cheap imported imitations.
- safe, simple installation

CPU-COOL (FOR 486) $29
PENTACOOL (FOR PENTIUMs) $39

PC POWER & COOLING, INC.
5995 Avenida Encinas, Carlsbad, CA 92008 • (619) 931-5700 • (800) 722-6555 • Fax (619) 931-6988

We accept Visa, MC, COD, or PO on approved credit. Warranty period: Five years for Twin Power and Turbo-Cool 450, Two years for Turbo-Cool (except 450), Silencer, and CPU coolers. One year for all others (except 110 Alert).

Hours: 7 a.m. - 5 p.m. (PT) Mon. - Fri. Silencer, Turbo-Cool, TwinPower, CPU-Cool, PentaCool, and 110 Alert are trademarks or registered trademarks of PC Power & Cooling, Inc. ©1993 PC Power & Cooling, Inc.

Circle 101 on Inquiry Card (RESELLERS: 102).
erPC is one of the more significant technologies to appear in this
decade. And it has the ability to carry us into the next decade.
Macintosh line, which is due out soon. As such, it will undoubt-
edly be the best-selling RISC processor of 1994. And it will be
withstanding sustained throughput as high as 80 MBps from a theoretical
maximum of 133 MBps. Bus isolation also means that PCI pe-
ripherals can work with any CPU speed or design, from a 486 to
a 200-MHz Alpha, an important cost factor for large systems
houses planning future systems. PCI is a robust specification,
tightly defined and tested with sophisticated simulation, and it also
supports forward-looking features such as plug-and-play, low-volta-
ge operation, and a 64-bit data path.

Newton Intelligence technology
Apple Computer
As Garry Trudeau’s scathing series of Doonesbury comic strips
suggested last summer, Apple’s Newton MessagePad is an im-
perfect implementation of a PDA. The technology it employs,
however, breaks new ground in mobile computing and is a solid base on which
to build better models. That technology—
not the MessagePad as a whole—receives
BYTE’s Award of Excellence.
Newton Intelligence is an innovative,
object-oriented operating system that suc-
cessfully shields casual users from inter-
nal complexities. Its pen-based user interface challenges existing
notions of how a computer should look and feel. Newton applications
are data-centric, not document-centric; all information
is tagged and stored as you enter it, and you can access it from any
application.

OLE 2.0
Microsoft
More than three years in gestation, OLE 2.0 takes Interapplication
Communication and compound documents to a higher level than
its predecessors, OLE 1.0 and DDE. As a key element of Micro-
soft’s vision of object-oriented software, OLE 2.0 will be har-
nessed by developers for commercial and in-house applications.
The specification defines a standard way of communicating and
sharing objects among compliant programs; for example, you
could embed a slide created in a presentations package (based,
perhaps, on data residing in a spreadsheet) into a word process-
ing document. The 2.0 release of OLE adds dragging and drop-
ing of objects, in-situ object editing, and support for macro-
like automation. Most important, OLE 2.0 is designed with an eye
forward the future——specifically, toward creating a path for users
and developers that leads from Windows to Microsoft’s object-
oriented operating system, code-named Cairo. Thus, OLE 2.0 is
built to support link tracking, network remote procedure calls, and
other capabilities not yet implemented in Windows.

PCI 2.0
PCI Special Interest Group
Nobody questions the need for local-bus expansion capability in
PCs, particularly for boosting graphics display performance.
With VESA’s VL-Bus specification already providing that func-
tion, then why PCI? Because, unlike the 486-centric VL-Bus,
PCI (Peripheral Component Interconnect) fully answers the local-
bus design needs of new Pentium- and RISC-based systems right
now. As a mezzanine bus with buffered isolation from the actual
CPU local bus, PCI can support more peripherals than VL-
Bus. In addition, PCI devices can work concurrently with the
CPU, an important performance factor with multitasking, mul-
titasking environments.

With data bursting and buffering, the Intel-developed PCI bus
cleverly skirts the performance drawbacks to bus isolation, yield-
ing sustained throughput at high as 80 MBps from a theoretical
maximum of 133 MBps. Bus isolation also means that PCI pe-
ripherals can work with any CPU speed or design, from a 486 to
a 200-MHz Alpha, an important cost factor for large systems
houses planning future systems. PCI is a robust specification,
tightly defined and tested with sophisticated simulation, and it also
supports forward-looking features such as plug-and-play, low-volta-
ge operation, and a 64-bit data path.
WITHOUT THIS SEAL, YOU'RE ONLY TESTING YOUR LUCK.

Nothing is more frustrating than a PC problem. It can mean hours of wasted productivity and hundreds of dollars of expense for both the user and the manufacturer. A PC with the QAPlus Tested™ seal means that the manufacturer uses QAPlus software in a rigorous program to assure that its PCs are fully compatible and meet the highest standards of quality.

A COMPLETE QUALITY ASSURANCE SOLUTION
One facet of the QAPlus Tested program is QAPlus/Factory™ which provides dynamic burn-in capabilities using state-of-the-art diagnostics. Its exhaustive testing, tracking, and reporting features facilitate the effective measure and control of production processes.

QAPlus/Factory can help eliminate product returns and repair calls due to incompatibility and marginal quality assurance testing. The bottom line is lower manufacturing and support costs, increased product quality and customer satisfaction, and a more competitive business.

BACKED BY COMPREHENSIVE SUPPORT
QAPlus/Factory customers can receive an on-site quality survey by our PC quality assurance expert, along with installation and training. Plus, they will be enrolled in our Priority Support Program which includes remote diagnostic troubleshooting, access to DiagSoft's BBS, and frequent product updates to support the latest technology.

THE INDUSTRY STANDARD
DiagSoft's QAPlus software is the de facto standard for PC compatibility and quality assurance testing. QAPlus/Factory is in use worldwide by leading manufacturers and integrators, such as: Digital Equipment Corporation, Gateway 2000, Intergraph, Micronics, Mylex, and Trillium Computer Resources. They help us ensure that our QAPlus software is on the leading edge of technology.

THE SEAL THAT MAKES THE DEAL
The QAPlus Tested seal on a computer system ensures PC users they are receiving a system that has passed the most rigorous diagnostic hardware tests available. Our QAPlus OEM version and remote control software can also be bundled with systems to allow support personnel to remotely operate systems, and provide an even greater level of support.

ISO 9000 SUPPORT
QAPlus/Factory supports the ISO 9000 requirements for testing and traceability. It streamlines this process by ensuring that all data collection is automatic and consistent throughout the process.

FEATURES INCLUDE:
- Network or Stand-Alone Operation
- Unattended Scripted Testing
- Complete Test Logging
- Hardware Level Diagnostics
- Extensive System Information
- Detailed Quality Analysis Reports

WE WROTE THE BOOK ON PC QUALITY ASSURANCE AND WE'LL GIVE YOU A COPY — FREE!

Don't push your luck, call DiagSoft now for our FREE Guide to PC Quality Assurance. Also from DiagSoft: QAPlus/WIN™ for tuning and troubleshooting Windows™, QAPlus/FE™ for power users and service/support professionals, Power Meter™ for performance measurement and comparison, and QAPlus, the diagnostic leader.
Aldus PageMaker 5.0

PageMaker 5.0 narrows the gap between QuarkXPress and the competition in the high-end desktop publishing market. With this software, Aldus has addressed the issues of professional desktop publishers. PageMaker now has finer typographic and dimensional controls and supports a wider variety of text and graphics formats, including direct support of Lotus 1-2-3, Excel, dBase databases, and compressed TIFF files.

PageMaker shores up its strong support between Windows and the Macintosh with seamless file support across platforms and automatic conversion of Mac PICT files to Windows metafiles. Aldus has also enhanced performance throughout the product. Publishers of non-English languages will appreciate the $99 bundle of 19 dictionaries, which includes medical and legal dictionaries as well as 15 European and New World languages with hyphenation. PageMaker 5.0 is a powerful upgrade.

ATT92010 Hobbit

AT&T Microelectronics

AT&T's ATT92010 Hobbit microprocessor is at the forefront of a wave of new CPUs designed especially for hand-held, highly mobile communicators and computers. Known collectively as PDAs (personal digital assistants), these diminutive devices often require more raw processing power than conventional desktop PCs.

The demands of handwriting recognition, object-oriented operating systems, and innovative user interfaces are creating a niche for speedy but power miserly CPUs. The Hobbit rises to these demands by delivering 13.5 MIPS while consuming only about 0.25 W. Together with its family of peripheral chips, the Hobbit provides a practical solution for first-generation PDAs such as the Eo Personal Communicator 440 and 880.

Banyan ENS for NetWare

Banyan Systems

Banyan's ENS (Enterprise Network Services) brings the company's crown jewel—the StreetTalk III global directory service—to Novell NetWare. ENS extends StreetTalk support to existing NetWare 3.x and 2.x installations. With ENS, you can manage multiple NetWare servers as a single system image, leveraging the communications capabilities of Vines (i.e., X.25, TCP/IP, and SNA) to distribute that virtual network over a wide area. Applications that are Vines-aware, such as the Vines version of Beyond's BeyondMail, enjoy true global directory services on NetWare-plus-ENS.

The NetWare Directory Service in NetWare 4.0 couldn't deliver the same benefits to users on NetWare 3.x and 2.x servers even if applications supported NDS (and most don't, yet). Those legacy NetWare servers aren't going away anytime soon. Kudos to Banyan for enrolling them in StreetTalk.

ColorScript Laser 1000

QMS

The first color laser printer priced at less than $15,000, the QMS ColorScript Laser 1000 produces high-quality color documents on plain paper for less than the materials cost of dye-sublimation or thermal-wax-transfer technologies. The 300-dpi, PostScript Level 2-compatible printer outputs up to 8 pages per minute in monochrome and about 2 ppm in 24-bit color. The unit includes a range of interface ports (e.g., Ethernet, AppleTalk, and serial/parallel) and 65 typefaces. Strong network support and monochrome capabilities (i.e., low cost and good performance) make the Laser 1000 an excellent工作组 printer for mixed color and monochrome uses. Other printer vendors are expected to release color laser printers this year, but the Laser 1000 makes QMS the leader in the field for now.

Folio Views 3.0

Folio

Folio Views 3.0 isn't just a Windows port of its DOS-based predecessor; it's a massive overhaul of that popular product. No more 2-MB limit on the size of an infoBase; version 3.0 boosts the capacity into the terabyte range. No more cumbersome batch-mode builder; version 3.0 can work incrementally, interactively, and in a way that enables multiple users on a network to extend a collaborative infoBase without stepping on each other's changes. And, though not apparent to the user, no more monolithic indexing and search apparatus; 3.0's client/server architecture should enable the development of local or remote DOS, Windows, Macintosh, and Unix clients.

Fractal Design Painter 2.0

Fractal Design

The luscious Painter 2.0 turns your Mac or Windows PC into an artist's studio, offering a wide range of media and materials for you to work with, and now also offering support for captured video frames, scanned images, color separations, and user-defined lighting. The package lets you "paint" with electronic oils, watercolors, pens, chalk, charcoal, and other media in a wide range of colors and shades on backgrounds textured to look like paper, canvas, and so on. There is perhaps no other graphics product on the market that's been so quick to produce a sense of excitement and accomplishment among both novice and expert artists.

FutureBasic

Zedcor

Zedcor's FutureBasic attempts to do for the Macintosh what Microsoft's Visual Basic does for Windows: provide an easy-to-use but powerful development environment for in-house corporate programmers, shareware developers, and hobbyists. It largely succeeds, surpassing the traditional Mac implementations of C and Pascal in terms of ease of use, and Apple's HyperCard in terms of flexibility and power.

FutureBasic is a remarkably full-featured tool that conceals
Now everything you need to begin writing C/C++ applications is at your fingertips - and well within your budget. C Set ++ FirstStep is a state-of-the-art, C/C++ development environment. It includes: • An ANSI standard conforming compiler for C/C++ • A visual tool for debugging • C++ Collection Class Libraries • A comprehensive Developer’s Toolkit (Version 2.1) with all necessary programming tools, and • WorkFrame/2: which provides an integrating environment that increases the effectiveness of those tools.

In short, with C Set ++ FirstStep for OS/2 from IBM Software Solutions, you can launch yourself right into writing high quality object-oriented applications.

To order C Set ++ FirstStep for OS/2, or for further information call 1-800-342-6672 (U.S.A.) or 1-800-465-7999, ext. 670 (Canada). Or contact your local IBM software dealer.
much of the complexity of Macintosh programming. Yet it’s capable of producing compiled code that rivals the performance of programs written in more difficult high-level languages. It runs on a system as small as a 1-MB Mac Plus, and it supports Apple Events, Color QuickDraw, QuickTime, and the entire Mac Toolbox. Packaged with an integrated 680x0 assembler, ResEdit, and MacsBug, FutureBasic is a long-needed tool for Macintosh development.

Lotus Improv 2.1 for Windows
Lotus Development
During the same year that Next finally delivered a 486 version of its object-oriented operating system, Lotus delivered a Windows version of one of the most compelling applications for NextStep, the Improv spreadsheet. Improv breaks away from the traditional row-and-column organization of spreadsheets; instead it fills the cells with the results of formulas entered in English-like syntax. The multidimensional worksheet can be reorganized by dragging and dropping labels, and data can be imported and exported from 1-2-3 and other external data sources.

MGA series
Matrox Electronic Systems
Thanks to a capable 64-bit graphics chip, Matrox’s MGA adapters are the cards to beat for high-end graphics applications: GUI acceleration, 24-bit imaging, and CAD. The MGA chip supports 24-bit graphics at up to 1280- by 1024-pixel resolution and 8-bit graphics at 1600- by 1200-pixel resolution. In addition to providing the fastest Windows performance at any resolution or color depth, Matrox’s MGA chip (and Matrox drivers) support CAD applications with hardware pan, zoom, 2-D acceleration, and, in some models, hardware-assisted 3-D rendering and shading.

Other hardware operations include antialiasing of vector images and text (TrueType and Adobe Type Manager) as well as dithered 8-bit graphics that approach 24 bits at higher resolutions. Considering performance and features, pricing is competitive—from $599 to $2495, depending on memory configuration (from 2 to 4.5 MB of VRAM [video RAM] plus optional z-buffer memory) and whether 3-D support is present. The MGA series of boards also supports five different expansion buses: ISA, MCA, VLB, PCI, and SBus.

"When I ran the MGA Impression through BYTE’s suite of graphics benchmarks, it clearly outperformed the fastest video cards tested to date. But the real test came when I loaded some large images into Photoshop. Scrolling and zooming were almost instantaneous. Never have I been so impressed by the pure speed and exceptional quality of a graphics accelerator."
—Stanford Diehl

Microsoft Visual Basic for Windows 3.0
Microsoft
Already wildly popular among in-house corporate programmers and shareware developers, Microsoft’s Visual Basic 3.0 adds several new features and custom controls that can save hours of tedious coding in other languages. Corporate developers will especially appreciate its new database engine—the same engine found in Access 1.1. Microsoft’s relational database manager for Windows. That means Visual Basic inherits the ability to interact with databases stored in several common formats, including Access, dBase, FoxPro, Paradox, and Btrieve.

Thanks to a new visual data control in the toolbox, Visual Basic programmers can hook into these databases without writing any of the code that would normally be necessary. Visual Basic also adds support for OLE 2.0, which opens up some fascinating new possibilities for interaction with other Windows applications.

Paradox for Windows
Borland International
The appearance of Paradox for Windows should prove that Borland isn’t sitting on its DBMS laurels. ObjectPAL—Paradox for Windows’ application programming language—is a complete break from PAL. Not only is ObjectPAL easier to comprehend than its predecessor, but it more neatly accommodates the event-driven nature of Windows applications.

ObjectPAL aside, we applaud Paradox for Windows’ entire object-oriented approach. Its direct support for dBase files doesn’t hurt, either; nor does its variety of form-design, report-design, and graphing capabilities, which edge the package onto the same stage as some of the larger and more complex database application generators. The query-by-example crowd should be pleased: There’s a home for them in Windows.

PowerBook 165c
Apple Computer
The PowerBook 165c adds the benefit of a color passive-matrix LCD screen to a notebook PC that comes equipped with a 33-MHz 68030 processor, a 68882 FPU, external video, and 4 MB of RAM. Even though the display measures only 9 inches diagonally, it can display 640 by 400 pixels and provides rich color, good contrast, and a wide viewing angle. The PowerBook 165c’s power charger cranks out 24 W (up from 15 W) and can recharge the battery faster. In addition, the PowerBook 165c is less expensive than PC notebooks with active-matrix screens.
QEMM 7 finds room nobody else can.

Sooner or later, you’ll get an “Out of Memory” message. Whether you have 1 megabyte or 16.

TSRs and network utilities need memory right where your programs need it, too. It’s called ‘lower’ or ‘conventional’ memory. Adding RAM to your PC just gives you more expanded or extended memory — accessible to some programs, but not to TSRs like fax utilities, device drivers or network utilities like Novell NetWare. Fortunately, there’s an easy software solution to “out of memory” problems. Have your cake and eat it, too. The more memory you have, the more flexibility and reliability you can enjoy. Thanks to our patent-pending ‘Stealth’ technology QEMM finds as much as 96K more high memory than other memory managers.

No one has yet been able to match our performance. No wonder QEMM outsells all the others put together.

QEMM™ puts the maximum memory right where your favorite programs need it so you

“I needed another 32K for my favorite TSR. I added 2 megabytes. I still need 32K! What gives?”

Whether you’re running MS-DOS, IBM PC-DOS, DR DOS, Novell DOS or MS Windows; one megabyte or eight, don’t sacrifice; don’t compromise; don’t risk losing work.

Managing your memory well is the best way to assure your work won’t go to waste.

QEMM version 7 is the most powerful, flexible memory manager you can buy.

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

DOS 6 w/o MemMaker
DOS 6 with MemMaker
QEMM 5.5 with Optimizer
New QEMM version 7 Optimizer

Protect your productivity; keep your work safe.

Any task, from programming to writing the company business plan to composing a personal letter, takes time and thought. Your PC is supposed to make that process easier; your output better. When you can’t run your favorite grammar-checking TSR or have to get by without a vital network utility, you’re sacrificing productivity.

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

QEMM comes with the new version of Manifest, the award-winning memory analyzer that helps you see how your PC works.

It’s the utility that finds memory when nothing else can.

Quarterdeck

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

Circle 107 on Inquiry Card.
RealityEngine²
Silicon Graphics

Even for a company famous for graphics, Silicon Graphics' RealityEngine² is something else again. The specifications are mind-blowing—160 MB of bit-mapped memory, 12 geometry engines, 20 pixel generators, and 320 image engines—as are the results. RealityEngine² can produce true-color, antialiased, texture-mapped 3-D graphics animations in real time. You may never be able to afford a RealityEngine², but rest assured you'll be seeing more of what it can do in the years to come. If you're looking for the definition of state-of-the-art graphics, look no further than RealityEngine².

SQLWindows 4.0
Gupta

SQLWindows enjoys the rare privilege of being a SQL front end supplied by the same company that makes a killer SQL back end. Simply put, SQLWindows is full of good stuff from one end to the other: QuestWindow makes forms design exponentially simpler, TeamWindows provides the kind of project management and version control any project leader would be tickled with, and we'll never lose our respect for the application language's outline-based paradigm.

ThinkPad 750C
IBM

Faster, lighter, more powerful all around...these descriptors fit IBM PC Co. as well as one of its best products to date, the IBM ThinkPad 750C. The successor to the 720C notebook, this product takes away more than it adds. Gone are 1½ pounds of weight and a quarter-inch of length; among the new features are integrated audio capability and an upgraded processor, the Intel 486SL-33. The 170-MB hard drive can be easily removed in favor of a bigger one (when available), and you can swap out the floppy drive to substitute devices such as a cellular modem.

WordPerfect 6.0 for DOS
WordPerfect

With the first major update of its flagship program for DOS-based PCs in over three years, WordPerfect has satisfied the demands of its users who want spreadsheet functionality, pull-down menus, WYSIWYG graphics, and drag-and-drop image manipulation in a word processor. Although the resource requirements (16 MB of hard disk space for a full installation) are steep for a DOS-based application, WordPerfect certainly packs in the features. Advantages of WordPerfect over Microsoft Word include direct printing to fax cards, a full range of graphical image-editing operations, and word wrapping around irregularly shaped objects.
HOW TO BUY A DOUBLE-SPEED CD-ROM... WITHOUT GETTING TAKEN FOR A DRIVE.

Introducing Creative OmniCD.

If you've been thinking about adding the power and excitement of an internal CD-ROM to your PC, here's some great news: thanks to our exclusive Creative Double-Speed Technology, double-speed CD-ROM performance is now available at about the same price you'd expect to pay for a single-speed drive.

And we're not talking about just any CD-ROM here. This is a full-featured, MPC 2 compliant, XA-ready, 300KB/second, multi-session photo CD drive with a blistering fast 320ms access time:

The all-new Creative OmniCD.

WORKS WITH ANY SOUND CARD.

Of course Creative OmniCD works with your Sound Blaster—after all, it is the industry standard for PC audio. But what if you've already got another sound card?

No problem. Because Creative OmniCD works perfectly with just about every major brand of audio card... or even without a sound card for applications that don't use audio.

Best of all, Creative OmniCD opens up a whole new world of CD-ROM applications. Like photo CD—we've even included Aldus* Photostyler*SE image enhancing software right in the box. And also games, multimedia and business applications, education, and more.

THE BOTTOM LINE: A LOT MORE DRIVE, A LOT LESS MONEY.

Sure, there's plenty of other manufacturers offering double-speed CD-ROM drives. But as part of a complete package with an SRP of less than four hundred dollars? Now that's Creative.

For more information and the name of your nearest Creative Labs dealer, call 1-800-998-5227.

*SRP: Suggested Retail Price. © Copyright 1993 Creative Technology Ltd. Creative Double-Speed Technology, Creative OmniCD, Sound Blaster, and Sound Blaster and Creative logos are trademarks of Creative Technology Ltd. All other trademarks are the property of their respective owners. U.S. inquiries Creative Labs 1-800-998-5227 or 1-800-629-6633. International inquiries Creative Technology Ltd., Singapore, TEL 65-775-6215 FAX 65-775-8833.
Active Badge
Olivetti North America

Piggybacking on your company’s LAN, Active Badge is a means of keeping track of people within a workgroup. It allows your own computer’s desktop to “follow” you throughout a building. Using a small transmitter that you wear, Active Badge sends your location to the network. The network can then tell others where you are or allow you to call up your own desktop on any other computer on the network. You always know who is or isn’t available for a meeting, and you always have your own data at hand.

Adobe Premiere 3.0 for Macintosh
Adobe Systems

Adobe has taken an outstanding product and made it even better. Refinements include a streamlined interface, improved performance, and enhanced final quality of the video and audio. With 99 video and 99 audio tracks, you can create layered soundtracks as well as complex video overlays, titles, and special effects.

Borland C++ 3.1
Borland International

This development tool has several outstanding components. Its OWL (Object Windows Library), for example, lets you construct programs with a minimum of source code. Borland C++ has two integrated development environments: one for DOS and one for Windows. Both allow for rapid application development. (Borland announced version 4.0 late in 1993.)

Bounds Checker 1.0
Nu-Mega Technologies

This Windows debugging tool, now in version 2.0, finds tough-to-track bugs such as array boundary overruns, memory leaks, and bad parameters passed to API functions. Although it doesn’t offer complete debugging services, Bounds Checker is a must-have item for every Windows programmer’s toolbox.

Canon NoteJet 486
Canon Computer Systems

Buy a notebook, get a printer—that is Canon Computer Systems’ solution for the need to print documents while on the road. The 7.7-pound Canon NoteJet 486 comprises a 25-MHz Texas Instruments 486SLC processor, a 9½-inch backlit monochrome VGA LCD, 4 MB of RAM, and a 360-dpi BubbleJet printer shrunken down from a Canon BJ-10ex printer design. The nickel-cadmium battery in the model we looked at was atypically underrated, printing the entire 27-page Windows Write readme file despite the battery’s eight-page rating. Operation is a breeze, and print quality is easily readable.

ClarisWorks 2.0 for Macintosh
Claris

Our July 1993 review said it all: ClarisWorks 2.0 may be the only major application that many Mac users need to buy. This package seamlessly integrates word processing, a spreadsheet, a database manager, drawing software, and a communications program. It’s easy to shuffle work created in one segment to another segment.

ColorSync
Apple Computer

Apple has taken a big step toward making true WYSIWYG color-matching a reality with ColorSync. Color matching—the ability to get the same colors from a scanned image onto a printed document—has been a big concern for desktop publishers. Apple has also made ColorSync open, so other color-matching software providers can supply their own modules.

Common Ground
No Hands Software

Common Ground is a multiplatform document-interchange application that offers much of the same functionality as Adobe’s Acrobat. Its biggest feature, however, is that it works on low-end as well as high-end PCs. This makes Common Ground practical for many companywide document-processing projects.

Compel
Asymetrix

Asymetrix’s first foray into the world of presentation software is an impressive one. Compel offers excellent support of multimedia, from the user interface to support of OLE. You can link any type of data—text, graphics, video—to a multimedia event via Compel’s highly intuitive interface.

Cx486DRx2
Cyrix

Would you spend 20 minutes and between $299 and $399 to turn your 386 PC into a near-486-class system? Cyrix offers a significant performance upgrade for the millions of 386 PCs that are still in use.

Delrina WinFax Pro 3.0 and WinFax Pro for Networks
Delrina

Delrina has successfully combined optical character recognition with PC-based fax. No longer do you have to store incoming faxes as image files; WinFax Pro 3.0 converts them to text and then checks the spelling of the documents.

Eo Personal Communicator 440
Eo

The Eo has somewhat of a celebrity status as the star of AT&T’s TV commercials. And that scene is not staged, either—you really can fax from the beach with it, or make a cellular telephone call, for that matter. The Eo’s PenPoint pen-based...
When protecting your software against piracy and unauthorized use, make sure that your protection system has all the following qualities:

**A GOOD HARDWARE KEY**

Hardware-based software protection systems are now the standard worldwide. However, not all keys are the same. A good key should have all the following features:

- Compatibility and transparency. The key should work without any problem on your customers' computers. The user should be able to forget the key after connecting it.
- Unbreakable electronics. A customized ASIC (Application Specific Integrated Circuit) component integrated into the key will prevent reverse engineering and make cracking the hardware virtually impossible.
- A unique and inaccessible developer's code burnt into the ASIC. This code should never be held in the key's memory, where it can be read and altered.
- A Read/Write Memory inside the key should be available. The memory should be writable in the field, on any PC, without any special programming equipment.
- Very low power consumption, enabling the key to work even under the most adverse power conditions, on PCs and laptops, with or without a printer.

**POWERFUL SOFTWARE**

- A Linkable Protection Module with which calls can be made to the key from any point in the protected program.
- An "Envelope" encryption program. Such programs enhance security while making it possible to protect a software application even without its source code.
- Sophisticated antidebugging and encryption mechanisms.

**LISTEN TO THE EXPERTS:**

In all the products we tested, except the HASP, we could see through the encrypting and questioning procedures... and crack them.

**CT Magazine (Germany)**

MemoHASP: ...of all the protection devices tested it was without any doubt, the one which combines the best features.

**PC Compatible (Spain)**

Trying to crack a program... that was protected utilizing all of HASP's features - is like searching for the Holy Grail.

**Micro Systems (France)**

PC dongles... come with varying claims as to their transparency. The majority suffer from problems when a printer is connected... the DESkey and HASP-3 are not affected.

**Program Now (Britain)**

All of keys tested, HASP is the most ambitious one... the quality of HASP manufacturing seems excellent.

**PC Compatible (France)**

An easy to use software protection system for the Macintosh, which ensures an effective defense against software piracy...

**Life is difficult for pirates...** MaHASP is an optimal protection method, for the programmers... and for the users...

**Bit Magazine (Italy)**

**OPERATING ENVIRONMENTS**

- **PC**: DOS, WINDOWS, WINDOWS-NT, OS/2
- **SCO UNIX**: SCO Xenix, INTERACTIVE UNIX, AUTOCAD, DOS EXTENDERS, LANs

**AND THE BOTTOM LINE:**

We offer some of the most competitive prices in the market.

Since 1984, HASP has enabled thousands of software producers in more than 50 countries, including several Fortune 500 companies, to protect their software.

Please call us for our HASP evaluation package.
operating system and interface feature true ease of use, and the communications applications are intelligently designed. The Eo is larger than a PDA, but that gives you the advantage of a larger display to view full-page faxed documents.

FirstClass
SoftArc
What would you say to getting top-notch E-mail and conferencing in one easy-to-use multipлатform package? SoftArc’s FirstClass delivers just that. It is a rare example of a product that can increase productivity right out of the box with a minimum of fuss.

Flexscan F760iW
Nanao USA
Nanao has combined one of the sharpest displays with new power-saving features. After a period of inactivity, it cuts power consumption from 160 W to 16 W. This adds up to significant savings on the electric bill of a company using scores of these monitors.

Grid Convertible 386 and 486
AST Research
The Grid came in the wake of Momenta’s failed attempt to build a pen-enabled notebook PC. At first glance, the Grid Convertible looks like any other pen tablet, but the screen swivels up to turn it into a fairly standard notebook computer. In a nutshell, the Convertibles have set the standard for providing the best of both the pen and portable PC worlds in one well-designed package.

A Hard Day’s Night
The Voyager Co.
Even if you’re not much of a Beatles fan, you can certainly appreciate A Hard Day’s Night as an innovative use of the CD-ROM medium. The title contains the entire movie in QuickTime format accompanied by the original script and a related essay. The CD-ROM allows you to watch the movie linearly or jump around to different spots.

IBM Continuous Speech Series
IBM
IBM has quietly been working on getting you and your computer on speaking terms. The ICSS is the result of those efforts. It is an OS/2- and AIX-based speaker-independent speech-recognition technology that allows you to give your system commands by talking to it. ICSS will someday reduce many common tasks, such as retrieving E-mail or loading applications, to a one- or two-word spoken command.

JVC Personal RomMaker
JVC Information Products Co. of America
This Mac-based CD-ROM recorder wasn’t the least expensive one we tested, but it was the easiest to use and the most reliable. With extensive support for the Mac’s HFS, the JVC Personal RomMaker delivers ultimate control for creators of Macintosh write-once CDs. The unit’s dedicated hard disk, on which you assemble a CD-ROM image before committing it to write-once media, also makes for rock-solid dependability when creating generic ISO 9660 discs meant for use on any platform.

LANtastic 5.0 for Windows
Artisoft
Easy to use, easy to install, inexpensive, and full of features—what more could you ask for in a peer LAN? LANtastic’s Windows support is well integrated, and you also have the option of Mac connectivity.

Macintosh Centris 650
Apple Computer
Recently renamed the Quadra 650, this system offers great performance for a low price. It makes use of interleaved memory, which improves throughput by shaving off clock cycles.

Macintosh Centris 660AV
Apple Computer
Recently renamed a Quadra, Apple’s 660AV nevertheless retains its position as the best value in multimedia computers. Instead of stuffing a conventional desktop machine with numerous add-on boards, Apple created a highly integrated system with almost everything built in: an AT&T 3210 DSP to complement the 68040 CPU; a full-motion video digitizer; video sup-
port for NTSC, PAL, and SECAM; composite and S-video outputs; a new Geo-
Port for data, fax, and voice telephony; audio input and output; PlainTalk speech recognition; Ethernet and AppleTalk networking; and a special DAV (digital audio/video) connector for future expansion.

Microsoft Encarta 1994 Edition
Microsoft
If you own a CD-ROM drive but are dis-
appointed in the CD-ROM software you have seen, buy a copy of Encarta ’94: It will renew your faith in the medium. Superbly designed, Encarta is a multimedia version of the Funk & Wagnalls Ency-
pedia that Microsoft has enhanced and added to. Video and audio clips, anima-
tions, maps, and hypertext links all work together in ways that just make sense and enhance your ability to absorb and understand the information they convey.

Microsoft MS-DOS 6
Microsoft
Despite reports of some users experiencing problems, Microsoft has achieved a milestone by making file compression and memory management an integral part of the operating system. Millions of users who have never used either feature can now reap their benefits. (Microsoft recently began shipping a version 6.2 upgrade.)

Microsoft Visual C++ for Windows 1.0
Microsoft
Microsoft has wrapped a wide assortment of support tools around a good C++ compi-
der. These include tools for building user-
interface objects, “roughing out” applica-
tions, and combining executable code with the interface. At press time, Microsoft was planning to ship version 1.5 by the end of 1993.

NetWare 4.0
Novell
NetWare 4.0 represents a quantum leap in performance and ease of use over earli-
er versions. Also key is 4.0’s X.500-style NetWare Directory Service. NDS is a database of users, data, software services, and equipment, and it can span a LAN or a WAN (wide-area network). It allows
In the dog-eat-dog world of business presentations, we just made you a pit bull with the legs of a greyhound.

In dog racing as in business, if you're not leading the pack, the view seldom changes. Meet your new leg up on the competition: the Tektronix Phaser™ 200 color printer. It's lean, mean, and very very fast. Of course, you don't have to take our word for it, PC Computing magazine just called it the best overall presentation printer in the business. So much for the other guys.

But what is it that makes the Phaser 200 so good? For starters, the ink coverage and image quality are, in a word, brilliant. We at Tektronix didn't get to be the award-winning leader in color printers by sitting on our hands. Then there's speed. You get all of this great color at two pages per minute, which is nearly as fast as a regular black and white printer. Can you say increased productivity?

On top of all this, the Phaser 200 is a work group printer that gives you the advantages of a laser printer. Including true Adobe® PostScript™ Level 2, networkability, separate paper and transparency trays and price (did we happen to mention the Phaser 200 has a list price of only $3,695?).

For more information or a free output sample, come into your nearest Tektronix dealer or call us at 800/835-6100, Dept. 31J. For faxed information, call 503/682-7450, and ask for document #5001.

In closing, we just want to remind you that your competition is also reading this ad. And they're extremely hungry. So when choosing a presentation printer, the choice is quite simple. You can either eat, or be eaten. Bon appétit. Tektronix

Phaser is a trademark of Tektronix, Inc. PostScript is a trademark of Adobe Systems, Inc. All other marks are trademarks or registered trademarks of their respective companies.

Circle 116 on Inquiry Card.
administrators to get a handle on the structure of a company's network.

**NextStep for Intel Processors 3.1**

*Next Computer*

Next has taken the NextStep operating system, which many considered the best part of its ill-fated workstations, and placed it on the world's most popular hardware platform. If you want a truly object-oriented system today on your PC, then NextStep is your only option. You will also get a consistent and easy-to-use interface. (Version 3.2 started shipping in November 1993.)

**Pioneer DRM 604X**

*Pioneer New Media Technologies*

The Pioneer DRM 604X incorporates the best new CD-ROM technology into a single external unit. The drive can hold up to six CD-ROM discs in its caddy and automatically switches among them. The drive appears on a PC or Mac system as six different CD-ROM drives, and it can be easily accessed across a network. Pioneer's Quadraspin technology achieves a true 600-KBps transfer rate, four times the standard speed, and the drive is Photo CD and MPC compatible. Try the Pioneer drive, and you'll wonder how you ever survived with a single-disc, standard-speed CD-ROM drive.

**Psion Series 3a**

*Psion*

Psion doubled the usability of its already-capable hand-held computer, and the result is an easy-to-use, fun but productive computer that slips into your coat pocket. A new zoom function and a bigger screen make it easier to read your reminders. Even better, the new voice-recording feature lets you record brief messages and attach them to alarms and events. It is well worth the $499 price that you will likely pay for the Series 3a.

**Quicken 3 for Windows**

*Intuit*

The new version of the leading personal finance program for Windows lets you manage your finances in a calendar view, so you can look ahead to see when the bills are due while planning that getaway vacation and post other reminders to yourself as well. Toss in electronic credit-card payments, improved financial planning, and better checkbook balancing, and you have a well-crafted program for the home and small-business user. We know of one person who purchased his first PC just so he could use Quicken.

**R4400**

*Silicon Graphics*

The 64-bit R4400 is the most powerful Mips microprocessor; it features significantly larger caches than does the R4000. In 1993, it made its commercial debut in such machines as the Silicon Graphics Indigo and Magnum, where it forms the core of one of the most powerful Windows NT machines available. With an integer performance of over 90 SPECint92, the R4400 has far more horsepower for standard business applications than any 80x86 processor has.

**Stacker for Windows and DOS 3.0**

*Stac Electronics*

Speed and ease of use are the two hallmarks of Stacker 3.0. You can add reliability to that list, too. For these reasons, Stacker is still the premier compression utility for both Windows and DOS systems. (In mid-1993, Stac began shipping Stacker 3.1, which integrates seamlessly with MS-DOS 6, replacing Microsoft's DoubleSpace utility.)

**Symantec C/C++ 6.0**

*Symantec*

Symantec C/C++ 6.0 used to be Zortech C/C++. If we hadn't told you that, you would probably be unaware of any connection. Symantec C/C++ is such a quantum leap beyond its predecessor that the two may as well be in separate universes. Symantec C/C++'s user interface is designed around a workspace paradigm rich with toolbars, tear-off palettes, and an underlying drag-and-drop theme that significantly reduces overall mouse travel. With MFC (Microsoft Foundation Classes) and Bedrock bundled in, in addition to the Visual Programmer, Symantec C/C++ 6.0 is a tough act to follow.

**ThinkPad 500**

*IBM*

You'd be hard-pressed to find a 4-pound subnotebook with better Windows performance than IBM's ThinkPad 500. It packs a 50-MHz 486SLC CPU made by IBM, fast video, and a speedy hard drive. An intelligently designed keyboard and IBM's TrackPoint II pointing device make the ThinkPad easier to use.

**Video Machine for the PC**

*Fast Electronic U.S.*

The Video Machine delivers a high-quality video-production system to the PC by combining video editing, digital effects, audio mixing, titling, and graphics generation into one package. A 16-bit ISA board plugs into a PC slot, and audio/video connections to external devices are handled through a 62-pin cable splitter that plugs into the board. Video Machine uses standard control protocols to drive professional computer-controlled VCRs. The full-featured video-editing software follows the popular time-line interface—you create video clips and drop them onto the timeline along with titles and transitional effects. With Video Machine, you can turn your PC into a desktop video studio.

**Viper VLB**

*Diamond Computer Systems*

In a recent Lab Report on 486 PCs, we found Viper VLB video boards in many of the fastest graphics performers. This 32-bit VL-Bus card should be a top choice of anyone looking for the best in Windows performance.

**Watcom C/C++ 32**

*Watcom International*

This is not a C/C++ compiler package loaded down with application generators, class-library browsers, and all the other tools that require so many manuals that you have to get Hulk Hogan to deliver the package and Commander Data to comprehend it. Watcom C/C++ 32 is simply a very good C/C++ compiler that generates
Introducing the ViewSonic 17G — the first in our “Graphics” line of monitors. It’s unique! It’s powerful! And it’s affordable!

This unbeatable monitor features the OnView™ control system, an innovative technology that displays the status of each adjustment and function on the screen. Yes, OnView does make it very easy to adjust controls with precise accuracy. Two of the “hottest” controls are: ViewMeter™, which shows the current refresh rate and scanning frequency of the monitor, and ViewMatch™, that adjusts screen colors to closely match printer output.

And it’s “green”! Powering down to under five watts when inactive, the ViewSonic 17G supports the EPA’s Energy Star program, and is compliant with MPR-II standards for low radiation.

If that isn’t enough, the ViewSonic 17G has a special ARAG™ anti-reflection coating, Invar shadow mask and a specially-designed dynamic beam focus gun which provides a sharp, crisp screen image.

This feature-rich 17-inch monitor beats the competition — and the suggested retail price is only $999!
WordPerfect Office 4.0

WordPerfect

Multiplatform support is at the top of the list of improvements to be found in WordPerfect Office 4.0. With this version of the software, you can coordinate an entire workgroup’s E-mail, calendar, appointment list, and so on across Macintosh, Windows, DOS, and Unix systems. WordPerfect also made version 4.0 easier to use, providing mouse support for DOS applications.

Company Information

Adobe Systems, Inc.
(800) 833-6687
(415) 961-4400
fax: (415) 961-3769
Circle 1061 on Inquiry Card.
Aldus Corp.
(800) 333-2538
(206) 622-5650
fax: (206) 343-4240
Circle 1062 on Inquiry Card.
Apple Computer, Inc.
(800) 588-9696
(408) 996-1010
Circle 1063 on Inquiry Card.
Artisoft, Inc.
(800) 233-5564
(602) 670-7100
fax: (602) 670-7101
Circle 1064 on Inquiry Card.
AST Research, Inc.
(800) 876-4278
(714) 727-4141
fax: (714) 727-9355
Circle 1065 on Inquiry Card.
Asymetrix Corp.
(800) 448-6543
(206) 462-0501
fax: (206) 637-1504
Circle 1066 on Inquiry Card.
AT&T Microelectronics
(800) 372-2447
(215) 439-6011
fax: (215) 778-4106
Circle 1067 on Inquiry Card.
Banyan Systems, Inc.
(800) 828-2404
(508) 898-1000
fax: (508) 898-1755
Circle 1068 on Inquiry Card.
Borland International, Inc.
(800) 882-9299
(408) 439-1000
fax: (408) 439-9262
Circle 1069 on Inquiry Card.
Canon Computer Systems, Inc.
(800) 848-4123
(714) 438-3000
fax: (714) 438-3099
Circle 1070 on Inquiry Card.
Clarion Corp.
(800) 544-8554
(408) 727-8227
fax: (408) 967-7460
Circle 1071 on Inquiry Card.
Cyrix Corp.
(800) 462-9749
(214) 994-8388
fax: (214) 994-8397
Circle 1072 on Inquiry Card.
Dauphin Technology, Inc.
(800) 782-7922
(708) 971-3400
fax: (708) 971-8443
Circle 1073 on Inquiry Card.
Delrina Corp.
(800) 268-6082
(408) 363-2346
fax: (408) 363-2340
Circle 1074 on Inquiry Card.
Diamond Computer Systems, Inc.
(800) 736-2000
(408) 730-5750
Circle 1075 on Inquiry Card.
Eo, Inc.
(800) 458-0880
(415) 903-8100
fax: (415) 903-8190
Circle 1076 on Inquiry Card.
Fast Electronic U.S., Inc.
(800) 248-3278
(508) 655-3278
fax: (206) 671-3860
Circle 1077 on Inquiry Card.
Folio Corp.
(800) 543-6546
(510) 344-3700
fax: (501) 344-3790
Circle 1078 on Inquiry Card.
Fractal Design Corp.
(800) 297-2665
(408) 888-8800
fax: (408) 888-8836
Circle 1079 on Inquiry Card.
Gupta Corp.
(800) 876-3267
(415) 321-9500
fax: (415) 321-5471
Circle 1080 on Inquiry Card.
Haewlett-Packard Co.
(800) 752-0900
(415) 857-1501
fax: (800) 333-1917
Circle 1081 on Inquiry Card.
IBM
(800) 426-3333
(415) 752-0900
fax: (415) 780-3147
Circle 1082 on Inquiry Card.
Intel Corp.
(800) 548-4725
(406) 765-8080
Circle 1083 on Inquiry Card.
Intuit, Inc.
(800) 824-8742
(415) 322-1013
fax: (415) 322-1013
Circle 1084 on Inquiry Card.
JVC Information Products Co. of America
(714) 965-2610
fax: (714) 968-7080
Circle 1085 on Inquiry Card.
Lotus Development Corp.
(800) 872-3387
(617) 577-8500
fax: (617) 693-0968
Circle 1086 on Inquiry Card.
Matrox Electronics Systems, Ltd.
(800) 361-1408
(514) 685-2630
fax: (514) 685-2853
Circle 1087 on Inquiry Card.
Microsoft Corp.
(800) 426-9400
(206) 882-8080
fax: (206) 936-7329
Circle 1088 on Inquiry Card.
Motorola, Inc.
(800) 848-6686
Circle 1089 on Inquiry Card.
Nanoo USA Corp.
(800) 800-5202
(310) 325-5202
fax: (310) 530-1679
Circle 1090 on Inquiry Card.
Next Computer, Inc.
(800) 879-6398
(415) 366-0900
fax: (415) 780-3147
Circle 1091 on Inquiry Card.
No Hands Software, Inc.
(800) 589-8281
(415) 802-8800
fax: (415) 593-8688
Circle 1092 on Inquiry Card.
Novell, Inc.
(800) 636-9273
(801) 429-7000
fax: (415) 429-5155
Circle 1093 on Inquiry Card.
Nu-Mega Technologies, Inc.
(800) 889-2386
(800) 889-1135
Circle 1094 on Inquiry Card.
Olivetti North America, Inc.
(503) 345-3322
(508) 655-3278
fax: (801) 344-3700
Circle 1095 on Inquiry Card.
Pentium 1053 on Inquiry Card.
Silicon Graphics, Inc.
(800) 833-2538
fax: (415) 961-3769
Circle 1061 on Inquiry Card.
SoftWare, Inc.
(800) 628-3387
fax: (416) 754-1856
Circle 1051 on Inquiry Card.
Softtek, Inc.
(800) 441-7234
(503) 345-3322
fax: (503) 334-7474
Circle 1053 on Inquiry Card.
Symantec Corp.
(800) 265-4555
fax: (514) 685-2630
Circle 1029 on Inquiry Card.
Synetics International, Inc.
(800) 446-2001
(914) 591-5600
fax: (914) 591-6484
Circle 1054 on Inquiry Card.
Toshiba International, Inc.
(800) 265-5556
(519) 866-3700
fax: (519) 747-4971
Circle 1055 on Inquiry Card.
WordPerfect Corp.
(800) 451-5151
(801) 222-5000
fax: (801) 222-5077
Circle 1056 on Inquiry Card.
Zedcor
(800) 482-4567
(602) 881-8101
fax: (602) 881-1841
Circle 1057 on Inquiry Card.
The new VEDIT PLUS 4.0 does what no other editor can:

Edit/Patch/Browse any Text/Data/Binary file up to 2 Gigabytes.

- Unique multi-mode, multi-file editor handles any text, data or binary file up to 2 Gigabytes (2000 Megabytes).
- Edit DOS, Unix and Mac text files, fixed and variable length data records.
- Edit in ASCII, Hexadecimal, Octal or EBCDIC, or any combination of them using a split screen.
- Edit database (e.g. dBASE .DB), mainframe, Postscript, .EXE and other non-standard files.
- Hyper-browse CD-ROM files.
- Full featured program editor with flexible compiler support. Integrates tools from different vendors. Fully supports "make".
- Convenient word processing and printing.

The new VEDIT PLUS 4.0 is the result of 14 years of development and feedback from our 100,000+ users. We guarantee that it will be the fastest, most powerful, flexible, configurable and useful editor you have ever had. Try the new VEDIT PLUS risk free for 30 days. If you are not fully satisfied, return it for a full refund.

The World's Only Universal File Editor
Sure, the editor you got from Microsoft or Borland can edit small text files, but that's about all. VEDIT can edit, view, patch, search/replace any file you'll ever encounter - database, mainframe, Postscript, .EXE executable, binary, etc. Plus it can quickly edit those 100+ megabyte files for which no other editor is fast enough.

VEDIT edits data or binary files as effortlessly as text files. Its secret is incredible speed, huge file capacity and special editing modes.
- File modes support DOS, Unix and Mac text files, plus data files with fixed or variable length records.
- Display modes include five ASCII modes, Hexadecimal and EBCDIC, or any combination in a split screen.
- Long lines can be scrolled or wrapped.

Powerful Macro Language
VEDIT PLUS's new C-like macro language automates repeated editing operations, performs file translations and is ideal for "filters". It permits "off-the-cuff" macros to be typed in and immediately executed; there is no compilation.

The macro language is so powerful that just a few simple lines can do the same work as a tricky 100+ line C program. It can even interface to the hardware and machine language routines.

For example, the single command:

```
Search_Block("thomas",1000,4000,WORD+COUNT+COLSET,4,20,40)
```

searches for the 4th occurrence of the word "thomas" in the block between file positions 1000 and 4000, and columns 20 thru 40.

Ultimate Programmer's Editor
VEDIT has every advanced feature programmers expect. Multi-file, multi-window editing, search/replace with regular expressions, template editing, smart Indenting, parentheses matching and block operations by character, line, file or column. When shelling out, the unique V-SWAP program swaps VEDIT, any TSR's and even network drivers out of memory in order to run the biggest compilers.

You Already Know How To Use VEDIT
With a user interface similar to the Microsoft and Borland editors, you will immediately be productive with VEDIT. Drop-down menus, hot keys, mouse support, optional scroll bars, context sensitive help and point & shoot file selection make VEDIT easy to use, easy to learn. Safety features include undo, redo, auto-save and optional backup files.

Installation is trivial. Only the 95K VEDIT.EXE is required (no overlays) and a full installation is only 600K.

FREE Fully Functional Demo!
Call 1-800-45-VEDIT

VEDIT PLUS - DOS single user license: $149; DOS network 5 user license: $325; UNIX/XENIX, QNX: $285. Also VEDIT for DOS: $89.

A fully functional demo of VEDIT PLUS and a shareware VEDIT Jr. are available on CompuServe and on our BBS.

VEDIT is a registered trademark of Greenview Data Inc.

Toll Free: 1-800-45-VEDIT (1-800-458-3348)
Telephone: (313) 996-1300, Fax: (313) 996-1308
BBS: (313) 996-1304, CompuServe: 71333,3656; GO VEDIT

Greenview Data

Circle 71 on Inquiry Card (RESELLERS: 72).
Mainstream processors are becoming faster, RISCier, smaller, and less power hungry. They are also getting better at emulating non-native instruction sets.

DICK POUNTAIN
Since the 1981 launch of the IBM PC, the whole personal computer industry has been in thrall to the Intel 80x86 architecture. The bonds loosened only slightly in 1984 by the emergence of a smaller, secondary standard around the Apple Macintosh's Motorola 680x0 CPUs. Now for the first time in over a decade, it looks like there's a real chance of the market opening up to new architectures. All in all, this is an exciting time in microprocessor development.

The effect of the Intel and Motorola standards has been good and bad, though mostly good. The good speaks for itself; the huge proliferation of DOS, Windows, and Macintosh software that we use every day came about only because there were stable platforms to attract application programmers. Standardization has allowed the PC industry to grow and keep computers affordable.

**Standards Holdup**

The down side is that the performance of mainstream CPUs has evolved more slowly than it might have, had it not been constrained to preserve backward compatibility with these industry standards. In particular, the two main players, Intel and Motorola, could not easily adopt those innovations that today we group under the name of RISC, because they required architectural changes (e.g., in the optimum size of register files) that were too drastic to preserve backward compatibility.

As a result, a new breed of RISC CPUs has grown up that outperform the mainstream chips; however, they have been excluded from mainstream PC's for lack of compatibility and, instead, have been confined to the much smaller technical workstation market. These chips include Sun's SPARC, DEC's Alpha, the Mips R4x00, and Hewlett-Packard's PA-RISC. Also, because the workstation market is small in volume (although not in value), the production runs on these chips aren't big enough, thus making the chips too expensive to appeal to PC manufacturers.

Now this logjam is breaking for several reasons. Most important is the decision of IBM and Apple to shuck off their 80x86 and 680x0 standards in favor of the PowerPC for future products. This will shortly make the PowerPC 601 the best-selling RISC chip on the market, although its volume will still pale compared to 486 sales.

Also, emulation is at last becoming a practical way to achieve compatibility among different processors. Emulation has been around since Alan Turing and the first days of computing, but it has always been too costly in terms of performance to be commercially viable (remember the UCSD P-System?).

Now, machines like DEC's DECcpu AXP/150 (using the DECchip 21064 RISC processor) or Silicon Graphics, Inc.'s Magnum (using a Mips R4400) can run Intel 80x86 applications at acceptable speeds in addition to achieving blazing performance on native RISC code. The Magnum, for example, supplies 80 percent of the graphics performance of a 486DX/33 in running the BYTE low-level Windows benchmarks; two-thirds of the memory performance and almost five times the file I/O performance—a reflection of the amazing capabilities of the Windows NT file system.

The cumulative performance index of the Magnum running the Windows 3.1 low-level benchmarks is 2.12 times the performance of the 486DX/33 machine (see "Is There a Better Windows 3.1 than Windows 3.1?" November 1993 BYTE). Although this figure is skewed by the file I/O numbers, it indicates that you can get 486 performance from a RISC platform running some form of software emulation.

IBM and Apple are relying on emulation as a medium-term bridge from old to new platforms—while few native PowerPC applications are available—although the precise route is at present shrouded behind a swirling confusion of acronymic software layers like WABI, MAS, PowerOpen, SoftPC, and more.

Trends in operating-system design are helping make emulation feasible, too. Windows NT's HAL (hardware abstraction layer) and true microkernel architectures such as Mach greatly reduce the effort involved in porting a standard operating system to a new processor architecture, by concentrating all the hardware dependencies behind a small and well-defined software interface. Mac and Windows applications can spend anywhere between 60 percent and 90 percent of their time executing GUI-related system calls, so once these system routines are rewritten in native code only 10 percent to 40 percent of an application's code remains to be emulated.

The longer-term trend toward deeply object-oriented operating systems will insulate applications code even further from hardware. For example, Apple MessagePad applications written in Newtonscript are processor-independent, running on a software virtual machine.

This leads neatly to the third factor that's helping to erode the 80x86/680x0 dominance—namely, the newly created portable PDA (personal digital assistant) market sector. PDA applications, with their pen-based interfaces and notebook metaphors, look so completely different from desktop software that applications compatibility is not a big issue, only data portability. You won't want to run WordPerfect on a pocket organizer so long as you can transfer documents easily to and from your desktop machine. This freedom is allowing a whole new generation of tiny, low-power CPUs to struggle for supremacy (see "Intel/VLSI Join the PDA Fray" on page 101).

Of course, Intel is in no hurry to give...
State of the Art Microprocessor Trends

up a decade of dominance during which it has made a great deal of money. Even though it is denied the advantages of starting from a clean sheet, Intel's smart engineers have been able to pick enough of the good stuff out of RISC to produce the Pentium, which has had a mixed reception from industry critics; it's faster than many people believed possible from the 80x86 architecture, but it is still some way behind the RISC leaders.

Clone Wars

While this talk of breaking logjams is all very exciting, it's as well to remember that right now (and for some time to come) the Intel 486 is the industry workhorse, only recently displacing the 386 as the entry-level processor for PCs. But even here Intel's dominance is no longer complete because a pack of clone 486 manufacturers—most notably, AMD and Cyrix—are snapping way above its ankles.

Both AMD and Cyrix have developed clones of the 486 that claim to be reverse-engineered without using any of Intel's proprietary microcode, although in AMD's case, Intel is still disputing this claim in court. The clones use various stratagems to keep an edge over Intel. Cyrix focused on pin-compatible replacement chips that enable you to skip a generation, so the Cx486SLC, DLC, and DRx2 chips fit into 386 sockets but offer some 486 features and near-486 performance. On the other hand, AMD offers same-generation-but-faster parts; for example, 40-MHz (and soon 50-MHz) equivalents for the 486SX, where Intel has to stop at 33 MHz to protect sales of its 486DX. Recently, Cyrix has changed tack to confront Intel head-on at the top of the range. Cyrix's M1 chip aims to outdo Pentium in the "stealing RISC's clothes" game.

There has been much industry speculation about what architecture Pentium's successor, the P6, will adopt. One plausible suggestion is that it could adopt a hybrid architecture in which a "pure" RISC core emulates the older 80x86 instruction set in hardware, by translating 80x86 op codes into groups of native instructions—IBM is believed to be following this course for its future PowerPC designs. The advantage of such a "Trojan horse" strategy is that you could fully support current 80x86 applications, while a new generation of software that uses the RISC's faster native instructions is developed to wean users gradually onto a new architecture.

Another possible course is to make the Pentium architecture itself RISCier, and the most obvious way to do that would be to remove the bottleneck caused by the small 80x86 register file. This is the way Cyrix plans to go with the M1, employing a file of 32 registers that can be dynamically renamed to emulate the 80x86's eight registers. This would allow up to four complete processor states to be stored at once, enabling an aggressive strategy of speculative branch execution (i.e., following both branch paths in parallel until it becomes clear which is the winner). Cyrix claims that this technique will keep the M1's pipelines full longer than the Pentium's, even though they are deeper seven-stage "superpipelines" (see "M1 Challenges Pentium" on page 83).

Intel is giving away little about its intentions just now. Frank Spindler, Pentium processor marketing manager, says, "We see no end in sight to what we can deliver with the Intel architecture, both within the Pentium generation and future generations of processors." In 1994, Intel will introduce a new version of the Pentium based on a 0.6-micron process technology, he adds, which will allow faster clock speeds. How much faster Intel won't say, but many in the industry expect it to be at least 100 MHz.

Cutting Costs

With the arrival of the Alpha and the PowerPC, you've probably seen all the major new RISC architectures for some time to come. A generic modern RISC chip uses 64-bit data paths; large on-chip instruction and data caches; and separate integer, floating-point and branch-processing units that allow the issue of three instructions at once (referred to as superscalar). The units are deeply pipelined with instruction execution broken up into four to eight stages and often have a feed-forward scheme to satisfy data dependencies between consecutive instructions within the pipeline.

Instead of inventing new architectures, RISC vendors, detecting the scent of change in the air, are scurrying to reduce the manufacturing price of their current products (see "RISC Grows Up" on page 91). Broadly speaking, the cost of a chip in volume production is proportional to die size, so to make a chip less expensive, you use a newer fabrication process that allows smaller transistors, or you throw away some bits (e.g., from bus widths). Typical of this trend is the PowerPC 601, which is already cheaper than most 486DX variants thanks to an advanced 0.65-micron, four-layer metal process and a clever layout that reduces the space wasted by external interface pads.

Another effective approach is to attack overall system cost, rather than just CPU cost, by integrating more functions onto one chip so that fewer chips are needed to build a computer. A striking example of this is the DECchip 21066, which integrates a memory interface and PCI (Peripheral Component Interconnect) controller with an Alpha core.

Hot Chips

One question that's taxing all semiconductor manufacturers nowadays is how to reduce power consumption. Originally, it was the boom in laptop and notebook computers that made power into an issue, because the 2- to 3-hour battery life that most machines could offer was barely acceptable. Intel developed the 486SL, featuring on-chip power management and 3.3-V operation, for the portable market.

Then in April 1993, the U.S. government raised the stakes by instructing government agencies to purchase only certified energy-efficient computers; Intel killed off the 486SL and announced that SL power-saving technology would be incorporated into all its future CPUs. The new PDA market has given a further boost to the low-power quest, as these tiny machines are expected to run for weeks on just two or three penlight cells.

Another pressing reason to seek lower power consumption exists: Today's fastest CPUs are getting so hot that it has become
Power2 Takes the Lead—For Now

PAUL STATT

IBM's Power2 RISC processor, the successor to the Power1 found in its RS/6000 line, combines aggressive superscalar execution with a high-speed interconnect strategy. This combination delivers computing power unsurpassed by any other microprocessor. As you would expect, the Power2 is not inexpensive. It is used in three IBM RS/6000 systems that range in price from $62,500 (Model 58H) to $124,500 (Model 990). (Separate chip pricing isn't available on the Power2 since IBM installs it in IBM computers only.)

The Power2 proves that the processor with the fastest clock speed is not necessarily the most powerful. At 71.5 MHz, the clock speed of the Power2 is less than half that of the DECchip 21064 (200 MHz). Despite this, the Power2 is rated at 126 SPECint92 and 260 SPECfp92, more than double the score of the PowerPC 601 chip and a considerable floating-point advance over the 21064. Until DEC ships the 275-MHz DECchip 21064A this fall, the Power2 is the performance leader.

Its clock may tick a lot less often, but the Power2 does plenty with each tick. Specifically, the Power2 executes more instructions in parallel than any other RISC processor: as many as six instructions per cycle. And they can't be just any old instructions; to maintain that performance, the Power2 has to mix exactly two integer instructions, two floating-point instructions, and two branch or condition-code instructions. That precise mix is required by the Power2's architecture. The Power2 is a multichip module, a high-density package that mounts individual dies directly onto a substrate that incorporates an interconnection network.

The Power2 MCM consists of three processing chips: an ICU (instruction cache unit), a fixed-point (integer) unit, or FXU, and an FPU. Four DCU (data-cache unit) chips and an SCU (system-control unit) are combined with them. Everything is joined in a ceramic multichip module that contains a total of some 23-million transistors in a block with an area of 4096 mm²; the size of a Polaroid print. (The die size of the eight chips totals 1215 mm².)

Despite its size, the Power2 makes most of its own decisions, and it needs only 512 I/O connectors. A lot of that input and output is used to transfer main-memory data into the chip cache over a 288-bit bus (256 data bits plus error-correction code) with an incredible peak data bandwidth of 2288 MBps.

The Power2 adds some valuable extensions to the Power1: quad-word load and store instructions; a hardware square root instruction; and new instructions for conversion of floating-point values to integers. The incredible power of the Power2 won't be available to PC users: IBM will market Power2 computers to the high end, while pushing the lower-cost, PowerPC in the mass market.

Paul Stat is a freelance technology writer. You can reach him on the Internet at stat@aol.com. or on BIX c/o "editors."
State of the Art  Microprocessor Trends

embarrassing. This fact was driven home the day I first opened an Alpha-based workstation to reveal a huge finned heat sink reminiscent of a racing motorcycle. These chips are dissipating up to 15 to 30 W, and further speed increases threaten to lead straight back to the age of water-cooled computers.

Steve Furber, original architect of the ARM processor family, says that as you shrink a chip design, the capacitance of the transistors decreases. But since you’re switching them proportionally faster (by raising the clock frequency), the power that each transistor consumes remains the same. The transistors are now squeezed into a smaller area, so the power dissipated per square millimeter rises as the square of the process size. So, DEC’s Alpha built in a 0.1-micron process—five to 10 years from now—would run at 2 GHz and dissipate around 3 kilowatts (excellent for making toast) if nothing else changed.

Clearly other features must change, and foremost among those is the supply voltage: Voltage and power are related by another square law, so going down from 5- to 2-V operation yields a sixfold power saving (25/4), while dropping to 0.5 V—which seems theoretically possible—would reduce power 100-fold. Furber sees a target somewhere between: “There’s a very interesting breakpoint at about 0.9 V, which is where standard 1.5-V battery technology goes when it gets tired. If your logic only works at 1.5 V, you throw away a lot of battery life. I expect the people with real low-power motivation to find themselves aiming for 1 V sooner than they currently think they’re going to.”

To run the CPU at these lower voltages, everything in the system—memory, UARTs, video chips, and so on—has to come along, too. So the pursuit of single-cell operation for PDAs will eventually spawn a complete range of low-voltage parts, at which point there will be no reason for desktops not to follow suit.

Looking Ahead
You have more viable CPU choices available today than at any time since Intel introduced the first microprocessor back in 1971. Multiplatform operating systems, advanced emulation strategies, and new applications that don’t require 80x86 compatibility have created a more open market for microprocessors than has existed since before the introduction of the IBM PC. Whether Alpha, R4000, SPARC, or PowerPC can stay in the race with the 80x86, however, will depend on how well DEC, SGI, IBM, Sun, Apple, and the rest can package these technologies into solutions that meet customer needs as well or better than does an 80x86 processor.

Even if alternative architectures fail to capture more than 10 percent to 15 percent of the desktop market, they will provide price competition for Intel, and they will keep those 80x86 engineers busy pushing the envelope. In either case, the result will be better, more powerful desktop machines at reasonable prices. •

Dick Poundmaill is a BYTE consulting editor. You can reach him on the Internet or BIX at dickp@bix.com.

---

**Product** | **Old SRP** | **New SRP** | **Product** | **Old SRP** | **New SRP**
--- | --- | --- | --- | --- | ---
150MB Insider IDE Drive and Disk | $1599 | $599 | Single 150MB Disk (in 5-Pack) | $159 | $109
150MB Insider Drive and Disk | $1099 | $699 | Single 10MB Disk | $169 | $99
150MB Transportable Drive and Disk | $1225 | $699 | Single 90MB Disk (in 5-Pack) | N/A | $99
90MB Insider Drive and Disk | $799 | $499 | Single 65MB Disk | $120 | $59
90MB Transportable Drive and Disk | $399 | $399 | Single 35MB Disk | $79 | $39

Iomega’s just been tagged the new low price leader for removable storage. We’ve cut prices permanently on the most reliable storage devices around—including the high-performance MultiDisk™ 150 Drive See your dealer or call 1-800-695-4028.

---

*Iomega®* 1993 Iomega Corp. The Iomega Logo and Bernoulli are registered trademarks and MultiDisk™ is a trademark of Iomega Corp. 

Circle 89 on Inquiry Card.
Discover the basic principle of connectivity...

Look to SmarTerm® for visionary emulation and multi-platform connectivity.

*It's a basic principle worthy of Galileo:* SmarTerm's stellar PC-to-host connectivity puts you at the center of your system. New SmarTerm emulation software for Windows will expand your vision with a galaxy of UNIX, VMS, and DG host applications. SmarTerm 420 for Windows and SmarTerm 340 for Windows have both been upgraded. We also offer SmarTerm 470 for Windows, the first full-featured Data General 470 emulation product for Windows. And coming soon—SmarTerm for Windows NT!

**New Windows Sockets TCP/IP and more!**
Assure your system a window on the future with great new features like SmarTerm TCP/IP as a Windows Sockets DLL, drag-and-drop FTP, a dialing directory, a script recorder, and SmartMouse™ enhanced mouse support!

**Test a proven theory for reducing support costs.**
It's a fact. You'll save money and time with SmarTerm's pioneering corporate support tools and utilities. These corporate support tools include simplified keyboard remapping, pop-up keyboard, toolbox, customizable help system, and enhanced button palettes with icons or text.

**Discover SmarTerm.**
It's the only emulation software that includes LAT and SmarTerm TCP/IP as a Windows Sockets DLL (a $199 value) FREE in every package. Discover the basic principle of connectivity today.

Call 1-800 EMULATE (1-800-368-5283).
Absoft FORTRAN F77 for Windows NT™

by Absoft Corporation

A globally optimizing ANSI Standard FORTRAN 77 with all DoD MIL-STD extensions. Intel486™ and Pentium™ optimizations produce the fastest F77 applications for NT. Compatible with MS C/C++, windbg, and other NT SDK tools. VAX, Sun, Gray. Fortran 90 extensions aid in porting code to NT. Source compatible with other Absoft F77s for Macintosh, DOS, NeXTSTEP, & UNIX.

List: $695 Ours: $599 FAX: 0012-8601

Spread/VBX 2.1

by FarPoint Technologies, Inc.

Spread/VBX 2.1 is a versatile control used to implement not only spreadsheets, but grids, Listboxes, toolbars, and any other control imaginable. With over 250 properties, Spread/VBX 2.1 is the most comprehensive Visual Basic control available, unparalleled by any other package in its features, flexibility and power.

List: $245 Ours: $225 FAX: 0023-6801

WindowsMAKER Professional 5.0

by Blue Sky Software

Next generation of the most powerful C/C++ Code Generator and Prototyper for Windows 3.1, NT & Win32s. The fastest way to create full-featured Windows apps. This product stands out, does everything—even a toolbar can be created with 1 click! Test run your design, make changes interactively, generate code for multiple platforms—ANSI C, MFC, OWL, etc.; widest compiler support in industry. TrueCode technology—user code is 100% preserved. Highly recommended!

List: $1,096 Ours: $899 FAX: 2602-0003

Q+E Database Library

by Q+E Software

Q+E Database Library 2.0 streamlines DBMS-independent applications development by providing transparent access to major SQL and PC DBMS from user’s desktops with automatic support for ODBC & IDAPI. Q+EHR works with existing development tools and is simply the best way to add complete DBMS access to applications today, and tomorrow!

List: $699 Ours: $559 FAX: 2625-0002

c-tree Plus®

by FairCom

DOS • WINDOWS • NT • UNIX • OS/2 • SUN • R36000 • HP9000 • MAC • QNX • BANYAN • SCO. This well known, highly portable data management package has become established as the tool of choice for commercial development. Offering unprecedented data control, programmers may choose from direct low level access, ISAM level convenience, or SQL access with the FairCom Server. Single User, MultiUser, or Client/Server, ANSI Standard.

List: $595 Ours: $505 FAX: 1381-0008

Call Programmer’s Paradise® Italia for special pricing in Europe.

CA-Clipper 5.2 and CA-Clipper/Exospace

by Computer Associates

Buy CA-Clipper 5.2 or the competitive Upgrade, the premier Application development System, and take advantage of CA-Clipper/Exospace, which includes Virtual memory manager and allows you to run CA-Clipper Applications in Protected mode.

*CA-Clipper Comp. Uprg.: List: $199 Ours: $149
CA-Clipper/Exospace: List: $99 Ours: $85
FAX: 1004-0017

Reach new levels of programming power with Symantec C++ for Windows, DOS, and Win32s. Breakthrough new IDDE revolutionizes the way you work. Includes optimizations and tools, OPTILink linker and Blue Sky visual tools, with MFC 2.0 and Win32s, and 8000 pages of documentation.

Competitive Upgrade for Borland or Microsoft customers $189.

List: $499 Ours: $299
Comp. Upgrade List: $199 Ours: $189
FAX: 2132-0038

Network C Library

by Automation Software Consultants, Inc.

The most comprehensive library available for NetWare software development, supporting all versions of advanced NetWare. Over 450 C functions, include any features from the NetWare command line utilities and menu utilities in your C or BASIC programs for Windows or DOS. No licensing hassles. C library source code available.

List: $395 Ours: $355 FAX: 1004-9201

Symantec C++ Professional 6.0

by Symantec

Reach new levels of programming power with Symantec C++ for Windows, DOS, and Win32s. Breakthrough new IDDE revolutionizes the way you work, includes optimizations and tools, OPTILink linker and Blue Sky visual tools, with MFC 2.0 and Win32s, and 8000 pages of documentation.

Competitive Upgrade for Borland or Microsoft customers $189.

List: $499 Ours: $299
Comp. Upgrade List: $199 Ours: $189
FAX: 2132-0038
MetaWare High C/C++
by MetaWare, Inc.

NEW RELEASE! High C/C++ version 3.1. MetaWare's 32-bit compiler is shipping. Includes a 32-bit source-level debugger, and a 32-bit Application Developers Kit for Windows. The "Incremental Strengths" feature enables gradual migration from C to C++ one block at a time. High C/C++ provides optional ANSI conformance, eight levels of global optimization and a full implementation of C++ templates.

**List: $795  Ours: $689  FAX order #: 1590-0008**

---

**WATCOM VX•REXX**
by WATCOM Int'l Corp.

WATCOM VX•REXX is an easy to use visual development environment for creating applications that leverage the capabilities of OS/2 2.x and exploit the Presentation Manager graphical user interface. VX•REXX combines a project management facility, visual designer and an interactive source-level debugger to deliver a very approachable and highly productive visual development environment.

**List: $199  Ours: $99  FAX order #: 1693-0016**

---

**NEW THIS MONTH**

TNT DOS-Extender 6.0
by Phar Lap Software

GET NT power under 32-bit DOS! Microsoft Visual C++ 32-bit Edition and Phar Lap TNT now bring Windows NT power to DOS! Phar Lap's new TNT DOS-Extender lets you break the 640K DOS barrier, build multi-megabyte DOS applications and take advantage of powerful NT features, including threads, DLLs and multitasking!

**List: $495  Ours: $420  FAX order #: 1490-0009**

---

Microsoft Visual Basic 3.0
by Microsoft Corporation

Now with built-in data access, OLE 2.0 and more! New Program for Windows the fast, easy way with MS Visual Basic for Windows, Standard Edition. A visual development environment, flexible programming language, and now access to your data make this the most productive way to go from initial idea to impressive applications.

<table>
<thead>
<tr>
<th>Standard</th>
<th>List: $199</th>
<th>Ours: $139</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version Upg.</td>
<td>$49</td>
<td>Ours: $45</td>
</tr>
<tr>
<td>Comp. Upg.</td>
<td>$99</td>
<td>Ours: $95</td>
</tr>
<tr>
<td>Prof. Edit.</td>
<td>$495</td>
<td>Ours: $339</td>
</tr>
</tbody>
</table>

**FAX order #: 1269-0033**

---

**Borland C++ 4.0**
Borland International

New Borland C++ 4.0 is visual, and that's just the beginning. Only Borland C++ has true C++ support with exceptions, templates and the easiest, most powerful suite of object-oriented tools available today. With full support for DOS, Windows, Win32s and NT, it's the C++ Development System you've got to have.

**List: $499  Ours: $329  Upgrade List: $199  Ours: $189  FAX order #: 1681-0016**

---

**RoboHELP® 2.0**
by Blue Sky Software

RoboHELP® 2.0, the premier Help Authoring Tool for Windows & Windows NT, offers full document to help system conversion and vice versa. Turns Microsoft Word for Windows into a fully functional hypertext authoring system capable of producing Windows Help files as easily as it does plain text. Just fill in the actual help text when prompted. RoboHELP takes care of generating the RTF, HRJ and H files. Link tester allows you to simulate your design before you compile. Full support of all features in Windows 3.1 Help Engine, such as macros, secondary windows, and multiple hotspot graphics.

**List: $495  Ours: $448  FAX order #: 2602-0005**

---

**WATCOM™ C/C+++32 v9.5**
by WATCOM

C/C++32 is a professional, multiplatform C and C++ development system supporting 32-bit extended DOS, OS/2 2.x, Windows 3.x, Windows NT, Win32s, and AutoCAD ADS/ADI. The complete toolset includes: C and C++ optimizing compilers, royalty-free DOS extender with VMM support, licensed components from the MS Windows 3.x SDK, interactive source-level debugger, linker, profiler, Supervisor for executing 32-bit applications and DLLs under Windows 3.x, 32-bit run-time libraries for extended DOS, OS/2 2.x, Windows 3.x and Windows NT, and more.

**List: $599  Ours: $349  FAX order #: 1683-0003**

---

**GUARANTEED BEST PRICES!** (Call for Details)

To order call: 800-445-7899
Corporate (CORSOFT): 800 422-6507
FAX: 908 389-9227
International: 908 389-9228
Customer Service: 908 389-9229
Programmer's Paradise Italia: 39-2-480-16053
For more information on the products featured on these pages call FAX order #: 762-1378

**Programmer's Paradise**
1163 Shrewsbury Avenue
Shrewsbury, NJ 07702
*All prices are subject to change without notice.*
*Call for details on return policy and shipping charge.*
*Circle 91 on Inquiry Card.*
Develop Cross-Platform GUI Applications in a Single Stroke.

Master the art of multi-platform GUIs.

XVT Software is the leading choice of world-class developers for one reason: It is the simplest, quickest path to building quality applications that port to every GUI without compromises in look-and-feel or performance. Plus, it's easier to learn and use than native toolkits, so your time and effort go into your application, not your GUIs.

XVT gives you simultaneous original GUIs.

Because XVT uses native GUI objects, your application is indistinguishable from one written directly to the native toolkit. Through our layered architecture, you achieve equivalent cross-platform functionality appropriate to each GUI, without the overhead and inflexibility of proprietary emulation-based systems.

XVT puts complete C/C++ solutions at your fingertips.

XVT Development Solutions for C include an Interactive Design Tool. Solutions for C++ include an object-oriented application framework. Both include the XVT Portability Toolkit.

When combined with in-depth consulting, training and support, plus a wide range of Partners products, XVT forms the most comprehensive and advanced solution for developing completely portable GUI applications.

Developers judge XVT to be a masterpiece.


Call now for a Free XVT Demo and Technical Overview.

1-800-678-7988

The portable GUI development solution.

XVT Software Inc. 4900 Pearl East Cir. Boulder, CO 80301 (303) 443-4223 FAX (303) 443-9069

For European inquiries, contact: Precision Software GmbH
Phone: 49 0 61 03/37 940 Fax: 49 0 61 03/36 959

Circle 121 on Inquiry Card (RESELLERS: 122).
The Cyrix M1 architecture brings more of the benefits of superpipelining and superscalar execution to 80x86 programs without requiring recompilation.

BOB RYAN

Intel's Pentium is no longer the only superscalar 80x86 processor on the block. Cyrix recently unveiled its M1, a 64-bit superscalar processor architecture designed to execute the industry-standard 80x86 instruction set. Cyrix (Richardson, TX) plans a family of processors based on the M1 architecture. At this time, however, the company is mum about exactly what time this year it will release the first M1 processor.

According to Cyrix, the greatest advantage the M1 holds over the Pentium is that it runs your current software faster. Cyrix estimates that you will receive up to 90 percent of the performance benefits of the M1 architecture when using nonrecompiled code. Intel estimates that nonrecompiled code runs 70 percent as fast as optimized code on the Pentium.

The Pentium promised the best of both worlds: RISC-level performance coupled with the ability to run industry-standard software. It delivers this, but not to all programs. To get the best performance from a Pentium, you have to recompile your software using a Pentium optimizing compiler. And because commercial developers are not in the habit of releasing their source code, this means waiting for language suppliers to create the compilers, commercial developers to use them, and software publishers to get the results into your hands.

The nature of superscalar pipelined processors makes this recompilation necessary. Because they can execute instructions in parallel, a superscalar processor works best when it can avoid situations where one instruction is dependent on the results of a parallel one. Most superscalar processors rely on an optimizing compiler to keep instructions with interdependencies from executing in parallel. The M1 employs an advanced design to eliminate these dependencies.

The M1 architecture is superscalar; it can execute more than one instruction at a time. Consequently, like the Pentium, it
can execute two integer instructions at once. Unlike the Pentium, it can also execute integer instructions in parallel with floating-point ones, so floating-point execution does not stall the execution of fixed-point instructions. In addition, the M1 is superpipelined; it breaks instruction processing into more stages and finer stages than does the Pentium. This lets the M1 process more instructions at once and introduces higher timing margins per pipeline stage, which, in turn, lets the processor run at higher clock rates.

The significance of the M1 is twofold. First, it incorporates many innovations that will let your current crop of applications run much faster than they do now and make possible applications that use rich data types such as digital video. Second, if successful, the M1 will provide competition to Intel on the high end. This could result in lower prices for high-end 80x86 processors, whether Pentium or M1. The result is a higher price/performance ratio.

The Basics
The M1 consists of an IU (integer unit), an FPU, a unified cache, an instruction cache, a BPU (branch-prediction unit), an MMU (memory management unit), and a BIU (bus-interface unit). Because the specifics of these units will vary with different implementations, the discussion that follows concentrates on the principles of the M1 architecture, not on any one member of the M1 family. Cyrix plans to make specifics available when it is closer to shipping products based on the architecture.

The heart of the M1 is its IU, which, like the Pentium, contains two integer pipelines. In the M1, these are called the X pipe and the Y pipe, and they are divided into seven stages, as opposed to the five on the 486 and the Pentium. The seven stages are Fetch, Decode 1, Decode 2, Address Calculate 1, Address Calculate 2, Execute, and Writeback. By contrast, the 486 and Pentium pipelines use single stages for decoding and address calculation. A deeper pipeline lets the M1 have more instructions in various stages of processing than the Pentium or 486, but it also makes the pipeline more susceptible to hazards that can cause stalls and thereby introduce bubbles into the pipelines. (Bubbles are empty pipeline stages. You get optimal performance from a pipeline by keeping it full of instructions, not bubbles.) Dealing dynamically with hazard conditions is the major highlight of the M1 architecture.

The X and Y pipes are not identical. Change-of-flow, floating-point, integer multiply and divide, and so-called exclusive instructions can execute in the X pipe only. Exclusive instructions are any instructions that could fault during execution, and they typically include those that make multiple memory accesses. However, such instructions can use both pipelines to fetch their operands.

The IU prefetches instructions 16 bytes per clock from the 256-byte, fully associative instruction cache and deposits them into the 16-byte prefetch buffer in the Fetch stage. The instruction cache is small, but it is more flexible than the caches many processors use because it is fully associative; any instruction can be stored at any location in the cache, not just in a certain bank based on the set associativity of the cache.

In the Fetch stage, the prefetch address is used by the BPU to predict the direction of any conditional branch instruction in the buffer. Like the Pentium, the M1 deploys dynamic branch prediction using a branch target buffer. In addition, the BPU contains a return stack, where it pushes a target address during a subroutine call and pops it at return.

From the Fetch stage, instructions move to Decode 1, two instructions per clock. Here, the processor determines the length of both instructions. The two instructions then move to Decode 2, where the integer pipeline—a single unit up to this point—splits into the X and Y pipes.

Two major events happen in Decode 2. First, the instructions are fully decoded, and their entry points into the microcode ROM determined. Second, the M1 determines the optimum pipe for the execution of each instruction. Special logic in Decode 2 "looks down" each pipe to determine whether, for instance, the instruction in the X pipe should continue in this pipe or switch to the Y pipe. This logic helps eliminate or "squash" bubbles caused by stalled instructions. For now, Cyrix will
not reveal details of this "pipeline optimization" logic.

It is also important to note what does not go on in this stage. The M1 doesn't check for dependencies between instructions. As these are handled dynamically and could in fact change due to some of the advanced techniques used in the M1, there is nothing to be gained by checking for dependencies here.

After Decode 2, an instruction passes to Address Calculation 1 where addresses for operands are calculated. Here, the process gets very interesting, because you encounter the first major departure from standard implementations of the 80x86 architecture. Unlike every other 80x86 processor, the M1 doesn’t have eight GPRs (general-purpose registers). It has 32. More important, the M1 contains a mechanism—register renaming—that allows software that only knows about eight registers to take transparent advantage of the 32 GPRs: The M1 doesn’t mess with the logical 80x86 programming model. Register renaming has a big effect on how the M1 handles pipeline hazards that can degrade the performance of your software (see "Pipeline Hazards" on page 57).

Following Address Calculation 1 comes Address Calculation 2, which actually accesses the operands, making them available to the Execute stage. After the Execute stage comes the Writeback stage, where results are written to the register file. Most of the pipeline hazards, which can stall the M1's pipelines, appear in the last three stages.

Instant Gratification

The most common hazard in pipeline processing is a RAW (read-after-write). While an RAW hazard doesn’t introduce large bubbles into a pipeline, it can have a serious effect on performance because it can occur relatively frequently. To reduce such dependencies, the M1 uses data forwarding hardware to make operands and results from executing instructions available immediately to instructions earlier in the pipeline.

Consider this RAW example: Instruction i copies a value from memory to a register. Instruction j, which follows i in the pipeline, adds the retrieved value to that stored in another register. Normally, a pipeline interlock mechanism would stall instruction j in Address Generate 2 until i completes execution and moves to the Writeback stage, where it could then write the value to the register.

But with data forwarding, the value is immediately available to j. In effect, instruction j “reads” the result of i, instead of waiting for i to write to a register and then reading the register. This forwarding technique can bypass not only register writes but also memory writes, making data available without a wait for associated memory or register updates. It can also make data from the cache available to instructions as quickly as register-resident data.

An important note about data forwarding is that it occurs across the X and Y pipes. Thus, instructions that would normally stall in a 486 or Pentium pipeline can actually execute in parallel on the M1.

Register Renaming

While data forwarding is great for dealing with RAW hazards, it doesn’t have an effect on control hazards and can actually make possible the other types of data hazards. To handle these situations, the M1 employs register renaming.

Register renaming is transparent to software. Anytime it detects that an instruction in the Address Calculation 1 stage will write a value to a register, the renaming mechanism assigns one of the 32 physical GPRs to the indicated logical register. For example, if an instruction adds a constant to a value in memory and stores the result in register AX, register renaming will assign AX to the first open physical register.

The renaming logic uses a scoreboard system to keep track of which physical registers are in use and which are free. If the next instruction again writes to AX, the M1 will assign a different physical register to handle that write. To see how this mechanism eliminates WAR (write-after-read) and WAW (write-after-write) dependencies, consider the two instructions in the table “Standard 80x86 Operations.”

Assume the two instructions issue in parallel; the first instruction to the X pipe and the second instruction to the Y pipe. Continued
Without data forwarding, this combination will result in a stall because of the existing RAW dependency on AX: The second instruction will be stuck in Address Generate 2 until the first instruction moves to Writeback.

Now, consider the situation in the table “M1 Operations,” which reflects the M1’s use of data forwarding and register renaming. Assume that initially, logical AX is assigned to physical register 0, and BX to physical register 1.

The data forwarding allows MOV and ADD to use the contents of the memory location at the same time, removing the RAW dependency noted above. The second instruction doesn’t have to wait until the first instruction writes to logical register AX before it can use the data; therefore, both instructions can issue to the execute stage at the same time.

Without register renaming, however, you get a WAW hazard when both instructions execute together, as both instructions try to write to logical AX at the same time. The register renaming mechanism removes this hazard by assigning two different physical registers to logical AX. First, in the Address Generate 2 stage of the first instruction, it assigns logical AX to register 0. In the same stage of the second instruction, it then assigns AX to register 2, the next available physical register. Thus, when the two instructions move to Writeback, they write to different physical registers, with the first instruction writing to register 0 and the second instruction writing to register 2. Internal hardware keeps track of which register contains which version of logical AX while guaranteeing register integrity.

Speculative Execution

Although it handles data hazards through register renaming, the extended register set of the M1 is perhaps of greater benefit in dealing with control hazards. These are not as frequent as data hazards, but they can exact a much bigger performance hit. A control hazard often can be cleared only by accessing the external memory system, which consumes many more cycles than a one-stage bubble introduced by an RAW hazard.

As was mentioned above, the M1 employs dynamic branch prediction to try to keep the pipelines filled whenever it encounters an unresolved conditional branch instruction. It doesn’t have to wait until a branch condition is resolved before it can continue execution. (Branch prediction is a function of Fetch, which is several stages before Execute where a condition would be evaluated.) If the BPU predicts that the branch won’t be taken, it continues prefetching the current instruction stream. If it predicts that a branch is taken, it prefetches the new instruction stream and sends these instructions to the pipeline.

The M1 is not alone in letting processing proceed before a conditional branch is evaluated, but unlike processors such as the Pentium and the PowerPC, it permits this processing to proceed through the Writeback stage. In effect, the M1 lets instructions execute speculatively while waiting for a branch to be resolved. Other processors stall the pipelines so that registers can’t be written to until the condition is resolved.

Register renaming makes speculative execution possible. The M1 contains four checkpoint registers that it uses to match registers to a particular machine state during speculative execution. For example, registers 3, 4, 5, and 6 might correspond to the prespeculative state of the machine, while 0, 1, 2, and 7 might correspond to the logical registers after a conditional branch is encountered. Once the conditional branch is resolved, the checkpoint registers let the machine reconstitute its original state if the branch prediction was incorrect. This reconstitution takes just one cycle.

The four checkpoint registers allow four levels of speculation. Thus, the M1 can continue processing even when it has four unresolved conditional branches pending. The only caveat about speculative execution is that no memory writes are allowed to proceed beyond the write buffers that are appended to the two integer and one floating-point Writeback stages. The M1 also allows floating-point instructions to execute speculatively while maintaining precise exceptions.

Floating Point and More

Unlike Intel with the Pentium, Cyrix did not devote major design or silicon resources to boosting the floating-point performance of the M1 to RISC-like levels. Given that Intel’s own instruction profiling indicates that the average 80x86 business applications suite spends less than 1 percent of its processor cycles executing in the FPU, this neglect is understandable and defensible from a marketing standpoint. With 80x86 applications, integer performance is everything. The differences between the M1 FPU and that on a 486 include a four-instruction queue preceding the FPU, a write buffer that follows it, and enhancements to many of the floating-point algorithms.

Of greater interest are the two caches. One is a unified cache that contains both instructions and data; the other is the primary instruction cache. Thus, the unified cache is both the primary data cache and the secondary instruction cache.

The instruction cache is 256 bytes long and is fully associative, eliminating the need for any table lookup to access the contents of the cache. In parallel, the prefetch address is also sent to the MMU so that if prefetch misses in the instruction cache, it can access the unified cache without additional delay. The M1 contains special logic that preserves coherency between the instruction cache and the unified cache and between both caches and the execution pipeline, to handle problems introduced by self-modifying code.

The unified cache, which is expected to
be at least as large as the combined sizes of the separate instruction and data caches on the Pentium (8 KB each), holds both data and instructions. It is four-way set-associative and uses a 32-byte line size. Being unified, it can dynamically balance the changing needs of a program for more or less cache memory of each type. Because it is a physical cache, TLB (translation look-aside buffer) lookup ends, if necessary, address translation takes place before cache lookup. On a TLB hit, data and instructions are available immediately to the execution pipelines. A TLB miss introduces a minimum three-clock latency. On a complete cache miss, of course, the processor accesses the external memory system to bring the required instructions or data into the cache.

The unified cache has two read-write ports, so it can handle two accesses per clock. It does so by dual-porting the cache tags and TLB and by interleaving the cache memory on 16-bit boundaries. This results in a 16-level interleave factor—based on the 32-byte line size—which divides the cache into 16 banks. Thus, as long as two simultaneous accesses go to different banks, they can proceed in parallel. At least some members of the M1 family will support the MESI (modified, exclusive, shared, invalid) multiprocessor cache-coherency protocol.

The BIU determines the width of the M1’s connection to the outside world, which may differ with different implementations of the architecture. Internally, data buses are 64 bits. On the instruction side, the path from the unified cache to the instruction cache is 256 bits, while that from the instruction cache to the prefetch buffer is 128 bits. GPRs and integer write buffers are 32 bits, while the floating-point buffer is 128 bit, queue, and write buffers store 64-bit entities.

**Outstanding Questions**

Four questions remain on the M1: Will it be compatible? When will it be available? How fast will it be? And how much will it cost? Bruce Burkhardt, director of strategic marketing for Cyrix, states that the architecture has proven compatible with 80x86 software in simulation testing. He feels that the company’s experience in producing 486-compatible chips—as opposed to 486 clones—has given the company the experience it needs to implement the M1 architecture.

Burkhardt expects that systems based on the M1 will be available by the end of the year. That would indicate that Cyrix expects to sample the chip in the first half of 1994 and that the company may already have first silicon. Burkhardt declined to comment on first silicon or sampling dates. Pricing is also up in the air at this time.

Regarding performance, Cyrix expects the M1 to be faster in integer operations than the Pentium at comparable clock speeds, especially when running uncompiled binaries. By way of demonstration, Cyrix points to the inner loop of the sieve benchmark program, which the Pentium processes in 34 clock cycles. The M1 architecture processes the same loop in 20 clock cycles by using data forwarding, register renaming, and pipeline optimization to significantly reduce the number of pipeline stalls. Cyrix is not claiming that the M1 will run all integer code 70 percent faster than the Pentium but the demonstration does identify how the features of the architecture can work to keep instructions flowing through the pipelines.

What the demonstration doesn’t answer is how well balanced the M1 design is. In the Pentium, Intel worked hard on increasing the I/O bandwidth of both the instruction and data side of the processor. The M1 is more focused on the internals of the processing pipeline, although, of course, Cyrix didn’t neglect I/O bandwidth issues. Only testing of a final product in a system will tell whether Cyrix has achieved that balance of processing and I/O bandwidth so necessary to a successful processor design.

Burkhardt states that the M1 is designed for speeds of 100 MHz and above. Such speeds are a competitive necessity because Intel will have high-speed Pentiums from its 0.6-micron-device factory available early this year.

The M1 is an ambitious project, one that Cyrix thinks it can pull off based on its experience producing 486-compatible processors. While it won’t be possible to judge the success of the design until it is incorporated into systems, Cyrix deserves kudos for pushing the envelope on 80x86 designs in particular, and on commercial microprocessors in general.

*Bob Ryan is a BYTE technical editor. He can be reached on the Internet or BIX at b.ryan@bix.com.*
You are witnessing the birth of a new age.
Meet the first PowerPC-based RISC System/6000.

It's more than an introduction. It's a revolution. The price/performance leader of UNIX® systems—IBM's RISC System/6000®—has joined forces with the most exciting chip ever created—the new PowerPC 601™—to create the POWERstation™ 250. The 250 sets a new standard for entry performance—and price/performance. For your business, it means answers at lightning speed, from accounting to engineering to application development. In fact, there are thousands of proven Applications for the commercial-strength AIX/6000™ operating system. We're also delivering the first complete DCE for advanced client/server solutions. And we've brought technologies like multimedia and object toolkits to the RISC domain. With Wabi™, you'll run Windows™ applications at blinding speed. Macintosh programs too. And there's more. We're also launching POWER2,™ the industry's most powerful RISC technology, in the new POWERserver™ 990—delivering unprecedented processor performance. The future will see PowerPC and POWER2 technology in everything from notebooks to supercomputers. If you're ready for a real change of pace, call 1800 IBM-6676, ext. 669 today.

Power for a new age.

RISC System/6000

<table>
<thead>
<tr>
<th></th>
<th>Price</th>
<th>SPECint92</th>
<th>Cost/SPECint92</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM 25T</td>
<td>$9,390</td>
<td>62.6</td>
<td>$150</td>
</tr>
<tr>
<td>HP715/33</td>
<td>$9,990</td>
<td>24.7</td>
<td>$404</td>
</tr>
<tr>
<td>DEC™ 300L</td>
<td>$7,920</td>
<td>45.9</td>
<td>$173</td>
</tr>
<tr>
<td>IBM 990</td>
<td>$147,800</td>
<td>126.0</td>
<td>$1,173</td>
</tr>
<tr>
<td>HP 160</td>
<td>$136,530</td>
<td>82.0</td>
<td>$1,665</td>
</tr>
<tr>
<td>DEC 4000/610</td>
<td>$131,728</td>
<td>94.6</td>
<td>$1,392</td>
</tr>
</tbody>
</table>

Circle 86 on Inquiry Card.
Next Year, Over 130 Million Software Packages Will Arrive in Corporations Worldwide. SOMEBODY BETTER KNOW WHAT THEY'RE DOING.

SOMEBODY DOES.

That Person is the BYTE Reader.
✓ An elite cadre of multiplatform technology experts.
✓ Early Adopters: 87% of whom are first to learn about and adopt new products and technologies.
✓ Influential: The average BYTE Reader influences the purchase decisions of 107 others.

As RISC moves to the mainstream, vendors are broadening their offerings to appeal to various users

BOB RYAN AND TOM THOMPSON

Ever since Sun Microsystems popularized RISC workstations in the mid-1980s, the goal of RISC chip designers has been unvarying—better performance. Having the most powerful chip on the market meant more than bragging rights; it meant sales. Portable operating systems and the explosive growth of the workstation market meant that many people bought workstations based on performance alone.

Today, the possibility of RISC making inroads into the desktop computing market has blunted the hell-bent pursuit of performance. Suddenly, price/performance, features, and ease of integration have assumed greater importance as companies such as DEC, Sun Microsystems, IBM, Motorola, and Mips go head to head with the Intel 80x86 juggernaut. Raw performance will get you only so far if it prices you out of 95 percent of the market.

The possibilities of RISC on the desktop has had a direct effect on RISC design. RISC designers are beginning to broaden their product offerings. This trend toward product-line diversification has manifested itself in a number of new chips from RISC vendors.

Alpha Attacks System Costs
In 1992, DEC entered the RISC market in a big way, with the Alpha, a 64-bit RISC architecture that the company claims will carry it well into the next century. Alpha hit the scene with a splash. At introduction, it was the world’s most powerful microprocessor, and it remains the world’s fastest single-chip microprocessor. Offered at 133, 150, and 200 MHz, the DEC-chip 21064 is ideal for high-end workstations and multiprocessors. (Alpha should retake the world’s fastest bar-none crown from the IBM Power2 later this year with the release of the DECchip 21064A, a 275-MHz implementation of the Alpha architecture.)
Integrating an Alpha core with both memory and PCI controllers yields a powerful chip that is easy and inexpensive to integrate into a system. Despite its added functionality, the DECchip 21066 requires 14 fewer pins than the 21064.

Last year, DEC introduced the first variant of the Alpha architecture. Dubbed the DECchip 21066, the chip is designed to be the centerpiece of DEC’s RISC PC strategy. It will be used in systems that run Windows NT and thus compete directly with Intel’s high-end 486 and Pentium processors.

To compete with the high-end 80x86 machines, you need more than an inexpensive chip; you need an inexpensive system. The 21066 is designed with system costs in mind. It uses the 21064 core, so it is fast. It includes a memory interface—to SRAM (static RAM), DRAM, and VRAM (video RAM)—on the chip and a PCI (Peripheral Component Interconnect) controller; therefore, it has most of the logic a systems designer requires to implement a complete system. This is important since unlike the 80x86 machines, a huge support-chip industry doesn’t exist around the Alpha architecture or any other RISC architecture.

In a further attempt to keep system costs down, the 21066’s memory interface is 64 bits wide, which is half the width of the external memory bus of the 21064. Even though this narrower bus has a negative impact on performance, it makes it simpler to design a system around the 21066.

The 21066 is manufactured using DEC’s 0.68-micron, three-layer-metal CMOS technology. The chip’s size is 209 mm², and it operates internally at 3.3 V, although it can connect seamlessly to 5-V peripherals. Initially clocked at 166 MHz, the chip will dissipate over 20 watts of power, making it unsuitable for notebook implementations. The 21066 is priced at $424 each in quantities of 1000.

Based on simulations, DEC expects about 70 SPECint92 and 105 SPECfp92 performance from the 21066, which is a bit higher than the Pentium’s 66-MHz integer performance (64.5) and nearly twice its floating-point performance. With a high degree of integration that will result in lower system cost, the 21066 will find its way into many NT servers and high-end desktops.

Integration, SPARC Style

Another company aiming to keep system costs down is Sun Microsystems, which, in conjunction with Fujitsu, has developed the MicroSparc II, a follow-on to the original MicroSparc I architecture. The MicroSparc II is an implementation of version 8 of the SPARC architecture. As such, it is compatible with the thousands of applications available for SPARC systems.

The MicroSparc II is the low end of an expanding SPARC product line. It is designed for low-cost implementations, both desktop and portable. Above MicroSparc comes SuperSparc, a superscalar SPARC implementation built by Texas Instruments for desktop systems. At the top of the line, Sun has recently announced UltraSparc, a 64-bit implementation of SPARC that Sun hopes will help the company regain some of the technical and performance luster it has lost in recent years to DEC and MIPS. Like SuperSparc and the original MicroSparc, UltraSparc is being developed in conjunction with Texas Instruments.

As with the 21066, the MicroSparc II uses a high level of integration on the processor. In addition to the CPU core, it includes a DRAM controller, a graphics system interface, and an SBus controller. The primary distinction between the MicroSparc II and the 21066 is in the choice of I/O bus. DEC chose PCI, because it wants to make inroads into industry-standard desktops; PCI is establishing itself as a high-end standard, and it can be bridged to ISA. Sun chose SBus, which is found in SPARC systems from several manufacturers.

Sun is more interested in expanding its Solaris-based business than in joining the Windows NT bandwagon. The company is supporting Intergraph’s efforts to port NT to SPARC, but it has announced no intention of offering NT on its own machines.

The MicroSparc II is built with Fujitsu’s 0.5-micron, three-level-metal CMOS technology. It is a fully static design that operates at 3.3 V internally, and, like the 21066, it can interface to 5-V peripherals. It is designed to operate between 50 and 125 MHz. It is a large chip, packing 2.3-million transistors onto a die that measures 233 mm².
The MicroSparc II is a single-issue CPU, with instructions executing in either the integer or floating-point pipelines. To help keep floating-point instructions from blocking the integer pipeline, the FPU contains a three-entry instruction queue. The FPU is IEEE 754-compliant and can execute floating-point multiply instructions in parallel with other floating-point instructions. The integer pipeline consists of five stages and is preceded by a four-entry prefetch buffer.

Besides the integrated memory and bus controllers, the biggest difference between the MicroSparc I and II is the size of their respective caches. The MicroSparc I has a 4-KB instruction cache and a 2-KB data cache, where the MicroSparc II has a 16-KB instruction cache and an 8-KB data cache. Unlike most other new RISC chips, the caches are virtually addressed, meaning that lookup occurs using the virtual address, not the physical address generated by the MMU (memory management unit). In other words, the MMU is downstream from the caches.

This method eliminates any latency the MMU introduces before cache lookup, but it does require special logic to handle coherency problems when two or more virtual addresses map to the same physical address. In fact, this arrangement is a holdover from when the SPARC architecture was implemented on several chips. Then, the penalty for going off-chip to access the MMU was too high to implement physical caches (where cache lookup occurs after address translation).

In addition to using a 3.3-V power supply, the MicroSparc II is fully static. It also uses power management to conserve power. It can cut power to the caches by 75 percent when they are not being accessed, and in standby mode, it can stop the clock to all logic blocks. At 85 MHz, it is expected to consume about 5 W.

Sun expects the MicroSparc II to power both low-cost, high-volume desktop systems and SPARC portable systems. With the highest degree of integration yet seen in a SPARC processor, the MicroSparc II should significantly reduce costs to system vendors, while making it easier for them to design a system. The chip will sell for less than $500 each in quantity.

Portable PowerPC

At the Microprocessor Forum last fall, IBM and Motorola announced that they had produced first silicon of the PowerPC 603, the second member of the PowerPC family. The goal of the PowerPC 603 is to provide high performance while consuming little power, making it ideal for notebook computer designs.

The 603 uses 3.3-V, 0.5-micron, four-level-metal static CMOS technology to pack 1.6-million transistors onto a die that's 85.1 mm². By contrast, the PowerPC 601 uses 3.6-V, 0.6-micron static CMOS technology to place 2.8-million transistors onto a die that's 132 mm². Like the 601, the 603 implements a 32-bit version of the 64-bit PowerPC architecture, with a 32-bit address bus and a 32- or 64-bit data bus. The 603 uses the same superscalar design with a three-instruction dispatch.

However, the 603 differs from the 601 in a number of areas. First, the 603 uses a Harvard architecture: It has two separate 8-KB caches, one for instructions and one for data. Each cache has its own MMU. Both caches are two-way set-associative and use a least recently used algorithm.

Next, the 603 has five independent execution units. As with the 601, the 603 has a BPU (branch-prediction unit), IU (integer unit), and FPU. However, the 603 features a new load/store unit and an SRU (system-register unit) that is used to implement dynamic power management. The load/store unit handles data transfers between the data cache and the GPRs (general-purpose registers) and FPRs (floating-point registers). The SRU executes special-purpose-register and condition-register instructions.

The 603 will be available as 66- and 80-MHz parts. Maximum power consumption should be only 3 W at 80 MHz. A variety of power-saving techniques incorporated in the design should actually enable typical power consumption to hover around 1 to 1.5 W. This compares well with popular notebook CPUs such as the Intel 486DX/33, which can dissipate up to 3.2 W. The power-saving techniques used include a PLL (phase-locked loop)
State of the Art  RISC Grows Up

RISC COMPARISON
With prices below $500, these RISC chips can compete head-on with the top end of the 80x86 line.

<table>
<thead>
<tr>
<th>Transistor Count</th>
<th>Maximum Power Dissipation (80 MHz)</th>
<th>Price (Quantity 1000)</th>
<th>Size (mm²)</th>
<th>SPECint92</th>
<th>SPECfp92</th>
<th>Operating Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECchip 21066</td>
<td>1.75 million 20+ W (166 MHz)</td>
<td>$424</td>
<td>209</td>
<td>70' (166 MHz)</td>
<td>105' (166 MHz)</td>
<td>3.3 (5-V peripherals)</td>
</tr>
<tr>
<td>PowerPC 603</td>
<td>1.6 million 3 W (80 MHz)</td>
<td>N/A</td>
<td>85' (80 MHz)</td>
<td>85 (80 MHz)</td>
<td>85 (80 MHz)</td>
<td>3.3 (5-V peripherals)</td>
</tr>
<tr>
<td>MicroSparc II</td>
<td>2.3 million 5 W (85 MHz)</td>
<td>$500</td>
<td>233</td>
<td>57.2 (85 MHz)</td>
<td>49.5 (85 MHz)</td>
<td>3.3 (5-V peripherals)</td>
</tr>
<tr>
<td>Mips/NEC R4200</td>
<td>1.3 million 2 W (40/80 MHz)</td>
<td>$75 (6000 yen)</td>
<td>81</td>
<td>55' (40/80 MHz)</td>
<td>30' (40/80 MHz)</td>
<td>3.3</td>
</tr>
</tbody>
</table>

*Based on simulations N/A = not available.

The PLL and time-base register are still active. Return to a full-power active state takes several clock cycles. In the sleep mode, the time-based register is switched off, leaving no internal units operating. External logic can disable the PLL for further power savings. This mode consumes minimum power, but it takes a number of clock cycles for the PLL to resynchronize before the processor can be placed into full-power mode.

The 603 also uses dynamic power management techniques to reduce power consumption. Dynamic power management works by switching off the clock to certain processor subsystems when they are idle. The dispatch logic monitors the instruction stream, and if a certain subsystem—say the FPU—is idle and no floating-point instructions are forthcoming, the dispatch logic has the FPU clock disabled. Conversely, if the dispatch logic detects an incoming floating-point instruction, it can enable the FPU clock before issuing the instruction to it. This also explains the two additional execution units: Both the LSU and SRU can be disabled as necessary to save power.

Either cache can be switched off if it is inactive. For example, the 603 might be constantly fetching instructions but no data, so the data cache would be powered down. The dual-cache design also requires smaller on-chip buffers and eliminates the arbitration logic required for the 601's unified cache.

Also, the cache protocol has been reduced from four states (i.e., modified, exclusive, shared, and invalid) to three states (i.e., modified, exclusive, and invalid). The cache protocol is compatible with the four-state protocol. It was anticipated that the 603 would be used for stand-alone designs, so the sharing state was removed. These changes to the overall cache design use fewer transistors, which also translates into power savings.

Preliminary SPECmarks (obtained from simulations) indicate that a 66-MHz 603
Trying to find the facts about all of the different copy protection locks on the market can be as confusing as finding a needle in a haystack.

You may think all copy protection systems are the same, but the fact is that the Hardlock™ system is outstanding in its field.

Hardlock works better than the others in securing your applications against unauthorized use because it is the only lock that uses a programmable algorithm, far more complex to decode than simply reading the contents of a memory chip. Hardlock also features selectable anti-debugging and reverse engineering protection as well as protection against hardware emulators, which no other lock has.


Hardlock is state of the art.

Call us to find out more about how Hardlock can provide your masterpiece with the security it deserves.

1-800-562-2543

GLENCO ENGINEERING INC.
SERVING THE SOFTWARE INDUSTRY SINCE 1979
Software Protection • Data Security
Phone 708-808-0300 • Fax 708-808-0313

For DOS, Windows, Windows NT, OS/2, Unix, Xenix Single User, Network, CD-ROM Applications and More
State of the Art  RISC Grows Up

Mips/NEC R4200

The R4200 integrates a complete RISC pipeline and 24-KB cache on a die 82 mm². Its low power consumption and high performance make it ideal for notebook systems.

Reduction costs, optimize profits:
With a completely new copy protection technology.
• Easy to operate.
• Program installation with C·GUARD.
• Continue working without dongle.
• No unauthorized copies.
• Ideal for laptops.

* bulk discounts:
C·GUARD when ordering 1000: US $12
C·GUARD when ordering 100: US $15

Since 1985 over 1600 customers rely on our software protection products.

Currently looking for international distributors.
Finally, a computer information service you can’t outgrow.
No matter how hard you try.

You can range widely over a wide list of services that will help you, entertain you, teach you, and challenge you. Or delve deeply into your favorite topics, learning (or even teaching) more, meeting experts, and making friends with people who share your interests.

CompuServe lets you do everything from keeping in touch with our communication services, to getting advice from online hardware and software experts. It’s the one computer information service you won’t outgrow.

But you will have a good time trying.

For a low one-time membership fee and $8.95 a month, you can use our most popular services as often as you like: news, sports, weather, shopping, reference materials, our electronic mail service of up to 60 messages a month, and more. Plus there’s a whole universe of other, extended options available at nominal additional charges. Your first month on CompuServe will be free, and we’ll give you a $25 usage credit to explore our extended services.

To buy a CompuServe Membership Kit, see your computer dealer. For more information, or to order direct, call 800 848-8199 (614 529-1349 for international inquiries).

CompuServe®
The information service you won’t outgrow.™

Circle 70 on Inquiry Card.
Can the most powerful and reliable math software really be the easiest to use?

Macsyma®
A quarter century of software development is hard to beat.
$349*
Call 1-800-macsyma for a free demo disk.

Engineers and scientists who use Macsyma consistently describe it as more powerful and more reliable than any other mathematics software. Reviewers agree that Macsyma's on-line help system is the best in the field. IEEE Spectrum calls Macsyma "a national treasure" and says: "Users with heavy mathematics needs should insist on Macsyma."

And, the most recent PC Macsyma runs fully three times as fast as earlier ones on PC Magazine's 1992 benchmark tests.

* PC version in US and Canada. Academic & quantity discounts available. Macsyma is a registered trademark of Macsyma Inc.

Macsyma Inc.
20 Academy Street
Arlington MA 02174-6436 / U.S.A.

data and instruction accesses don't result in one access being blocked while the other makes use of the MMU.

Another factor in reducing the size—and thus the cost—of the R4200 is the manufacturing process used to make it. NEC uses a 0.6-micron, three-layer-metal CMOS technology to produce the R4200. The chip operates at 3.3 V, and, unlike the 21066, requires 3.3-V peripherals. In addition, it incorporates a number of power management techniques. It can power down unused functional blocks and prevent switching in unused execution units. The chip isn't a static design, however, so you must save the state of the processor before powering down completely. NEC expects the chip to draw about 1.5 W, making it ideal for notebook and portable applications.

The R4200 stacks up quite well against both the Pentium and the high-end 486s. It provides 80 percent of the Pentium's integer performance at about 10 percent of the price. It betters the integer performance of the 486DX2, at 20 percent to 25 percent of the price. As an economical platform for NT, the R4200 will be hard to beat.

Coming of Age
The chips previously described make one thing perfectly clear: RISC is no longer a fringe technology. All the major RISC vendors offer a range of solutions with different features, performance levels, and prices. True, some architectures have only a couple of representatives, but in these cases—Alpha and PowerPC especially—the vendors are committed to providing an ever-growing choice of CPUs.

Vendors are also offering embedded solutions based on desktop CPUs. IBM has announced a family of embedded processors based on the PowerPC—the PowerPC 400 series—and Motorola is expected to do the same shortly. DEC sells an embedded version of the 21066 called the 21068. Embedded processor sales help ameliorate the design costs of desktop CPUs, letting companies like DEC and IBM compete more effectively with Intel. These developments are necessary if RISC is to garner a significant share of the desktop computing market.

Bob Ryan is a BYTE technical editor. You can contact him on the Internet or BIX at b.ryan@bix.com. Tom Thompson is a BYTE senior technical editor. You can contact him on the Internet or BIX at tom_thompson@bix.com.
POWERFUL CALCULATION.  EFFECTIVE COMMUNICATION.

The Mathematica Notebook

Add introductions, explanations, and conclusions to your computations just as you would with a word processor.

Cut, paste, or edit your calculations or formulas at any time and your answers, plots, and graphics will be re-calculated or re-graphed right in the notebook.

Solve problems with custom solutions that you create using Mathematica's high-level programming language.

You've done the work, now it's time to let everyone know. Colleagues, your manager, the department head, your own students—they all need to understand what you've put together.

Mathematica already brings today's most powerful technical computing system to your desktop. But beyond that, the Mathematica notebook enables you to communicate quickly and clearly, either electronically or on paper. As you work in Mathematica you automatically create your own notebook—an electronic Mathematica document.

Live computations, plots, animated graphics, and text that you assemble in this notebook are then easily organized in an outline format for an impressive technical report, a personal record of your work, class courseware, or even book publishing. When your work is done, simply print it out, send it over the network, or present your notebook directly from your computer.

Print your report directly from your electronic notebook, controlling font styles, font sizes, and line spacing as you wish.

Use Mathematica to get work done faster and Mathematica notebooks to make a professional impression with your results. Nothing could communicate your ideas more convincingly.

For the latest information, call:

1-800-441-MATH

U.S. Canada

Wolfram Research

Wolfram Research, Inc.
+1-217-398-0700; fax:+1-217-398-0747; email: info@wri.com
For European inquiries:
Wolfram Research Europe Ltd.
+44-(0)993-883002; fax:+44-(0)993-883003; email: info-euro@wri.com

©1992 Wolfram Research, Inc. Mathematica is a registered trademark of Wolfram Research, Inc. Mathematica is not associated with Mathematica Inc. Mathematica and Research Inc., or MathTech. Inc. All other products mentioned are trademarks of their producers.

For Macintosh Information circle 123, For IBM/Compatible Information circle 124, For UNIX Information circle 125 on Inquiry Card.
This offer really stacks up.

IBM TCP/IP is a robust implementation of this standard protocol stack. And it's the perfect building block for creating client/server environments linking a wide number of both IBM and non-IBM platforms. Now if you order before Feb. 17, 1994, you'll get the IBM TCP/IP 2.0 Base Kit for OS/2® or the IBM TCP/IP 2.1 Base Kit for DOS/Windows™ for just $150 (regular price is $230) and additional copies for $130.

The DOS/Windows Base Kit incorporates all standard applications (Telnet, Mail, FTP, LPR, SNMP) with easy-to-use GUIs. Other kits include NFS,® NETBIOS and program development support including the Windows Sockets API. The OS/2 Base Kit also offers all the standard applications as well as new features like Network News, CID support for remote installation, and Workplace Shell™ Integration. Additional kits are available for X Window System,™ DOS/Windows Sockets applications support, NFS, NETBIOS and program development support.

Power, flexibility and value. The reasons for buying IBM TCP/IP keep stacking up. So call 1 800 IBM-CALL, ext. S83, and order today! It's a smart way to spell interoperability.

Making networks work

IBM
INTEL/VLSI JOIN THE PDA FRAY

A new PDA chip set from Intel and VLSI brings the 80x86 architecture to PDAs

PAUL STATT

No matter which way you slice it, CPUs designed for desktop computers don't work in small, hand-held devices. They are too big and power hungry, require too many support chips, and in some cases, are not powerful enough for tasks such as handwriting and, eventually, speech recognition. PDAs (personal digital assistants) need highly integrated designs that make the most of the chip real estate.

The first generation of such chips exists in devices such as the Apple Newton MessagePad (the ARM610) and the Eo Personal Communicator (the Hobbit 92010). Intel, which makes most of the CPUs found in the world's desktops, stayed on the sidelines as the first wave of PDAs hit the market. However, with partner VLSI, long a maker of AT-class chip sets, Intel hopes to make up lost ground with its Polar chip set.

Computer on a Chip
Microprocessors are the heart of every personal computer, but only the heart. A PC—be it a notebook, desktop machine, or network server—requires numerous other chips to handle I/O, access SRAM (static RAM), DRAM, and VRAM (video RAM), and provide the glue logic that connects these subsystems to the CPU. In addition to the CPU, a typical desktop 486 system includes an AT-class chip set that controls memory access and interfaces with an ISA expansion bus; a secondary cache controller to buffer access to main memory; and a video controller, perhaps on a separate local bus.

The Polar chip set from VLSI and Intel provides these or comparable functions on two chips. To build a working machine, you need little more than a power supply and some DRAM. The Polar chip set is the basis of what Intel and VLSI call a mobile companion computer. Mobile companion is the Intel/VLSI name for a PDA. It reflects the company's efforts to enable...
Polar Powers PDAs

The Intel 32-bit static CPU core operates at 33-MHz and 3.3 V. It's based on the Intel 386SL.

The local-bus subsystem features an integrated 2-KB cache and write buffer.

The hardware graphics accelerator speeds the drawing of graphics primitives and performs procedures such as BitBlt, pattern fill, and expand.

The power management unit can selectively turn peripherals on or off and allocate power intelligently to them.

The nonvolatile memory controller can mix flash RAM, ROM, and SRAM as needed. It offers fast access to the local bus and can store operating system or application code.

The DRAM controller supports RAM access by the CPU, graphics accelerator, and video display, and it offers burst support for video FIFO (first-in/first-out).

The LCD interface directly to an LCD panel. The panel can have a resolution of 840 by 480 pixels with 16 gray shades.

The IPC interfaces directly to an LCD panel. The panel can have a resolution of 840 by 480 pixels with 16 gray shades.

The Polar chip set is a highly integrated solution that offers just about all the functionality you need in a PDA system.

The IPC

At the core of the Polar chip set is the Integrated Processor Controller, or IPC. Designated VLSI part number VI86C300, it is a 32-bit processor architecture with support logic packaged in a 176-pin TQFP (thin quad flat package). Among the support functions it integrates are memory management, video control, and power management. The processor core of the new chip is a fully static Intel 32-bit CPU based on the Intel 386.

One of the key differences between the IPC and the 386 is that the former includes a cache controller with an integrated 2-KB cache and a tag RAM. This cache is unified, holding both instructions and data, and write-through. While the cache is too small to put the performance of the IPC on a par with 386 desktop systems that use external caches, it does provide a performance boost of cacheless 386 systems and helps reduce contention for main memory between the processor and the graphics subsystem. The IPC reduces this contention further by using a four-entry write buffer between the cache and DRAM.

One thing to note about the IPC is that DOS-based 386 programs cannot run on the new chip. Intel states, however, that the IPC's design should make it relatively easy for programmers familiar with the 80x86 architecture to write software for mobile companion computers.

In addition to the CPU core, the IPC handles both volatile and nonvolatile memory, the latter without discrimination. There are three types of nonvolatile memory: (1) flash memory, which can be likened to a RAM disk that stays on when the machine is turned off, (2) ROM, and (3) SRAM. All three types can be used interchangeably; an application never needs to know where it gets its bits from.

The large array, nonvolatile-memory interface is tuned for high-performance XIP (execute-in-place) code, as well as for data storage. This means that you can turn off a PDA using the Polar chip set at any time and return to the same screen when you switch it back on. Separate programmability of each of four banks allows mixing of flash, ROM, and SRAM device types. Additional signals are provided for programming control and power management of advanced flash-memory devices that do not require power to maintain data in memory.

The page-mode DRAM controller supports different chip configurations—256 KB by 16 bits, 512 KB by 8 bits, 1 MB
The controller and accelerator work with Video and Power. To handle video output, the IPC integrates an HGA (hardware graphics accelerator). A 640-by-480-pixel LCD controller and its 148618-compatible real-time clock are both tightly integrated with the IPC's power management unit.

The interconnect bus is multiplexed, offering high speed coupled with a low pin count.

The dual 82C59 interrupt controllers and its 148618-compatible real-time clock are both tightly integrated with the IPC's power management unit.

The interconnect bus is multiplexed, offering high speed coupled with a low pin count.

The 16C55Q UART digitizer interface supports a separate inking plane on an LCD.

The polar chip set uses a separate ELC to support two PCMCIA 2.0 cards. The ELC is fully buffered and supports hot and cold insertions.

The dual 82C59 interrupt controllers and its 148618-compatible real-time clock are both tightly integrated with the IPC's power management unit.

The IPC is designed with low-power operation in mind. It is fabricated with a 0.8-micron, three-layer-metal CMOS process and supports 3.3- and 5-V operation. The IPC uses a fully static core that can preserve the state of the CPU even when the system clock is shut down. The IPC can generate 20-, 25-, or 33-MHz system clocks.

The IPC also contains a power management controller that is enabled by a system management interrupt and accessible via software. In addition to the simple types of on/off power management provided by hardware-based solutions used in PCs, the IPC power management system can be controlled by the operating system which can usually make better judgments about which subsystems should remain active and which can be powered down. The power management system can shut down individual subsystems on the chip. Power dissipation is estimated at just over half a watt when operating at 3.3 V.

The IPC is designed with low-power operation in mind. It is fabricated with a 0.8-micron, three-layer-metal CMOS process and supports 3.3- and 5-V operation. The IPC uses a fully static core that can preserve the state of the CPU even when the system clock is shut down. The IPC can generate 20-, 25-, or 33-MHz system clocks.

The IPC also contains a power management controller that is enabled by a system management interrupt and accessible via software. In addition to the simple types of on/off power management provided by hardware-based solutions used in PCs, the IPC power management system can be controlled by the operating system which can usually make better judgments about which subsystems should remain active and which can be powered down. The power management system can shut down individual subsystems on the chip. Power dissipation is estimated at just over half a watt when operating at 3.3 V.

The MPC

The MPC As previously mentioned, in addition to the IPC, the Polar chipset contains the MPC (VLSI part number V186C100), which is designed for standard I/O but incorporates several optimizations to better enable telecommunications. The MPC is the peripheral controller complement of the IPC. Packaged as a 100-pin TQFP, the MPC includes a serial-communications port for networking or printing, an infrared I/O port for a keyboard or remote access, and audio I/O for voice messaging, including voice storage and message forwarding. The MPC also uses analog I/O for system monitoring and control. A keyboard interface is optional, and a high-performance digitizer interface is standard.

The UART (universal asynchronous receiver/transmitter) part of the MPC is compatible with the VL16C550 standard and with its infrared I/O option, offers programmable I/O address and programmable interrupt levels. The UART may be configured to operate through a normal serial connector or through a dedicated I/O pin that connects directly to an infrared LED. This HPSIR (Hewlett-Packard Serial Infrared) interface is compatible with those found on the HP 95LX, 100LX, and OmniBook Super Portable Computers. The MPC's audio features let you store, forward, and play back recorded sounds. The chip itself has the power to work like a telephone, as well as like a fax machine or modem (with the appropriate PCMCIA cards). The ADC (A/D converter) allows for battery monitoring so that you won't waste your last amp recording a phone call.
THE AM386SC DOES DOS AND WINDOWS

To produce a device to power a PDA (personal digital assistant), Advanced Micro Devices has taken what might seem an obvious approach—integrating all the features of a PC on a single chip. The Am386SC microprocessor combines a DOS/Windows-compatible 386 microprocessor core with AT-system architecture logic and a power management unit. Unlike the Polar chip set, hand-held computers that use this chip run both Windows and DOS. An Am386SC-based PDA will be a tiny PC in size and price. The Am386SC is inexpensive—$50 each in lots of 10,000—and relatively small—a 208-pin TQFP (thin quad flat package). And it's the only logic chip a computer requires; add some DRAM, flash ROM, and perhaps some SRAM (static RAM), and you have a computer system. In a PC based on the Am386SC, you don't need a separate PCMCIA 2.0 chip, a keyboard interface, a serial- or parallel-port interface, a graphics chip, timing, or power management chips. And, most important, you don't require a 32-bit 80x86 microprocessor. All those features are built into the AMD chip.

The downside of this totally integrated solution is that not every PDA manufacturer will want every part. It's easy to imagine the desire for a separate chip for, say, pen input or voice messaging, so AMD promises to build custom designs for its volume customers. Every design will start with the 80x86 CPU at its core; AMD will be able to integrate whatever the PDA maker needs into an Am386SC.

The key feature of this chip is its greatest strength and weakness—it's a PC. The PDA market today has no standards at all; therefore, it's probably not a bad idea to build a PDA around the existing PC standard. If the PDA market grows up to be a market for smaller, less expensive versions of existing personal computers, AMD's strategy will pay off. However, if consumers start demanding new standard features from their PDAs—such as telecommunications power, pen input, handwriting, or voice recognition—PDAs based on the Am386SC will need to hang a lot of hardware on their slots simply to keep up. Those impediments may prove too great, if, and when, a PDA standard emerges.

The Am386SC is a marvel of integration.

AT on a Chip

1. The Am386SXLV core includes a system management mode that can slow the processor down to 0 MHz without losing the CPU state.
2. The power management control unit monitors all system activity and determines which of five operating modes will best conserve power.
3. The memory controller supports a high-speed 16-bit data path to DRAM or SRAM and to local-bus devices.
4. The internal LCD video controller is fully 6845-compatible and supports up to 640 by 400-pixel resolution in a single or split screen.
5. Other interfaces include two interrupt controllers, two DMA controllers, an internal timer/counter, a real-time clock, and an ISA bus controller.
6. The internal video controller supports a control palette fully 6845-compatible and supports up to 640 by 400-pixel resolution in a single or split screen.
7. The power management control unit monitors all system activity and determines which of five operating modes will best conserve power.

The Polar chip set is the first in a series of offerings from VLSI/Intel. In the works is a follow-on chip set based on an Intel 486 core. Such an offering may be a competitive necessity because other compa-
The AT&T Hobbit Enters Its Second Generation

The AT&T Hobbit chip sets betray their corporate heritage. These are chips designed first and foremost for telecommunications applications. AT&T Microelectronics first offered a set of chips for PDAs (personal digital assistants) in 1992. The 92K Hobbit family, the chips that are used in the Eo Personal Communicator, has five parts: a CPU, a system controller, a bus controller, a video-display controller, and a peripheral-bus controller.

The price seemed high at $99 for the chip set, but it was complete. Late last year, AT&T introduced two new chip sets designed to broaden the line, with trade-offs in performance, system size, cost, battery life, and feature sets.

The AT&T92020 processor provides higher performance—it uses a 6-KB prefetch buffer as opposed to the 3-KB buffer on the 92010—and requires less power than the original 92010 CPU. It also works with all the existing 92010 support chips except for the ISA controller. ISA support doesn’t figure very highly in the new Hobbit offerings.

On the other hand, the AT&T92020M performs and uses power like the original AT&T92010, but it works with a new pair of support chips, a system manager and a video controller, for more integrated performance with a lower chip count. The most highly integrated solution is the AT&T92020MX, which needs only a single support chip—a system controller. Both the 92020M and the 92020MX use a multiplexed address and data bus to lower their pin count.

All the members of the Hobbit family operate at 3.3 V. The Hobbit architecture grew out of research by Bell Labs into processor architectures designed to run C programs as quickly as possible. Hobbit processors use high-speed context switching and interrupt response to support the unique needs of PDAs running multiple applications and telecommunications.

Hobbit chip sets are designed to support the advanced communications features that you’ll probably come to expect of a PDA. For example, support for AT&T’s reprogrammable multimedia DSPs (digital signal processors) is built in, as is support for AT&T’s DSP-based 3.3-V 32-bit PCMCIA data pump, which, in turn, can support a high-speed fax or modem, two-way paging, or cellular connections.

AT&T is betting that the PDA future will look more like a telephone with a computer in it, and less like a small computer that can also fax and talk. It’s a compelling bet, if only because the public is accustomed to small portable telephones and big stationary computers.

AT&T 92K Hobbit Family Processors
With the three 9220 processors, AT&T offers a wide range of solutions to PDA OEMs.

<table>
<thead>
<tr>
<th>CHIP SET</th>
<th>AT&amp;T92010</th>
<th>AT&amp;T92020</th>
<th>AT&amp;T92020M</th>
<th>AT&amp;T92020MX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$99</td>
<td>$152</td>
<td>$111</td>
<td>$78</td>
</tr>
<tr>
<td>Architectural enhancements</td>
<td>None</td>
<td>Wait for Interrupt</td>
<td>Wait for Interrupt</td>
<td>Wait for Interrupt</td>
</tr>
<tr>
<td>Performance</td>
<td>1.5 MIPS</td>
<td>16.0 MIPS</td>
<td>13.5 MIPS</td>
<td>11.5 MIPS</td>
</tr>
<tr>
<td>Performance/power</td>
<td>54 MIPS/MB</td>
<td>76 MIPS/MB</td>
<td>54 MIPS/MB</td>
<td>40 MIPS/MB</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>250 mW (typical)</td>
<td>210 mW (typical)</td>
<td>250 mW (typical)</td>
<td>290 mW (typical)</td>
</tr>
<tr>
<td>Display type</td>
<td>LCD/CRT (92014)</td>
<td>LCD/CRT (92014)</td>
<td>LCD/CRT (92024M)</td>
<td>LCD</td>
</tr>
<tr>
<td>Maximum resolution</td>
<td>640 by 800</td>
<td>1024 by 768</td>
<td>1024 by 768</td>
<td>840 by 480</td>
</tr>
<tr>
<td>Gray levels</td>
<td>256</td>
<td>256</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>PCMCIA slots</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>P-ISA slots</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

* Support chip that supplies the indicated function

Advanced RISC Machines, for example, recently introduced the ARM7DM, its second-generation processor for the Apple Newton. The ARM7DM fixes two shortcomings of the ARM610 used in the current Newton MessagePads; it operates at 3.3 V as opposed to 5 V, and it uses a fully static design. Both characteristics are essential in PDA-class processors. Also, AT&T has recently introduced new versions of its Hobbit chips (see the text box "The AT&T Hobbit Enters Its Second Generation").

Another company with a recent PDA chip is AMD, which has preserved DOS compatibility with its Am386SC (see the text box "The Am386SC Does DOS and Windows" on page 104). Whether DOS proves to be a plus or a minus on such systems remains to be seen.

Speculating about the future of these new, highly integrated chips and devices is an irresistible temptation. Recall that the original microprocessor—the Intel 4004—was not designed with personal computers in mind; nobody had ever heard of such things. The microprocessor, conceived as an inexpensive industrial controller, has managed to replace large expensive, centralize computers with something quite different. The small, fast, and inexpensive PDA chip sets may similarly evolve into something—or end up in a machine—unlike anything its creators ever imagined.

Paul Stott is a freelance technology writer who has been covering the computer industry for 10 years. You can reach him on the Internet at stott@aaol.com or on BIX to “editors.”
Now C++ programmers can discover the DBMS power of dBASE, FoxPro & Clipper.

Not only is the new CodeBase++ 5.0 100% compatible with the data, index and memo files of dBASE®, FoxPro® and Clipper®, you also get all the important benefits of programming in C++.

You get C++ speed and size. Most developers are familiar with the amazing speed and compact size of C and C++ programs. Now harness this speed for your own database programs. Compare the performance with those "executables" of dBASE, FoxPro, Clipper (which contain imbedded interpreters) to those of similar C and C++ programs. Also, be sure to compare the size of their EXE's to those created with CodeBase++ (which are as small as 45K!).

You get object oriented programs. CodeBase++ 5.0 is a C++ class library for database management. Now you can experience the object oriented productivity gains of C++, together with the power of a complete DBMS.

You get multi-user sharing with dBASE, FoxPro and Clipper. Now your multi-user C++ programs can share data, index and memo files at the same time as concurrently running FoxPro, Clipper and dBASE programs. Turbo-charge critical xBase applications sharing data on a network with C++ and CodeBase++ with no incompatibilities.

NEW - You get xBase queries and relations with instant results.
We've added Bit Optimization Query Technology to CodeBase++ for stunning query performance (BOT is similar to FoxPro's Rushmore). Our product analyzes your queries using index information, so a record is only actually retrieved when it belongs in your query solution set.

With CodeBase++ you can literally query a huge 500,000 record data file in less than a second on a 25MHz 80386!

You get C++ portability. As with C, ANSI C++ is an international standard across all hardware platforms. This means you can port CodeBase++ applications between DOS, Windows, NT, OS/2, Unix, and Macintosh—today.

NEW - You get code generation. Save hours of coding time with our automatic source code generation, containing all of the specialized class definitions needed to support your data structures.

NEW - You get code generation. Save hours of coding time with our automatic source code generation, containing all of the specialized class definitions needed to support your data structures.

Using our visual report writer is easy, simply draw your report, then include it in any program you write.

PLUS - You get CodeReporter FREE! Our visual report writer, CodeReporter, uses the speed of BOT to run reports lightning fast. To test this amazing performance yourself, call: 403/437-2410 for your free working model.

CodeBase++ 5.0
The C++ Class Library for Database Management

Call Now
403-437-2410

TRY OUR
C, BASIC AND PASCAL
VERSIONS!

©1993 Sequiter Software Inc. All rights reserved. CodeBase++ is a trademark of Sequiter Software Inc.
All other product names mentioned herein are trademarks of their respective companies.

Circle 110 on Inquiry Card.
One of the most challenging feats for any desktop computer is the successful display of digital-video images from sources such as CD-ROM, the airwaves, or a LAN-based video conference. Full-motion video leaves no room for pauses or glaring errors. An operating system may take a few seconds to start up a program or write out a file to disk, but full-motion video needs to hit the screen 30 frames per second, every second.

The newest entry in the mad dash for digital video is a scheme by C-Cube Microsystems (Milpitas, CA) dubbed VideoRISC Compression Architecture. The heart of VideoRISC is the VideoRISC Compression Processor, or VCP. It can compress and decompress video signals fast enough for you to enjoy full-screen, real-time video on your computer. Before, you had to rely on expensive, dedicated hardware for this level of video quality or sacrifice resolution, the number of colors, or the frame rate. Most likely, you'd compromise on all three.

The VCP will allow vendors to scale both the capability and the price of video hardware. For example, it will allow easier implementation of videoconferencing at the high end. At the low end, it will allow CD-ROM drives to display high-quality animations in real time, a feat that their limited bandwidth makes impossible while using uncompressed video. (At 640-by 480-pixel resolution and 24 bits per pixel, you require a bandwidth of over 27 MBps to handle real-time video. Double-speed CD-ROM players deliver 300 KBps.)

But effective video compression has many other applications as well. With VCP, cable companies can fit 50 times as many channels on their digital networks. Satellites can handle 50 times as many signals. The market for other machines, such as boxes that decompress video signals from your cable company, could be substantially larger. Given the potential size of these markets, it is quite possible that the
YCP could become more important than microprocessors such as the 486.

**Starting with Standards**

The most popular method for compressing video signals is MPEG, a derivation of the popular JPEG standard used to compress and decompress still images. MPEG 1 handles SIF (source input format) resolution signals of 360 by 240 pixels, while MPEG 2 handles broadcast-quality 720 by 480-pixel signals. When linked in parallel, VCPs can encode such signals in real time. It takes two VCPs to encode real-time MPEG 1, eight to encode MPEG 2.

MPEG compresses consecutive frames by making the first frame a reference frame. It then finds the difference between this frame and the rest of the frames and compresses this difference.

MPEG computes the difference by breaking the frame into 8- by 8-pixel blocks and searching for the best match for these pixels in the reference frame. It compresses the difference using a technique called DCT (Discrete Cosine Transform), which is similar to the one used in JPEG. Once computed, the coefficients are then Huffman-coded to produce the final signal that is often one-tenth to one-twentieth the size of the original.

MPEG includes several important functions that are difficult to implement on a general-purpose CPU. When each 8- by 8-pixel block is compared to the reference frame, the best match may not be in the corresponding location, because objects often move across the screen. To get high-compression ratios, MPEG needs to take advantage of this redundant data even though it has moved in relation to the reference frame. It uses a computationally intensive search procedure to find such redundancies. Unlike general-purpose CPUs, the VCP has a special functional unit devoted to this search. It also has a functional unit dedicated to the Huffman coding that forms the last step in the MPEG algorithm.

**Chip Basics**

At the core of the VCP is a RISC microprocessor that runs a small, embedded operating system. Even though you could run many different jobs on this processor (including most software for basic machines), the structure is tuned to the MPEG algorithms.

The internal architecture of the RISC core is similar in some respects to that of many of the DSPs (digital signal processors) on the market. DSPs are popular for sound processing—which is like video processing, an analog encoding/decoding chore—so the similarity should not be surprising. The Fourier transform that DSPs use to generate reverberation or other sonic novelties is similar to DCT.

The VCP chip can function as both a general CPU and a DSP at the same time. The backbone of the chip is the processing pipeline, which forks where the processing path splits into a RISC half and a DSP half. All instructions are preprocessed in a similar way in the first part of the pipeline. After the split, however, standard arithmetic instructions flow down one fork, while DSP-specific instructions flow down the other.

The four initial stages that process all instructions include Fetch 1, where the instruction is retrieved from the cache; Fetch/Read/Decode, where the operands from the registers are retrieved and the
cause splitting the two 32-bit quantities is an integral part of the OCT. A more complicated DSP instruction moves from the Execute stage to the DSP fork of the pipeline, which uses three stages to complete the instructions.

The branch of the pipeline used for the complicated instructions is where most of the VCP's power lies. The canonical DSP instruction, the MAC (multiply/accumulator) instruction, is where two numbers are multiplied together and added to an accumulator register. MAC operations are frequently used in signal processing, and DSP designers concentrate on making them as fast as possible. In many cases, the small, tight loops of DSP programs repeat MAC codes many times to find a large sum. The VCP is optimized for these computations.

In addition to optimizing a MAC instruction, the VideoRISC includes many functions not found in general-purpose DSP chips, which are required by the MPEG algorithms. For example, one command computes the spatial frequency of 8 bytes by finding the sum of the squares of the differences between pairs of the bytes. This is an integral part of the DCT. A normal processor would be slowed down because splitting the two 32-bit quantities that the memory systems delivers would probably take the same amount of time as the actual computation.

Another set of instructions averages two different 32-bit quantities in a variety of ways. One instruction will find the average of two 32-bit numbers; another will split the 32-bit words into half-words and find the average of four 16-bit numbers; and a third will average the 8 bytes. All these extra instructions prove to be very useful in computing the DCT.

Although the VCP has many complex computational instructions, it still qualifies as a RISC core because the extra instructions can only access the registers. They can't load information directly from the memory for their operation. This means that a compiler (or the machine-language programmer) can still rearrange the loads and the computations so that there are a minimum of conflicts.

The Motion Estimator

Estimating motion, or changes, from frame to frame is one of the most common bottlenecks in the MPEG compression routines. The algorithm looks for sections of the screen that move from one position to another between frames. This small amount of motion is present whenever a camera pans across a scene or when a person or object moves across the background.

The motion estimator is essentially another processor that runs on its own. Its basic function is to take a rectangle of pixels in one frame of the video and compare it to a reference frame to find the change in horizontal and vertical position that will make the best match. The quality of the match is judged by positioning the rectangle over each possible displacement in the reference frame and summing the differences between the pixels that overlap. If an exact match is found, there will be no difference between the source pixels and the ones in the reference frame, and the sum will be zero.

The programmer can set the range of this search procedure to a flexible area of the reference frame. The chip can also calculate the best displacement in half-pixel increments, because it has the ability to interpolate between neighboring frames.

Once the motion estimator receives the coordinates of the two frames and their location in memory, it finds the best displacement estimation. When done, it will raise an interrupt, and the main CPU will be able to get the right solution from the register. The half-pixel interpolation is done in a special part of the motion estimator, not with the averaging functions in the main CPU.

To overcome performance bottlenecks involved in accessing main memory, the motion estimator has its own memory that holds a 16- by 32-pixel subset of the reference frame and a 32- by 8-pixel subset of the frame being compared. The MPEG algorithm itself compares 8- by 8-pixel blocks of data to all possible displacements in a 40- by 24-pixel block of the reference frame. To implement this function, the VCP performs a number of comparisons concurrently. It loads four blocks of the frame being processed into the 32-by 8-pixel memory and eight blocks of...
the reference frame into the 16- by 32-pixel memory. The four blocks are then compared against the reference frame memory, and the best result is stored in a register.

The search then proceeds as the VCP loads in a new 16- by 32-pixel block of the reference frame and compares the four blocks to this block from the reference frame. If any of the blocks find a better match in this region, the better displacement vectors replace the ones currently in the registers. Half of this block (8 by 32 pixels) is a duplicate of the last block from the reference frame, because the best alignment might lie across the boundary. This process is repeated twice more. At this time, the registers hold the best motion displacement estimate for all four blocks. The motion estimator now generates an interrupt for the main processor.

Although the process of doing four searches simultaneously might seem a bit strange, the design optimizes the memory-access strategy. Loading the reference block into on-chip memory makes access fast. This is important, because many parts of the reference block will be compared to all 64 pixels in each 8- by 8-pixel block. Loading four 8- by 8-pixel blocks at once makes sense, because many of these pixels will also be compared against all 64 pixels in each of the four blocks.

How important is the motion estimator? Steve Purcell, C-Cube Fellow and the chief architect of the chip, says that it would take about 2000 MIPS of processing power to duplicate the work done by the motion estimator, roughly the cumulative might of 18 Intel Pentium processors. This is because the chip is able to chain together the work of 32 logical units that are doing part of each comparison in parallel. The computational work is so regular that it is easy to do in parallel.

After motion estimation is complete, the VCP uses special functional units for processing the last layer of encoding. In this layer, the 64 coefficients computed for each frame of the DCT must be compressed one last time by using a variable-length encoding scheme. This method gives common values short vectors and rare values the longer ones. The net effect is that the entire transmission shrinks in size.

The Final Results

The VCP has two functional units for handling this process, one for compression and the other for decompression. Both act as smart buffers that hold all the incoming and outgoing data until it is needed and then transform it while it is waiting. The incoming buffer, for instance, waits until it has the coefficients for an entire frame before passing them on to the main CPU, which assembles the digitized image.

The main CPU could compute this information. Most of the standard compression programs for PCs will use some form of Huffman encoding from time to time, but it is inefficient to do this 1 bit at a time. Most machines are not successful at writing variable word lengths because they are optimized to load values aligned on word boundaries in standard, 16- or 32-bit sizes. As before, the standard processors are optimized for standard word sizes—not variable bits—and these differences are significant enough to merit the additional functional units.

The Memory Hierarchy

Most processing chips focus their attention on one stream of instructions that must be done in sequential order. In contrast, the work going on in the center of the VCP is more like a three-ring circus: Different functional units on the chip need to access both the main DRAM holding the images and the video I/O streams. The memory hierarchy is tuned to make it easier for the chip to bring information on and off the chip successfully.

Like most general-purpose CPUs, the VCP uses caching to speed up memory access. It uses an instruction cache and a data cache to handle instruction and data flow to the CPU pipeline. The data flowing in and out of the variable-size compressor and decompressor bypasses this cache, because it is unlikely that any of this information will be used again. Putting the cache between these units and
The only Windows™ statistics package you'll ever need.

#1 for DOS and Windows
Rated “the best general-purpose statistics program” for the PC by Software Digest®. SYSTAT for DOS is now joined by SYSTAT for Windows. This addition to the SYSTAT family takes full advantage of Windows, with pull-down menus, dialog boxes, sizable windows, and the ease of use you expect in a Windows package.

SYSTAT for Windows runs in standard and 386 enhanced modes and can take advantage of Windows advanced memory management. No matter how large or complex your analysis is, you can use SYSTAT.

SYSTAT delivers a balance of power and simplicity. It lets you analyze and manipulate data with a comprehensive range of advanced statistical procedures, and present your results with stunning graphics.

Just point and click
SYSTAT is a full-fledged Windows application. Just point and click. SYSTAT’s QuickStat™ buttons give you simple, single-click shortcuts to common statistical analyses.

More statistics, from the basic to the most sophisticated
A full range of univariate and multivariate statistics—from t tests to multidimensional scaling. With a few clicks you can turn most statistics into graphs and perform:
- multiway crosstabs with log linear modeling
- nonparametric statistics
- principal components and factor analysis
- cluster analysis
- time series
- nonlinear estimation
- correlation matrices
- means, effect, and dummy models
- post hoc tests

SYSTAT offers the most advanced multivariate general linear model available for Windows.

The most graphics
No other statistical or graphics package can produce all the scientific and technical graphs that SYSTAT can—nor surpass its ease of use. Graphics capabilities include:
- histograms
- single, multiple, stacked, and range bar graphs
- single and grouped box plots
- stem-and-leaf diagrams
- pie charts
- scatterplot matrices
- 3-D data and function plots
- contour plots
- control charts
- maps with geographic projections
- Chernoff faces
- complete color spectrum
- log and power scales
- confidence intervals and ellipses
- linear, quadratic, step, spline, polynomial, LOWESS, exponential, and log smoothing

"SYSTAT (for Windows) - with its superb graphics, high-quality statistical algorithms, and reasonable price - is an excellent choice." PC Magazine

For more information, special offers for current users, and demo disks, call:
708-864-5670
For Windows circle 114,
For IBM/DOS circle 115.

main memory would just fill the cache with nonreusable data and add complexity to the cache circuitry.

Splitting off this data stream also allows the cache to be much more efficient. The VCP cache achieves hit rates of nearly 100 percent, because the programmer can anticipate the needs of the program perfectly. In many cases, the programmer can request data almost 100 cycles before it is needed to give the memory system ample time to fulfill the request.

The memory-access circuitry is also flexible enough to access images stored in different formats. For instance, it is common to store a bit map in row-major order, where each 32-bit word contains 4 bytes that are next to each other on the same row. The VCP, however, often converts bit maps into a format that stores 4 bytes from a 2- by 2-byte grid into one 32-bit word. Some of the special CPU instructions for computing statistics such as spatial frequency use this format. The memory circuitry is designed to read and write blocks of data in either format, so it is possible to import data in row-major order, operate on it in 2- by 2-byte block format, and then rewrite it out in row-major order without doing complicated rewriting. The CPU doesn’t need to worry about this, because the memory hardware automatically rearranges the bytes.

Toward Tomorrow
In recent years, the relentless speed improvements of general-purpose RISC chips have made many special-purpose hardware implementations obsolete. The high cost of developing hardware with only a limited market could rarely compete with the ease of using RISC chips developed for larger markets. Video compression and decompression, though, require so many complicated instructions that it is often impossible to do the job in real time without a $100,000 machine.

The VCP represents an excellent fusion of specialized hardware and the ability to perform general mathematical functions. The designers deliberately left extra programmability in each of the functional units to match different MPEG implementations. Because MPEG is not completely specified—it is a combination of a set of guidelines and a final format—it is entirely possible that the MPEG compressors from different companies will generate output with different qualities. Everyone is free to implement the encoding algorithms differently. For instance, the VCP lets you limit the motion estimator to 8- by 8-pixel blocks, because many MPEG implementations work at this level.

This flexibility is important. For example, it lets some companies use a less complicated compression algorithm that is easier for a general-purpose processor to decompress. The algorithm would still need the power of the VCP and its multiple functional units for compression, but it wouldn’t need the VCP for decompression. This lets companies offer video systems at different capabilities and price points. That, in turn, hastens the day when video will become a common data format on your system.

Peter Wayner is a BYTE consulting editor. You can reach him on the Internet at pw@access.digex.com or on BIX as “pwaner.”

---

Introducing the $139 investment no computer user can afford to be without...

"Don’t take chances... Get the ultimate protection: Back-UPS from APC."

 APC Back-UPS provide instantaneous battery power during power disturbances, so your data and hardware are safe!

Back-UPS 250

PC World Top 20 Upgrade

Blackouts, brownouts, sags... if you use computers, your bottom line is directly linked to your power line. The fact is, your data and hardware are vulnerable to problems that surge suppressors and power directors just aren’t equipped to handle.

Now there’s an Uninterruptible Power Supply (UPS) to suit any budget. Back-UPS® are perfect protection for LAN servers, personal computers, phone/fax systems, POS equipment, or any other device that can go down when the power does. If lightning is a concern, Back-UPS are even backed by a $25,000 insurance policy against surge damage to your equipment (see details).

So don’t wait for the inevitable power problem to rob your business. Protect your productivity with Back-UPS available where quality computer products are sold.

APC Back-UPS provide instantaneous battery power during power disturbances, so your data and hardware are safe!

 APC Back-UPS are perfect protection for LAN servers, personal computers, phone/fax systems, POS equipment, or any other device that can go down when the power does. If lightning is a concern, Back-UPS are even backed by a $25,000 insurance policy against surge damage to your equipment (see details).

So don’t wait for the inevitable power problem to rob your business. Protect your productivity with Back-UPS available where quality computer products are sold.

APC Back-UPS provide instantaneous battery power during power disturbances, so your data and hardware are safe!

800-800-4APC, dept. A2

Makes a great Christmas gift!
ADVANCED OPERATING SYSTEMS

A look inside the next generation of computing environments, including IBM's Workplace OS, Microsoft's NT, and software from Novell/USL, Sun, Next, and Taligent.

MICROKERNELS
Small Kernels Hit it Big ....... Page 119
Microkernels are the core of new operating systems, but the implementations vary.

Objects on the March ....... Page 139
Object-oriented operating systems will benefit programmers and users alike, as well as pave the road to distributed computing.

PERSONALITIES
Personality Plus .......... Page 155
How the Workplace OS and NT implement emulation, plus a look at Wabi, SoftWindows, and Equal.

AIX SystemView
NetView/6000 V2

NetView®/6000 Version 2 from IBM Networking Systems offers a greater range of management functionality, has an end user interface that keeps things simple, and incorporates OSF™/DME standards. It's a UNIX®-based management platform that runs on RISC System/6000® workstations with IBM's
open AIX/6000™ operating system. And it installs with just 6 clicks of a mouse. Now that’s control.

It’s also just the beginning. NetView/6000 offers open topology and dynamic discovery for the automatic mapping of both IP and non-IP devices. It can natively manage SNMP, CMIP and other protocols. And it provides an easy way to set thresholds, establish filters and automate responses to events. It even collects performance data so you can analyze overall network productivity and implement preventive maintenance. That’s control with power.

And speaking of power, IBM supports NetView/6000 with powerful applications like System Monitor/6000 for distributed management and Trouble Ticket/6000 for extensive problem management. For small businesses or remote branches with 32 nodes or less, NetView/6000 Entry is an effective, low-cost solution. And NetView Service Point offers two-way communications with NetView on the host. That’s control with power and flexibility.

For enhanced support and customization, IBM has established the NetView/6000 Association. This impressive list of leading hardware and software developers continually adds to the growing number of robust solutions that are rapidly helping NetView/6000 emerge as the management platform of the future. That’s control with power, flexibility and support.

These days, it’s manage or be managed. Control or be controlled. NetView/6000 provides an unsurpassed combination of superior functionality and open architecture. It’s a solution so sophisticated and flexible that it can manage not only your heterogeneous network, but itself as well. And that means you can take control of your own destiny.

Obviously, we can hardly control our enthusiasm.

To order or for more information about NetView/6000, call 1 800 IBM-CALL, ext. 117.

NetView/6000. It may well be the perfect way to resolve all of your control issues.

IBM, AIX, NetView and RISC System/6000 are registered trademarks and SystemView and AIX/6000 are trademarks of International Business Machines Corporation. UNIX is a registered trademark of UNIX System Laboratories, Inc. OSF is a trademark of The Open Software Foundation, Inc. ©1993 IBM Corp.
Talk to someone who actually owns an ALR EVOLUTION V, and you'll no doubt hear them echo the words of *Info World*. From designers to MIS directors, the EVOLUTION V family of Pentium Technology based systems has proved to be an instant favorite among users. And if you take a look at all the awards and reviews these systems have already received, it's pretty clear that the PC industry press couldn't agree more. Backed by the industry's first leading warranty, the EVOLUTION V family and entire ALR product line deliver an unbeatable combination of performance, service, and value. So call ALR today, and stop missing out.

**True 64-bit Pentium Technology starting as low as $2495**

"Evolution V is Pentium PC you can't afford to miss"

Some systems shown with optional monitors. Prices, specifications and configurations are subject to change without notice. Verify competitive pricing with manufacturer. Prices based on U.S. dollars. ALR is a registered trademark of Advanced Logic Research, Inc. Intel Inside and Pentium Processor logo are trademarks of Intel Corporation. All other brand and product names are trademarks or registered trademarks of their respective owners. ©1993 by Advanced Logic Research, Inc.

Circle 240 on Inquiry Card (RESELLERS: 241).
The Great OS Debate

Since the dawn of microcomputing, users and developers have jousted with one another to defend the honor of their chosen operating systems. The battle still rages; the dust hasn’t even begun to settle. New contenders will exploit mainstream RISC workstations built around MIPS, Alpha, and PowerPC processors even as they ride the Intel performance escalator. But the grounds of the operating-system debate are subtly shifting. Microsoft, IBM, USL (Unix Systems Laboratories), Sun Microsystems, and others are rapidly converging on a set of common design themes—microkernels, objects, and personalities. The battle is no longer about whether to layer object-oriented services and emulation sub-systems (i.e., personalities) on a small kernel. Everyone’s doing that. The question isn’t whether to build an operating system in this style but how to do the job right. — Jon Udell, Senior Technical Editor

MICROKERNELS

In Windows NT, layered subsystems communicate by passing messages through a microkernel. But NT doesn’t follow the pure microkernel doctrine, which holds that all nonessential services should run in the processor’s nonprivileged (user) mode. IBM, USL, and others say that NT’s executive, a layer above the NT microkernel that runs security, I/O, and other services in privileged (kernel) mode, compromises NT’s claim to be a microkernel-based system. Microsoft, however, notes that NT’s privileged-mode executive subsystems communicate with each other and with the kernel by passing messages, just as its user-mode emulation subsystems do.

IBM’s Mach-based Workplace OS, meanwhile, will adhere to the pure microkernel doctrine, relegating the pager, the scheduler, the security system, the file systems, and even major parts of its device drivers to user mode. With this approach, says IBM, its microkernel will be especially valuable as a base that OEMs can customize for specific purposes. USL, however, says that its Chorus microkernel, which can run services in kernel mode or user mode, gives the best of both worlds. It can locate services in kernel mode for performance or in user mode for flexibility.

In “Small Kernels Hit It Big,” Peter D. Vahel explores these and other issues across a range of microkernel-based systems. And in “The Chorus Microkernel,” Dick Pountain takes a close look at the advanced technology chosen by USL as the foundation for future Unixes.

OBJECTS

As applications supporting Microsoft’s OLE 2.0 begin to roll out, mainstream users are getting a glimpse of an object-oriented, document-centered style of computing in which applications function as components. Apple, IBM, and partners are countering with OpenDoc, a portable compound-document standard that will bring OLE-like benefits to a broader range of platforms than are supported by OLE. Apple says that OpenDoc’s object technology, which relies on IBM’s groundbreaking System Object Model, or SOM, offers developers and users the full power of object-oriented programming—including inheritance—while remaining language-neutral. Microsoft says that OLE 2.0’s Compound Object Model, which is closely aligned with C++ yet does not support inheritance, will nevertheless yield better results by requiring developers to articulate interfaces precisely and consistently.

On the horizon looms Taligent, an objects-from-the-ground-up system that IBM and Apple say will redefine computing. Meanwhile NextStep, available now on Intel and Motorola platforms, delivers the distributed-object technology that the others are all still talking about. In “Objects on the March,” Peter Wayne explores some of the key issues in object and distributed-object computing.

PERSONALITIES

But will it run 1-2-3? For the new breed of operating systems, the answer is almost certainly yes, even on non-Intel hardware, thanks to a hybrid emulation strategy that offsets the inherent inefficiency of pure processor emulation by implementing GUI libraries in native RISC code. Applications lean heavily on GUI libraries nowadays; Windows and Mac libraries are appearing as “personalities” on a variety of new operating systems.

In “Personality Plus,” Frank Hayes investigates how Microsoft’s Windows NT and IBM’s Workplace OS implement personalities. Frank also explores popular third-party solutions like Sun’s Wabi (Windows Application Binary Interface), Insignia Solutions’ SoftWindows, as well as Quorum Software Systems’ Equal.
Welcome to the NEW communication generation

Complete access to the Internet—the data superhighway connecting 15 million people worldwide.

- Local dialup numbers worldwide
- Electronic mail
- Private and public file areas
- Financial services
  End of day market reports and financial news, Electronic periodicals
- MBS bank liquidations and repossessions inventories
- Business to business Floppy Pages directory of services

- Periodicals
  Including
  BBS Callers Digest, 10 Percent, USA Today
- Shopping
  Shocking Gray and other electronic catalogues, Debsco Membership Warehouse
- Home
  Kacera Industries do-it-yourself forum
- Travel
  Travel 'Tainment services
- Sports
  Live sports updates throughout the day

- International forums on health, politics, social issues
- Thousands of shareware files
- Interactive games
- Live real-time chat
  One on one or in a meeting room
- Trade Exchange
  Barter forum
- Real estate
  Shop for a home by viewing full-color photographs, qualify for a mortgage, shop insurance rates

One Corporate Drive • Clearwater, Florida 34622
To activate your membership:
800-736-0122

Circle 275 on Inquiry Card (RESELLERS: 276).
A microkernel is a tiny operating-system core that provides the foundation for modular, portable extensions. Every next-generation operating system will have one. However, there's plenty of disagreement about how to organize operating-system services relative to the microkernel. Questions include how to design device drivers to get the best performance while abstracting their functions from the hardware, whether to run nonkernel operations in kernel or user space, and whether to keep existing subsystem code (e.g., a legacy version of Unix) or to throw everything away and start from scratch. IBM, Microsoft, and Novell’s Unix Systems Laboratories answer these questions differently; each company has strong opinions about how and why its approach will work best.

It was the Next computer’s use of Mach that introduced many of us to the notion of a microkernel. In theory, its small privileged core, surrounded by user-mode services, would deliver unprecedented modularity and flexibility. In practice, that benefit was somewhat obscured by the monolithic BSD 4.3 operating-system server that Next wrapped around Mach. However, Mach did enable Next to supply message-passing and object-oriented services that manifest themselves to the end user as an elegant user interface with graphical support for network setup, system administration, and software development.

Then came Microsoft’s Windows NT, which touted not only modularity but also portability as a key benefit of the microkernel approach. NT was built to run on Intel-, Mips-, and Alpha-based systems (and others to follow) configured with one or more processors. Because NT would have to run programs originally written for DOS, Windows, OS/2, and Posix-compliant systems, Microsoft exploited the modularity inherent in the microkernel approach by structuring NT so that it did not architecturally resemble any existing operating system. Instead, NT would support each layered operating system as a separate module or subsystem.

More recently microkernel architectures have been announced by Novell/USL, the Open Software Foundation, IBM, Apple, and others. One prime NT competitor in the microkernel arena is Carnegie Mellon University’s Mach 3.0, which both IBM and OSF have undertaken to commercialize. (Next still uses Mach 2.5 as the basis of NextStep, but it is looking closely at Mach 3.0.) Another is Chorus 3.0 from Chorus Systems, which USL has chosen as the foundation of its Unix offering (see “The Chorus Microkernel” on page 131). Sun’s SpringOS, an object-oriented successor to Solaris, will use a microkernel, and the Taligent Operating Environment will rely on the same microkernel that IBM is developing for its Workplace OS. Clearly, there’s a trend away from monolithic systems and toward the small-kernel approach. That’s no surprise to QNX Software Systems and Unisys, two companies that have for years offered successful microkernel-based operating systems. QNX Software’s QNX serves the real-time market, and Unisys’ CTOS is strong in branch banking. Both systems exploit the modularity enabled by a microkernel foundation with excellent results.

Fueling the current microkernel frenzy is the recent fragmentation of the operating-system market. With no one vendor a clear winner in the operating-system sweepstakes, each needs to be able to support the others’ applications. AT&T tried this tack a few years ago with Unix System V release 4.0, by including support for the Berkeley
and Xenix extensions. But while SVR4 has done well enough, it hasn't been the grand unification of Unix for which AT&T (now Novell's USL) had hoped. On the other hand, Microsoft's NT seems to have succeeded—at least in this respect—by being the first to unify multiple subsystems capable of running Win32, Win16, DOS, OS/2, and Posix applications. IBM is responding with a portable successor to OS/2, the Workplace OS. Its truly modular operating-system architecture, with plug-and-play components and multiple operating-system personalities, may advance expectations still further.

Defining the Microkernel

A microkernel implements essential core operating-system functions. It's a foundation for less-essential system services and applications. Exactly which system services are nonessential and capable of being relegated to the periphery is a matter of debate among competing microkernel implementers. In general, services that were traditionally integral parts of an operating system—file systems, windowing systems, and security services—are becoming peripheral modules that interact with the kernel and each other.

When I first learned about operating systems, the layered approach used by Unix and its variants was the state of the art in operating-system design. Groups of operating-system functions—the file system, IPC (interprocess communications), and I/O and device management—were divided into layers. Each layer could communicate only with the one directly above or below it. Applications and the operating system itself communicated requests and responses up and down the ladder.

While this structured approach often worked well in practice, today it's increasingly thought of as monolithic because the entire operating system is bound together in the hierarchy of layers. You can't easily rip out one layer and swap in another because the interfaces between layers are many and diffuse. Adding features, or changing existing features, requires an intimate knowledge of the operating system, a lot of time, some luck, and the willingness to accept bugs as a result. As it became clear that operating systems had to last a long time and be able to incorporate new features, the monolithic approach began to show cracks. The initial problems vendors encountered when SVR4 shipped in 1990 illustrate this point.

The microkernel approach replaces the vertical stratification of operating-system functions with a horizontal one. Components above the microkernel communicate directly with one another, although using messages that pass through the microkernel itself. The microkernel plays traffic cop. It validates messages, passes them between components, and grants access to hardware.

This arrangement makes microkernels well suited to distributed computing. When a microkernel receives a message from a process, it may handle it directly or pass the message to another process. Because the microkernel needn't know whether the message comes from a local or remote process, the message-passing scheme offers an elegant foundation for RPCs (remote procedure calls). This flexibility comes at a price, however. Message passing isn't nearly as fast as ordinary function calls, and its optimization is critical to the success of a microkernel-based operating system. For example, NT can, in some cases, replace message ports with higher-bandwidth shared-memory communications channels. While costly in terms of nonswappable kernel memory, this alternative can help make the message-passing model practical.

Portability, Extensibility, and Reliability

With all the processor-specific code isolated into the microkernel, changes needed to run on a new processor are fewer and group logically together. Since the processor market seems more likely to fragment than to converge on a single architecture, running an operating system on more than one processor may be the only way to leverage buyers' investment in hardware. Intel is still on top of the microprocessor hill, but IBM/Motorola/Apple, DEC, Mips, and Sparc International, among others, are making determined runs at its dominant position.

Extensibility is also a major goal of modern operating systems. While hardware can become obsolete in a few years, the useful life of most operating systems may be measured in decades. Whether the operating system is small like DOS or large like Unix, it will inevitably need to acquire features not in its design. For example, DOS now supports a disk-based file system, large hard disks, memory management, and—most radically—Windows. Few, if any, of these extensions were envisioned when DOS 1.0 shipped.

Operating-system designers have learned their lesson and now build operating systems that make adding extensions manageable. There's no alternative. With increasingly complex monolithic systems, it becomes difficult, if not impossible, to ensure reliability. The microkernel's limited set of well-defined interfaces enables orderly growth and evolution.

There's also a need to subtract features. More users would flock to Unix or NT if these operating systems didn't require 16 MB of memory and 70 MB or more of hard disk space. Microkernel does not necessarily mean small system. Layered services, such as file and windowing systems, will add bulk. Of course, not everyone needs C2 security or wants to do distributed computing. If important but market-specific features could be made optional, the base product would appeal to a wider variety of users. Martin McElroy, brand manager for Workplace OS at IBM's Personal Systems Products division, says that IBM's Mach implementation will eventually run the gamut from "palmtops to teraLOPS." The services riding on the microkernel can be customized to meet the needs of the platform and the market.

The microkernel approach can also help improve the overall quality of the computing environment. Systems like Unix, OSF/1, and NT require hundreds of thousands of lines of code and take years to mature. Programmers who write applications for these systems don't have time to worry about undocumented APIs; they've got their hands full just learning about the hundreds of APIs that are documented. The learning curve for new operating-system calls is becoming so steep that no developer can reasonably expect to know and use them all.

The result is that no one can guarantee the correctness of code making use of several system-service APIs, and no one can guarantee even the correctness of the operating system itself. A small microkernel that offers a compact set of APIs (the OSF microkernel will have about 200, and the tiny QNX microkernel has just 14) improves the chances of producing quality code. This compact API is visible to the systems programmer only; the applications programmer must still wrestle with hundreds of calls. But it certainly enhances the value of microkernels such as IBM's, which the company plans to license to OEMs for customized development.

What's In and What's Out?

As we have seen, the proper division of
Why do they call it a dongle?

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.

Sitting in front of his computer, drinking pots of coffee and smoking cartons of cigarettes, he’d write pages of code. It took time. Years in fact. But he did it. He wrote the most powerful computer program in the world. Now came the hard part. Selling it.

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.

Call It What You Like

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.

“Name it after you, Don!” urged his peers. So he did. Soon everyone was calling the key a dongle, after Don Gall—the lonely software developer who did what he had to do.

You’ve Come A Long Way, Baby

Today, dongles are different. Fact is, they’ve come a long way. Leading the industry with security solutions, Rainbow Technologies has changed the face of hardware keys. They work with multiple applications, are programmable and network versions control concurrent usage. And they’re always transparent to the end-user.

Sentinel Family from Rainbow

Truth is, more and more developers are using keys. And the Sentinel Family is the most widely used in the world. In fact, over 6,000 developers use Sentinel from Rainbow. Why? They are simply the most effective, reliable and easy to implement keys on the market.

Learn more about securing your software and how keys provide developers with extra value. Call for a free copy of “The Sentinel Guide to Securing Software.” And see just how easy it is to install a hardware key into your application in just minutes. Try it with our low cost Sentinel Evaluation Kit. Order one for your DOS, OS/2, Windows, Macintosh or UNIX based application.

And remember, when you need a dongle, you need Sentinel—the only dongle Don Gall would use.

CALL 800/852-8569 FOR YOUR FREE GUIDE TO SECURING SOFTWARE

Some call it a dongle. Those who know, call it Sentinel.

RAINBOW TECHNOLOGIES

9292 JERONIMO ROAD, IRVINE, CALIFORNIA 92718 • 714/454-2100 • fax 714/454-8557

International offices are located in the United Kingdom, Germany and France.

Circle 262 on Inquiry Card (RESELLERS: 263).
The general idea is to include only those operating-system personalities. IBM uses the Mach microkernel: 1.22 HYT E JANUARY 1994

Many microkernel designers include process scheduling, but IBM’s implementation of Mach locates scheduling policy outside the microkernel, using the kernel only for process dispatch. IBM’s approach separates policy from implementation, but it requires close collaboration between the external scheduler and the kernel-resident dispatcher.

Device drivers may be in-kernel, out-of-kernel, or somewhere in between. Some implementations (e.g., OSF’s) locate device drivers in the microkernel. IBM and Chorus locate the device drivers outside of the microkernel but require that some driver code run in kernel space so that interrupts can be disabled and set. In NT, device drivers and other I/O functions run in kernel space but work with the kernel only to trap and pass interrupts.

IBM’s Paul Giangarra, system architect for the Workplace OS, says that separating device drivers from the kernel enables dynamic configuration. But other operating systems (e.g., NetWare and OSF) achieve this effect without abstracting the devices from the kernel. While NT doesn’t permit dynamic configuration of device drivers, Lou Perazzo, project leader for NT development, notes that its layered driver model was designed to support on-the-fly binding and unbinding of drivers. But the necessary support for this feature didn’t materialize in the first release of NT.

Dynamic configuration notwithstanding, there are other reasons to treat device drivers as user-mode processes. For example, a database might include its own device driver optimized for a particular style of disk access, but it can’t do this if drivers reside within the kernel. This approach also yields portability since device-driver functions can, in many cases, be abstracted away from the hardware.

IBM’s forthcoming Workplace OS uses a Mach 3.0 microkernel that IBM has extended (in cooperation with the OSF Research Institute) to support parallel-processing and real-time operations. This implementation counts five sets of features in its core design: IPC, virtual memory support, processes and threads, host and processor sets, and I/O and interrupt support. Giangarra refers to the Workplace OS microkernel as its hardware abstraction layer (not to be confused with NT’s HAL, which is just the lowest slice of the NT microkernel). The file system, the scheduler, and network and security services appear in a layer above the microkernel. These are examples of what IBM calls personality neutral services, or PNSes, because they’re available to any of the individual operating-system personalities layered above them.

A key distinction between the IBM PNS layer and NT’s own service managers is that IBM’s PNS layer runs in user space, while the bulk of NT’s services run in kernel space. IBM’s approach aims to let OEMs add or replace system services freely; NT’s system services are intended to remain in place.

Perhaps the best way to describe the relationship of the kernel to the nonkernel processes is that the kernel understands how the hardware works and makes the hardware operation transparent to the processes that set and enforce operating-system policy. In IBM’s case, process and thread management is a kernel function. However, only the process dispatcher actually resides in the kernel. The scheduler, which sets policy by checking priorities and ordering thread dispatching, is an out-of-kernel function.

This is an important distinction. Dispatching a thread to run requires hardware access, so it is logically a kernel function. But which thread is dispatched, Giangarra says, is irrelevant to the kernel. So the output of the scheduler makes decisions about thread priority and queuing discipline.

The other microkernel implementations don’t delegate the scheduler to the periphery. Why would you want them to? In IBM’s case, the company plans to license its microkernel to other vendors, who might need to swap the default scheduler for one that supports real-time scheduling or some specialized scheduling policy. NT, which embodies the notion of real-time priorities in its kernel-resident scheduler, does not currently expose these to the programmer. You cannot modify or
INTELLIGENCE RECOGNIZED!

"ZyXEL modems are now among the best performers" – PC Magazine

Leading publications are continuing to recognize, rave about and award the many smart performance features that make ZyXEL the industry leader. And why shouldn’t they? Our Ultra High Speed Modems fit a wide range of configurations, giving you more Intelligent Features that save you time and money.

"ZyXEL modems are loaded with features, they comprise a virtual treasure box of surprises."

– Boardwatch Magazine

The ZyXEL U-Series offers Intelligent Features to ensure speed, reliability and true "plug-and-play" operating ease. Our new VoiceFax Software and two-way fax ability lets you send and receive voice mail from remote locations. Our Rackmount and NMS give you simultaneous control of hundreds of sites. And, if you’re on the go, our New U-1496P Portable Modem/Fax offers cellular capability and portability.

"Some modems are good. Some modems are fast. ZyXEL modems are good and fast."

– Computer Shopper

The ZyXEL PLUS Series gives you up to 19.2 Kbps, with DTE speeds of up to 76.8 Kbps in modems that come with a 5-year warranty** and will soon be upgradable to V. Fast Advantage.***

"ZyXEL modems scored a three-way tie for best two-way communications modem.”

– BYTE

Out of the 62 modems tested, ZyXEL was honored by PC Magazine as one of only three modems proving 100% reliable connections. Also, ZyXEL modems are compatible with most other modems and operate in both synchronous and asynchronous modes as well as in all environments: DOS, Windows, OS/2, Macintosh, UNIX, NeXT and Amiga. And, with V.25bis for synchronous communications, ZyXEL is compatible with IBM's A5/400 and RS/6000.

ZyXEL's Intelligent Features:

• Ultra High Speed 19.2/16.8 Kbps
• V.32bis/V.22, V.22bis/V.22, BELL 212A
• V.17-14.4 Kbps, EIA Class 2, G3 Fax, S&R
• V.42/V.42bis with Selective Reject-MNP 3/4/5
• Digitized Voice Capability
• Caller ID/Distinctive Ring
• Remote Configuration
• Auto Fall Forward/Fall Back
• Call-Back Security with Password Protection
• Line Probing Techniques
• 2/4 Wire Leased/Dial Line
• Auto Data/FAX/Voice Detection****
• Upgradable by EPROM

Find out what the Industry Experts already know. Call ZyXEL. A Wise Investment. An Intelligent Modem.

(800) 255-4101

To find out more about the

U-1496P
PORTABLE WITH CELLULAR
call your ZyXEL
sales representative today!

*Available with Windows® DOS,™ and Macintosh® versions. **2-year warranty for Rackmount models. ***Past upgrade price depends upon the model. This offer is valid in USA and Canada only. ****Auto Data/Fax/Voice detection available on DOS version. Windows/Mac version available with Auto Fax/Voice detection. Prices and specifications are subject to change without prior notice. All trademarks and logos are the property of their respective owners.
replace the NT scheduler.

Memory management, like scheduling, is divided between the microkernel and a PNS. The kernel itself controls the page hardware. The pager, operating outside the kernel, determines the page replacement strategy (i.e., it decides which pages to purge from memory to accommodate a page fetched from disk in response to a page fault). Like the scheduler, the pager is a replaceable component. IBM is providing a default pager to boot Workplace OS, but the primary paging mechanism will be integrated with the file system. The Workplace OS file system (like NT's) unifies memory-mapped file I/O, caching, and virtual memory policies.

PNSes can include not only low-level file system and device-driver services but also higher-level networking and even database services. Giangarra believes that locating such application-oriented services close to the microkernel will improve their efficiency by reducing the number of function calls and enabling the service to integrate its own device drivers.

**Mach and OSF/1**

The OSF, whose OSF/1 1.3 will also incorporate Mach microkernel technology, includes virtually the same microkernel features as does IBM. The code for this version of OSF/1 was frozen in December 1993 and is due to be distributed to OSF licensees in the second quarter of 1994. IBM is a member of the OSF, and the two organizations have been exchanging microkernel technologies. However, OSF's approach differs from IBM's in important ways. OSF/1 was reworked to be able to call Mach for basic system services. Then the entire OSF/1 server system was placed on top of Mach and run in user space. What IBM divides into separate PNSes and layered personalities, OSF lumps into a single structure.

Why the monolithic Unix server running on top of the microkernel? OSF/1 is mature and proven code, and the OSF says it wasn't feasible to start from scratch. The amount of code reuse between OSF/1 1.3 and the previous version of OSF/1 is over 90 percent. On the other hand, the OSF is also rewriting parts of the Mach kernel in C++, to be able to provide better support for object management.

The net result is that OSF/1.3 is less modular than Workplace OS. But by reusing a substantial part of OSF/1, the OSF can ship a more or less complete microkernel-based operating system to its members ahead of the expected debut of the Workplace OS in late 1994. Note that it is precisely this configuration—the OSF/1 server running on Mach—that IBM currently demonstrates as the Unix personality of its Workplace OS.

The OSF's goal is to let the Mach-plus-OSF/1-server combination run efficiently on massively parallel hardware systems. One of the active areas of study in the OSF Research Institute is to configure systems with dozens or hundreds of processors and to observe distributed operating-system behavior as the number of processors grows. The Mach microkernel will run on all processors, but the server—which provides file system, process management, and networking services—need run only on some.

According to Ira Goldstein, vice president of research and advanced development at the OSF Research Institute, future Mach-based versions of OSF/1 will be able to run the OSF/1 server system either in user space or kernel space, depending on the system administrator's choice when configuring the system. Running the OSF/1 server in kernel space will improve performance, because procedure calls will replace message passing, and all server code will remain in memory. Running the server in user space makes it swappable, potentially freeing memory for user programs. Note that USL is planning the same sort of flexibility for its Chorus-based offering. Arthur Sabsevit, chief scientist at USL, expects the same advantages that NetWare 4.0 developers currently enjoy. Services will be developed and tested in user space. Once debugged and deemed trustworthy, they can move to kernel space for best performance.

The OSF is still investigating the issue of where to locate device-driver support. Currently, drivers reside within the Mach microkernel. Goldstein says this approach should not preclude dynamic configuration of drivers. Since the OSF is working closely with IBM on microkernel issues, it will look at the IBM approach to device drivers when it receives the technology.

**Is NT Really a Microkernel OS?**

NT's microkernel serves primarily to support a specific set of user environments on top of a portable base. Its concentration of machine-specific code in the microkernel makes NT relatively easy to port across diverse processors. NT is also extensible, but not in the same way IBM's Workplace OS will be. Whereas IBM wants to license its microkernel separately, it is unlikely that Microsoft will attempt to unbundle NT's microkernel. This is one reason why many observers now conclude that NT is not, in fact, a true microkernel in the same sense that Mach and Chorus are. These critics also note that NT does not rigorously exclude layered services from kernel space (although OSF/1 and Chorus/MIX aren't religious on this point either) and that NT's device drivers cooperate minimally with the kernel, preferring to interact directly with the underlying HAL.

Workplace OS applications talk to user-mode "environment subsystems" that are analogous to the Workplace OS's personalities. Supporting these subsystems are the services provided by the NT executive, which runs in kernel space and does not swap to disk. Executive components include the object manager, the security monitor, the process manager, and the virtual memory manager. The executive, in turn, relies on lower-level services that the NT kernel (or microkernel, if you will) provides. Its services include scheduling threads (the basic level of execution), handling interrupts and exceptions, synchronizing multiple processors, and recovering from system crashes. The kernel runs in privileged mode and is never paged out of memory. It can only be preempted to handle interrupts. The kernel rides on the HAL, which concentrates most hardware-specific code into a single location.

Lou Perazzoli says that NT's design was...
Extraordinary Exo-Upgrade.

Upgrade To CA-Clipper 5.2 For $299 And Get A Copy Of New CA-Clipper/ExoSpace And Your Choice Of Another Product Absolutely FREE!

CA-Clipper 5.2: The Complete, Professional Programming Environment.

CA-Clipper 5.2 is a robust language, an efficient linker, a flexible preprocessor and a high-performance compiler. It includes: an editor, debugger and make utility for creating PC- and LAN-based applications.

Break Through The 640k Barrier With New CA-Clipper/ExoSpace!

CA-Clipper/ExoSpace increases directly addressable memory by up to 2,500% — from 640k to 16 megabytes. Eliminate virtual memory swapping, greatly improve performance and run your Clipper applications in protected mode. Existing 5.2 users can get CA-Clipper/ExoSpace for only $99!

Break through the 640k barrier with the ultimate extended memory manager. Increase directly addressable memory from 640k to 16 megabytes. Over 550 time-saving, problem-solving functions in one high-performance package. Raise your productivity with the efficiency of CA-Clipper.

New RDDS For FoxPro, Paradox and dBASE IV.

Replaceable database drivers for all the most popular development systems. Plus you can customize CA-Clipper with user-defined commands and functions. And seamlessly integrate modules from languages such as C, Assembly, dBASE and Pascal. There are no runtime fees, no additional licenses, no LanPaks.

So what are you waiting for? Call right now and upgrade to the new standard in Xbase development.

See your local Dealer Today Or Call Computer Associates at 1-800-225-5224, Dept. 20500.

New CA-Clipper 5.2.


Circle 244 on Inquiry Card.
driven by strong biases toward performance and networkability, as well as by the requirement to support a specific set of layered personalities. The resulting separation of function between kernel and nonkernel modules reflects these goals. For example, data transfers to the file system and across the network run faster in kernel space, so NT provides in-kernel buffering for the small (16 to 32 KB) reads and writes that typify client/server and distributed applications. Locating these I/O functions in the kernel may violate the academic purity of the NT microkernel, says Perazzo li, but it supports NT's design goals.

Decisions regarding mechanism and policy were motivated by similarly pragmatic concerns. For example, Win32 support did not require a traditional process hierarchy, but other environment subsystems (e.g., OS/2 and Posix) did. The NT executive provides a set of process management services sufficient for the current set of NT personalities, and potentially for others that are similar but not yet supported (e.g., VMS). Radically different alternatives that would require modifying the executive are, however, beyond the scope of NT users.

Because executive components such as the process manager and the virtual memory manager run in kernel space (although they're not technically part of the kernel), some critics say NT is more monolithic than Microsoft likes to admit. However, while these executive-level resource managers do reside in kernel space, they nonetheless function as peers and communicate by passing messages just as the user-level subsystems do.

The NT model is object-based, even though not completely object-oriented. System resources such as processes, threads, and files are allocated and managed as objects; each object type exposes a set of attributes and methods. User-visible resources including windows, menus, and files are also built on object foundation. Because of their status as objects, these resources can be named, protected, and shared. NT distinguishes between kernel- and executive-level objects. Kernel objects have threads, events, interrupts, and queues. Executive objects, which executive resource managers create and manipulate, package the more basic kernel objects—adding, for example, names and security descriptors—and, in turn, pass them to user-mode subsystems.

**Interrupts and Device Drivers in NT**

Like other microkernels, the NT kernel also handles interrupts and context switching. An interrupt is handled within the kernel and then dispatched to an ISR (interrupt service routine). The kernel uses an interrupt object to associate an interrupt level with an ISR; this arrangement conceptually separates the device drivers from the interrupt hardware. It also leads to a distinction between NT and most other microkernels in terms of the I/O subsystem. In Mach and in Chorus, device drivers reside above the kernel and access the hardware entirely through its services. In NT, the I/O manager, which includes file systems, device drivers, and networking support, generally bypasses the kernel and works directly with the HAL underneath the kernel. Kernel support is still required for interrupt processing, but in other respects, drivers work autonomously.

Perazzo li says there are good reasons to design the device-driver interface this way. For example, IBM found that it could not accomplish all device-driver functions out-of-kernel and had to find a way to let parts of drivers run in kernel space. NT establishes an object-based link to device drivers for interrupt handling and dispatch and then lets the drivers work directly with their associated devices through the HAL.
CONTROL UP TO 96 PC FILE SERVERS WITH 1 KEYBOARD AND MONITOR USING...

COMMANDERTM

- Select via Keyboard
- Dual access up to 250 feet away (optional)
- No external power
- Mix PC, PC/XT, PC/AT and PS/2
- "AutoBoot™" Feature boots attached computers without operator intervention
- Able to Broadcast to all attached computers

- PS/2 and Serial Mouse support available
- Each unit accommodates from 2 to 8 PCs
- Up to 12 units can be cascaded
- Mounting kit available for 19" and 24" rack installation

Dealer Program Available

PC, PC/XT, PC/AT and PS/2 are trademarks of International Business Machines Corp.
The small QNX microkernel is designed to be able to easily add service modules for specific uses.

Nothing prevents applications vendors from writing specialized device drivers, Perazzoli notes, but these must be distinct from the application and must cooperate with the NT I/O subsystem. Is that a limitation? Perhaps not, in view of the impressive I/O performance NT has shown in benchmark tests.

AT&T and the Chorus Nucleus

The Chorus microkernel resembles IBM's and OSF's implementations of Mach in many respects. Like Mach, it takes a minimalist approach. Chorus includes support for distributed processors, multiple distributed operating-system servers (much like the Mach-OSF/1 combination), memory management, and interrupt handling. It can also communicate transparently with other instances of the Chorus microkernel, making it a good foundation for highly distributed systems.

There are several implementations of the Chorus nucleus microkernel. Chorus/Mix, the version of the Chorus operating system with Unix interfaces, includes separate versions for SVR3.2 and SVR4 compatibility. USL will offer the Chorus/Mix V.4 as a microkernel implementation of SVR4. USL and Chorus Systems plan to work together to develop Chorus/Mix V.4 as the future direction of Unix. The figure "The Chorus/Mix Structure" on page 126 shows how Chorus/Mix V.4 is configured on top of the nucleus microkernel. Chorus also supports an SCO-compatible implementation of Chorus/Mix for use specifically on PCs.

The Chorus nucleus does not include device drivers in the kernel. As with IBM's approach, device drivers work through the kernel to access hardware. According to Michel Gien, general manager and director of R&D for Chorus, this enables a higher-level component called the device manager to keep track of drivers dispersed throughout distributed systems.

On the Drawing Board

Sun, Apple, and Taligent are also moving toward a microkernel-based operating-system architecture for their respective platforms. None of these companies was willing to discuss its plans in any great detail, but all acknowledge that microkernel technology is a crucial ingredient of operating-system design.

Sun's SpringOS, which is still in the design and implementation phase, is incorporating a microkernel and making use of object extensions. While details are sketchy, it appears that SpringOS will use a large amount of existing Solaris code, much in the same way that OSF/1 uses the existing OSF/1 server. Sun has not yet announced support for any of the independent microkernels, and it may be developing its own. Still less is known of Apple's and Taligent's efforts. Although Apple will have the rights to use the Taligent Operating Environment, the company is also rumored to be developing a microkernel for the Mac System 7.

Microkernels Here and Now

QNX and CTOS are two mature microkernel operating systems that have been shipping for years. The 8-KB QNX microkernel handles only process scheduling and dispatch, IPC, interrupt handling, and low-level network services. It exports just 14 kernel calls. The compact kernel can fit entirely in the internal cache of some processors, such as the Intel 486.

A minimal QNX system can be built by adding a process manager, which creates and manages processes and process memory. To make a QNX system usable outside of an embedded or diskless system, add a file system and device manager. These managers run outside of kernel space, so the kernel remains small. QNX Software claims that this message-passing system has performance at least comparable to that of other traditional operating systems.

CTOS, introduced in 1980, was written for Convergent Technologies workstations, a family of Intel-based machines built to run in "cluster networks" linked by ordinary telephone wire. Now sold by Unisys, these CTOS-based machines were demonstrating the benefits of message-based distributed computing long before the term became fashionable. The tiny 4-KB CTOS microkernel concerns itself only with process scheduling and dispatch and message-based IPC. All other system services communicate with the microkernel and with each other through well-defined message interfaces.

Networking is integral to CTOS workstations and effectively transparent to applications, which do not need to know whether a request for service will be handled locally or remotely. The same message-based IPC transmits the request in either case. Building modular system services to service such requests is straightforward. One practical result has been that CTOS applications running unattended in remote branch offices are easily controlled by central management tools.

The Microkernel Advantage

If you're charting the enterprise computing strategy for your organization, you've got to be excited about the trend toward microkernel-based operating systems. Increasingly, you will be able to match kernel-independent networking, security, database, and other services to your available hardware, and customize systems for individual user's needs.

Of course, end users don't care much about how operating systems work, they just want to run the applications that enable them to do their jobs. Will microkernels influence end-user computing? You bet. By abstracting application-level interfaces away from underlying operating systems, microkernels help ensure that an investment in applications will last for years to come, even as operating systems and processors come and go.

The full benefits of microkernels won't be apparent for years. It will take that long to field the operating systems and for useful add-on modules to appear. Some benefits (e.g., quality and robustness) may never be directly apparent to users. However, it's clear that microkernels are here to stay.

Peter D. Varhol is assistant professor of Computer Science and Mathematics at Rivier College in New Hampshire. He can be reached on the Internet or BIX at pvarhol@bix.com.
WHEN REMOTE ACCESS PRODUCTS WERE TESTED IN THE ARIZONA DESERT, GUESS WHO HAD THE HOTTEST SOLUTION?

The test was part of a comprehensive analysis of remote network access solutions done by ZD Labs. They packed up nine dial-in server products and sent a technician out to do some real field testing—in the town of Sedona, Arizona, pop. 7940.

He dialed in to the ZD Labs LAN in Foster City, California. And when he logged off, he had a winner: Remote LAN Node® (RLN™) from DCA®—a unique software solution that lets up to 16 remote users dial in at once and function just like locally connected PCs.

RLN PROVED IT COULD TAKE THE HEAT.

We'll let ZD Labs do the talking. "The best product was Remote LAN Node—a software solution that acts like a multiprotocol router when installed on a PC on a LAN."

The report went on to say, "Our winner, DCA's RLN, stood out for its capability to handle multiple communications protocols," commenting that "it won hands-down on flexibility, allowing our remote users to connect to both IPX and IP servers in the same call."

All in all, the report concluded, if you're looking for versatility, "None of the other products we tested came close."

THE BEST SOLUTION UNDER THE SUN.

Remote LAN Node extends the full capability of the network to remote users, allowing them to function as true remote nodes.

RLN is both protocol- and application-transparent. So you can access any network protocol, such as IPX/SPX (Novell®), SPP/IPC (Banyan®), NetBEUI (Microsoft®) and TCP/IP—or any interconnected combination. And, as ZD Labs pointed out, you can access them simultaneously. You only dedicate one PC as a comm server for 16 concurrent users. And RLN offers three levels of configurable security—enabling the industry's first Remote Security Adapter.

GET IT WHILE IT'S HOT.

Call us, and we'll send you a reprint of a Corporate Computing article detailing the ZD Labs test report. We'll also send an informative booklet, "Just Like Being There—A Guide To Remote Network Access."

And finally, we'll send you a free copy of RLN client software, so you can dial in to our LAN Lab server and judge for yourself. You won't have to go to the desert. "Our winner, DCA's RLN, stood out hands-down for functionality, allowing our remote users to dial in simultaneously."

In fact, you won't have to leave your office. But you'll find yourself in a whole new world. 1-800-348-3221, ext. 46DD*

THE FREEDOM TO COMMUNICATE.

*Call (404) 475-8380 if outside the U.S. and Canada. ©1993 Digital Communications Associates, Inc. All rights reserved. DCA and Remote LAN Node are registered trademarks and RLN is a trademark of Digital Communications Associates, Inc. All other trademarks are property of their owners.

Circle 248 on Inquiry Card (RESELLERS: 249).
From parallel 860s, to 386, 486 and Pentiums...

NDP™ Fortran and C/C++
Drive Them All!

Microway's industry-leading 32-bit Fortran produces the highest quality numeric code and supports all x86 operating systems, processors and numeric devices. NDP Fortran was used to port industry standards like SRAC's COSMOS/M to the 486 and is required to use AspenTech's ASPEN PLUS, IBM's OSL, and Fluid Dynamics' FIDAP. The compiler uses advanced numeric optimizations and instruction scheduling which favor fast numerics and RISC devices.

NDP Fortran, C/C++, Pascal
and our new Fortran 90
for the 386, 486, Pentium, and 860 run under either Extended DOS, OS/2, NT, UNIX V.3/4, SOLARIS, or COHERENT.

The extended DOS compilers feature GREX, Microway's proprietary device-independent graphics library. To run large applications on DOS, our VCPI-based, demand paged virtual memory is superior to all alternatives. We also offer DPMI support for the OS/2 and the Windows DOS Prompt Box. The OS/2 compilers include support for OS/2's 32-bit graphics engine.

Microway's NDP Fortran 90 is a full implementation of the ANSI Fortran 90, which includes the entire array syntax notation, dynamic memory allocation, module definitions, and a complete library of intrinsics. Call for your free demo disk and white paper.

If you plan to use a 386, 486, 860 or Pentium and require portability across operating systems, numeric speed, precision and superior technical support, then NDP Fortran, C/C++ or Pascal is the only solution.

QuadPuter®-860... 200 Megaflops
The 200 megaflops of Microway's QuadPuter-860 are optimally harnessed using NDP Fortran-860, libraries from IMSL, NAG and KUCK, and the PSR Vectorizer.

GIGACUBE™
Microway can build you a customized one gigaflop NFS computational server using five QuadPuters® running in one of our industrial grade Towers for under $50K. We also configure less expensive 486 workstations. All feature industrial grade American power supplies based on Todd cores and flow-through filtered cooling.

To learn why more government research labs, universities and engineers worldwide specify "Microway" call our Technical Support Department.

To enroll in our Fortran 90 Professional Training Seminar in Boston in January or San Jose in March, please call 508-746-7341.

Corporate Headquarters, Research Park, Box 79, Kingston, MA 02364 USA • TEL 508-746-7341 • FAX 508-746-4678
U.K. 081-541-5466 • Germany 40-524-5096 • Greece 01-222-3511 • India 11 681 0645 • 9-751-2929
Italy 2-749-0749 • Japan 079 822 5855 • Poland 22-414115 • Portugal/Spain 1-351-458-2443 • Russia 095 155 0303

Technology You Can Count On
The Chorus Microkernel

Amid all the hype about microkernel-based operating systems, don't overlook Chorus/MiX, a commercially proven Unix variant from France that offers a number of enhanced features.

**DICK FOUNTAIN**

Life has never been tougher for operating-system designers. Any operating system that aspires to cope with all the directions computing will take in the coming decade needs to fulfill a formidable wish list—multitasking, networking, fault tolerance, symmetric multiprocessing, and massive parallelism—while maintaining binary compatibility with industry-standard software across heterogeneous distributed platforms. Oh, and would it also support object orientation, please? As daunting as all this sounds, however, there's an existing, commercially proven operating system that supports all these features. It's made in France, and it's called Chorus/MiX.

Chorus/MiX is a microkernel-based, distributed Unix operating system that grew out of research into packet-switched networks in the late 1970s at INRIA (Institut National de Recherche en Informatique et Automatique), a government-funded laboratory in suburban Paris. In 13 years of development, Chorus has passed through four major versions and has absorbed key concepts from all the most important academic research projects in the distributed-systems field. Message passing was influential at Stanford University's System V, threads and distributed virtual memory by Carnegie Mellon University's Mach, and network addressing by Amsterdam University’s Amoeba.

In 1982, version 0 of Chorus established the basic principle of a small distributed kernel (called the nucleus) that directly supports IPC (interprocess communications). By 1986 the Chorus team had spun off from INRIA into a new company, Chorus Systèmes (now Chorus Systems), to exploit Chorus in the commercial arena. The current product, Chorus/MiX, is based on version 3 of the Chorus nucleus. It presents a standard, 100 percent binary-compatible Unix System V release 3.2 or SVR4 interface with added real-time and multithreading features.

Chorus has met with considerable success in its home country; communications giant Alcatel, France's equivalent to AT&T, has just adopted it as the standard operating system for all its future PBX equipment. More recently, Chorus has started to attract attention in the U.S., announcing deals with Unisys, Tandem, Cray Research, The Santa Cruz Operation, and Unix Systems Laboratories. It is available for a wide range of hardware, from the Intel 80x86 family to the Inmos Transputer, and Motorola has recently announced the development of a RISC chip in the PowerPC family that will have the Chorus nucleus "on-chip" for embedded applications.

**Chorus Basics**

Chorus systems are built on a tiny nucleus (typically only 50 to 60 KB in size) that handles scheduling, memory management, real-time events, and communications. Everything else in the operating system is a server that sits on top of the nucleus and communicates with it by passing messages. File managers, stream and socket managers, and even device drivers are all treated as servers; a group of such servers is called a subsystem. In the case of Chorus/MiX, the complete Unix V implementation is such a subsystem (see the figure "Chorus Nucleus with Layered Unix Services").

This extreme modularity confers many important advantages. For example, in the Unix subsystem, only those servers that are actually being used need to be loaded into memory. The ease of substituting one modular server for another simplifies the implementation of fault tolerance and redundant backup.

The system-level communications abilities allow easy distribution of the operating system by running a separate nucleus on each processor. Combining these abilities lets you build distributed fault-tolerant systems that can reconfigure themselves dynamically.

The ability to support conventional operating systems as subsystems means you could develop multiple "personalities"—say OS/2, Unix, and Windows—and have them interwork transparently via the common underlying communications layer. IBM appears to be basing its future operating-system strategy on a similar idea, implementing it on the Mach 3.0 microkernel rather than on Chorus.

Perhaps more important than these advantages is the fact that the modular Chorus system can remain comprehensible and maintainable even as it grows very complex. You can write, test, and debug servers on a running system in piecemeal fashion. In contrast, monolithic operating systems that grow by adding on extra layers tend to reach a crucial complexity barrier beyond which they become very difficult to manage.

**The Chorus Nucleus**

The IPC manager in the Chorus nucleus (see the text box
“Inside the Nucleus” below) delivers messages between actors on the same site, but a network manager external to the nucleus is responsible for keeping track of ports throughout the system and for the dirty business of network communications. (For definitions of these terms, see the text box “A Chorus Lexicon” on page 136.)

At present, the network manager supports both OSI and Internet protocols. In addition, it acts as a communications server for those special actors that need to access network services directly; for all other actors, IPC is network transparent.

As well as being compact, the Chorus nucleus is also highly portable to different CPU architectures, because only the supervisor and part of the memory manager are hardware dependent. Indeed, this isolation of hardware dependencies is perhaps the strongest commercial rationale for adopting a microkernel approach. Similar reasoning lies behind the HAL (hardware abstraction layer) in Windows NT, which so far supports Intel, Mips, and DEC Alpha processors.

**Messages and Efficiency**

The choice of a message-passing rather than a shared-memory paradigm for IPC in Chorus is the key to its elegant ease of distribution, particularly in heterogeneous environments where shared memory can be a nightmare to implement. However, message passing has a reputation for being less efficient than shared memory, and since every server in a Chorus subsystem such as Unix ultimately relies on IPC to communicate with other servers, any message-passing overhead will have a serious impact on overall system performance.

Accordingly, Chorus’s designers have made great efforts to optimize the IPC system. Chorus messages use a very simple format—just untyped strings of contiguous bytes—and the IPC manager implements no flow control or security checks. System builders add these facilities at the subsystem level using the raw services provided by the nucleus, so that their overhead is incurred only where necessary.

The RPC (remote procedure call) mode of communication employs optimizing algorithms (or lightweight RPC) that exploit any locality of client and server. For example, when both client and server threads are executing on the same site, the IPC manager instructs the memory manager to move the message data by simply remapping addresses, without any actual copying. When copying between sites does occur, a copy-on-write scheme ensures that data is transferred only as needed. Given a host processor that provides on-chip communications, such as the Inmos T9000 Transputer, the Chorus IPC service can be mapped directly onto the hardware. The French firm Archipel has done this for its Volvox range of massively parallel supercomputers.

The nucleus’s supervisor has also been subject to extensive optimization, both to improve performance and to achieve 100 percent binary compatibility for the Unix subsystem. Version 2 of Chorus employed a pure message-passing interface to Unix and required that all device drivers be part of the nucleus executing in privileged mode. All Chorus/Unix processes had to contain user-level stubs to convert system calls into messages; this altered the memory map and spoiled Unix binary compatibility.

Version 3 of Chorus, therefore, introduced a new class of entities, called supervisor actors, that execute in the supervisor’s address space in privileged mode but are still

---

**INSIDE THE NUCLEUS**

The Chorus nucleus is divided into four functional parts:

The multitasking real-time executive allocates local processors and schedules threads using a priority-based preemptive scheme (or, optionally, by time slicing). The executive’s programming interface provides primitives for thread creation and destruction, as well as synchronization via semaphores, spin locks, mutexes, or condition variables. Here, as elsewhere, the Chorus philosophy is to provide a variety of efficient but low-level mechanisms, leaving the choice of performance trade-offs to the (sub)system builder.

The memory manager supports distributed virtual memory. The basic unit of stored data is a segment that normally exists on some form of backing store. The virtual address space of an actor is divided into contiguous regions that map a portion of a segment into physical memory. System actors called mappers manage segments, maintaining the coherence of distributed shared memory when different threads access the same segment concurrently.

The supervisor dispatches interrupts, exceptions, and traps to dynamically defined device drivers and other real-time event handlers at run time. Its response time is fast enough for Chorus to be applied in real-time control systems.

The IPC (interprocess communications) manager delivers messages between ports throughout the system. Two communications modes are supported: a simple, nonblocking, asynchronous send/receive protocol in which messages are not acknowledged, and an RPC (remote procedure call) with full client-server semantics.
For millions of dBASE developers, this is a fairy tale come true: new CA-dBFast 2.0, the first and only dBASE-compatible database and language for Windows.

CA-dBFast meets two giant needs: moving existing dBASE applications to Windows and developing dazzling new applications in record time. It's the one solution that lets you take advantage of Windows while protecting the huge investment you've made in Xbase technology.

With CA-dBFast 2.0, you get a proven, stable environment that's more visual and more intuitive than anything you've ever used. And there's no need for Microsoft's confusing, intimidating SDK, so creating applications with CA-dBFast is — true to its name — fast.

CA-dBFast includes Windows interface objects for pull-down menus, push buttons, radio buttons, check boxes, scrolling list boxes, bit-mapped graphics and more.

FOR A FREE DEMO DISK, CALL 1-800 CALL CAI, Ext. 190.

With CA-dBFast applications, there are no license fees, royalties or key diskettes to bother with. And recipients of runtime programs don't need CA-dBFast to run the application — just Windows. CA-dBFast is also compatible with CA-CLIPPER, dBASE III Plus, dBASE IV, and FoxBASE.

So whether you want to wake up old applications or build brilliant new ones, there's only one way to marry Windows beauty and Xbase power.

Check out CA-dBFast today.

New CA-dBFast Release 2.0

© Computer Associates International, Inc., One Computer Associates Plaza, Islandia, NY 11768-7200. All product names referenced herein are trademarks of their respective companies.

Circle 245 on Inquiry Card.
compiled and loaded as separate modules. Supervisor actors, alone among Chorus objects, are granted direct access to the hardware event facilities, and they can install threads (called connected handlers) that are called directly by nucleus code, like parameterized subroutines, and then return control to the nucleus.

Connected handlers provide a conventional system-trap (rather than message-passing) interface to the nucleus, thus restoring Unix binary compatibility. Their judicious use greatly reduces interrupt response time and enables device drivers to be implemented entirely outside the nucleus. You don't need to modify the nucleus to accommodate new device types, and drivers can be dynamically loaded and destroyed with no loss of interrupt response. While Chorus adheres to its elegant theoretical principles for the most part, it is pragmatic enough to relax them when performance requires it.

**The modular approach** simplifies implementation of fault-tolerant systems that can reconfigure themselves dynamically. (Figure courtesy of Chorus Systèmes)

**Ports and Port Groups**

A Chorus port represents both a resource (i.e., a queue of messages waiting to be consumed by one or more threads) and an address to which messages can be sent. Many threads within an actor can use the same port, so you can improve the performance on a multiprocessor machine, transparently to the existing clients, by adding more processors. Ports can also be dynamically migrated to a succession of different actors, which provides the basis for Chorus's run-time reconfiguration abilities.

Chorus can assemble a number of ports into a named port group, which introduces an extra level of indirection into communications. Messages sent to a port group are "multicast" to all its members; since the membership of the group can change over time, this provides a powerful mechanism for the dynamic binding of messages.

Before examining groups further, I need to explain a little about naming objects in Chorus. Chorus employs a single, global name space with names that are usable at any level, from nucleus to application. This contrasts with systems such as the DNS (Domain Name System) servers used under TCP/IP on the Internet, in which names are local to each site and a central name server routes messages. Chorus's name management is fully distributed, which removes a potential point of failure in the name server and makes it easier to achieve high-reliability systems.

Chorus generates names called UIs (unique identifiers) for all actors, virtual memory segments, and IPC addresses (i.e., ports and port groups), in such a way that the UIs are unique in both time and space; no two objects in a distributed Chorus system will ever use the same UI for as long as the life of the system. UIs are 128-bit quantities formed by concatenating a site number, which records the birthplace of the object, with a "stamp" chosen from a very large, sparse random-number space. If you need to build a gateway from one distributed Chorus system to another, you can preface each system's UIs with an extra domain name identifying the system.

Chorus supplies the raw means for protecting names, although the actual protection policies must be implemented in subsystems. Objects created by external servers (e.g., segments) rather than by the nucleus are named by global capabilities constructed by combining the UI of a port of the server that manages the object with a 64-bit key that holds access control information. Protection in Chorus can be summed up by the following three rules:

1. Only possession of a port gives the right to receive on it. Ports cannot be shared between actors.
2. Only knowledge of the name of a port or port group gives the right to transmit to it. The knowledge of names is protected against forgery by the

**Threads and messages** work much as you'd expect if you're familiar with Mach or Windows NT, and you won't go far wrong if you think of actors as the Mach or NT equivalents of processes. Port groups introduce a multicast capability that's a powerful mechanism for dynamic binding of messages.
THERE ARE HUNDREDS OF REASONS TO USE WINDOWS NT. AND ONE GREAT REASON TO TRY IT NOW.

Get Windows NT for only $295 and we'll send you a free CD-ROM Applications Sampler.

Experience the new generation of applications

See how the new generation of 32-bit applications for Windows® can change the way you work and make you more productive. When you get the Microsoft® Windows NT® operating system for the special price of $295, you'll get a free CD-ROM Windows NT Applications Sampler.

You'll be able to sample some of the hundreds of 32-bit applications that are on the market right now. Applications for accounting, CAD/CAM, manufacturing, and automation. Tools to help you run your business better. Because with Microsoft Windows NT, you can run a new wave of PC applications previously available only on minis and mainframes. And you're able to integrate them with the thousands of existing applications for Windows.

Windows NT: the foundation you need

New 32-bit applications need the power, security, reliability, and manageability of Windows NT. With full, 32-bit, preemptive multitasking, Windows NT saves you time.

It can also protect your investment. Because as your company grows, Windows NT provides a foundation that will grow with you. You can choose to add more processors or move to more powerful hardware (e.g., Digital® Alpha AXP®, MIPS® R4000 series, Intel® Pentium®) without having to change your operating system or applications software.

Get a free CD-ROM Applications Sampler

Get Windows NT today for only $295, and we'll send you a free CD-ROM Applications Sampler. But order today. This limited-time offer ends February 15, 1994.

FOR A LIMITED TIME, GET WINDOWS NT FOR ONLY $295 AND RECEIVE A FREE CD-ROM APPLICATIONS SAMPLER.

FOR THE NAME OF YOUR LOCAL RESELLER OR TO ORDER BY PHONE, CALL (800) 426-9400, DEPT. KY4.

Microsoft
A Chorus Lexicon

Actor. The equivalent of a Unix process; it provides an execution context for one or more threads. An actor is the unit of distribution in Chorus, the smallest software entity that can be allocated to a site. It is not the smallest unit that can be allocated to an individual processor, however; Chorus can allocate the individual threads within an actor to different processors on a multiprocessor site, so that Chorus supports tightly coupled parallel computers as well as loosely coupled networked computers.

Ports. Queues attached to actors by which threads of one actor send messages to threads of another. Sending messages via ports rather than directly to the other thread decouples communication from execution, so communication in Chorus becomes transparent with respect to distribution; one thread need not know where another is executing in order to communicate with it. A thread can only ever belong to one actor, but a port can migrate from one actor to another, redirecting all messages to the new actor.

Site. The basic unit of computing hardware under Chorus, consisting of one or more processors and some memory and I/O devices. It might be a whole computer or just a board in a rack. Each site runs one nucleus.

Thread. The unit of execution in Chorus. It has the same meaning (i.e., a lightweight process) as does it in Windows NT and OS/2. Unlike a heavyweight Unix process, a thread does not need a private address space but only its own stack, and many threads can share the same address space. Under Chorus, that address space belongs to an actor.
SOME APPLICATIONS NEED A REAL TIME OPERATING SYSTEM

Whether you're monitoring a nuclear reactor or handling credit-card transactions, you need realtime performance you can count on around the clock. The kind of performance QNX has delivered for well over a decade. QNX sustains a host of successful mission-critical applications in a wide range of industries. From POS to medical instrumentation, from SCADA to voice mail, thousands of VARs and OEMs rely on QNX for their realtime solutions. It's easy to see why. QNX is a microkernel OS combining realtime executive-class speed with a rich, self-hosted development environment. You won't have to waste time on cross-development, so you'll see faster time-to-market and easier maintenance for your applications. QNX is remarkably flexible. You can easily strip it down to an embedded system or build it up to a vast network serving hundreds of CPUs. QNX follows Open Systems standards like POSIX and TCP/IP, so all your applications become all the more portable and interoperable. And you can run most popular DOS packages— even Microsoft® Windows™ 3.1 in standard mode under QNX. So if you're looking for a time-tested foundation for your mission-critical applications, it's time for a real realtime solution. It's time for QNX.
Be in totally different worlds at the same time.

With the world’s #1 PC X connectivity software from Hummingbird.

In today’s computing landscape, as a PC user you need to be in many different worlds. You may work in DOS, MS-Windows or Windows NT, and still need access to X Windows applications running on UNIX, VMS, or other operating systems. Hummingbird’s PC X servers let you do just that. Imagine being able to copy and paste text and graphics between these environments on your PC screen. Or, with our X development tools, you can port or develop X applications right on your PC.

For performance, maturity and compatibility, nothing beats Hummingbird. And for good reason. For the second year running we are the world leader in PC X server sales, and we continually lead the way with innovative features, many of which have become industry standards.

So, if you are looking to expand your computing horizons, look to Hummingbird. Many Fortune 500 companies already have. Our products are sold and supported in 40 countries.

The Hummingbird family of PC X servers includes:
- eXceed/W for MS-Windows
- eXceed/NT for Windows NT
- eXceed/OS2 for IBM OS/2
- eXceed/DOS for DOS
- eXceed/Xpress for serial connection.

Other Hummingbird Products:
- eXceed/NT-XDK X development toolkit for PCs with NT
- eXceed/W-MDK OSF/Motif toolkit for MS-Windows
- eXtend Host-based PC to UNIX file management system.

Contact us for more information, or for the Hummingbird reseller nearest you.
Objects on the March

PETER WAYNER

Microkernel technology lays a foundation for modular systems that can evolve in an orderly manner, but it doesn't guarantee results. For example, you could argue, with some justification, that MS-DOS already is a microkernel to which users add extensions such as networking and Windows. Of course, redefining DOS in this way doesn't sweep away the instabilities and conflicts that arise when you pile on arbitrary mixtures of TSR programs, device drivers, and memory managers. Similarly, Macintosh users find that INITs and other system extensions often lead to trouble.

Clearly what's needed is an object-oriented approach to the design of operating systems—one that lends discipline to the process of adding modular extensions to a small kernel. Microsoft, Apple, IBM, Novell/USL (Unix Systems Laboratories), and Sun Microsystems are all moving their operating systems in this direction. Taligent, the IBM/Apple joint venture, hopes to leapfrog everybody else with its from-scratch object-oriented operating system. Next, meanwhile, ships Motorola and Intel versions of NextStep, the most advanced microkernel-based and object-oriented operating system available. NextStep lacks the bottom-to-top object orientation that will be Taligent's hallmark, but at least it's available today.

Fully object-oriented operating systems will appeal strongly to systems programmers and users alike. At the system level, objects will enable programmers to dig deeply into the depths of the operating system to customize it to their needs, without disrupting system integrity. At the application level, users will find that they can mix and match features and accessories.

Objects also pave the road to distributed computing. Objects are units of code and data that communicate by sending and receiving messages. When built correctly, the objects in a system are highly interchangeable, and it can be a relatively straightforward task to swap remote objects for local objects and thereby extend object communication across a network. Programmers must compensate for the latency inherent in such a distributed system, but that's not the hardest problem that these systems introduce. The tough nut to crack will be uniform directory services that enable programmers to name and search for objects on a network that may be scattered worldwide.

The seamless nature of object systems will radically alter the way we think about where our data is. Data will be encapsulated in objects that will in some cases be able to roam to where they are most needed. We are in the habit of thinking that a document is simply stored on a particular hard disk. Distributed object systems will ask us to surrender that comfortable certainty in exchange for the power and flexibility of location-transparent storage.

If we're to entrust our data to object systems, we'll have to be sure they can handle it securely. What's to prevent a malicious user from forging messages to access information? The next generation of operating systems will include cryptographic protocols that will enable objects to authenticate messages. Complete object systems will also have to provide ways to authorize some forms of interobject communication while denying others.

All this won't happen overnight; it's going to be a long, evolutionary process. But it's important to understand how the technologies available today and those available in the near future—Microsoft's OLE; the OpenDoc standard...
from Apple, IBM, WordPerfect, Novell, and Borland; IBM’s DSOM (Distributed System Object Model); Next’s PDO (Portable Distributed Objects); and Taligent’s frameworks—will prepare users for life in a world of distributed objects.

The Evolution of Microsoft’s OLE

Applications at the top of the object food chain will be most users’ first taste of these emerging object systems. For Windows users, that means applications that use Microsoft’s OLE technology. With the first version of OLE, which debuted with Windows 3.1, users could insert objects into client documents. Those objects referred to (in the case of linking) or contained (in the case of embedding) data in a format recognized by server applications. Users double-clicked on the objects to launch the server applications and transfer data to them for editing.

OLE 2.0, available now as a Windows 3.1 extension, redefines the client document as a container. When a user double-clicks on an OLE 2.0 object that’s been inserted into a container document, it can be activated in place. Suppose, for example, that the container is a Microsoft Word 6.0 document and the inserted object represents a range of cells in Excel 5.0 format. When you double-click on the spreadsheet object, Word’s menus and frame controls magically become those of Excel. In effect, the word processor becomes a spreadsheet while the contained spreadsheet object has focus.

Clearly, the user benefits from this compound document model, but for programmers, OLE 2.0 requires a radical mind shift. They’re used to writing applications that can, to a large extent, control the user interface. Under OLE 2.0 or similar systems, the programmer must build an application that’s prepared to surrender substantial autonomy and function as a cog in a machine. Programs have to conform to rigid interfaces in order to interact successfully with other objects. OLE’s designers strode to find the right balance: The interface had to be sufficiently rigorous to ensure trouble-free object interaction, yet flexible enough to allow objects to evolve in interesting and useful ways.

The root interface supported by all OLE 2.0 objects is called IUnknown. It provides a method, QueryInterface, that describes other, more specialized interfaces supported by each object. To inquire about one of these, your program consults QueryInterface, which supplies the name of the interface. How do you know which names to inquire about? They’re listed in the system registry.

When you call through an interface to the methods it supports, you’re using a virtual function table, or vtable, that is quite similar to the vtables generated by C++ compilers. But while the structures generated by C++ compilers can differ from machine to machine and from compiler to compiler, OLE’s vtables present a standard, well-known mechanism.

The similarity to C++ does mean, however, that OLE 2.0 is much easier to use in C++ than in any other language. Calling OLE 2.0 objects from C, for example, requires substantial effort. You have to create and initialize vtables explicitly, duplicating work that’s done automatically by a C++ compiler. The C++ bias of OLE 2.0 stands in sharp contrast to the language neutrality of IBM’s SOM (System Object Model), the object-dispatch mechanism at the heart of OpenDoc (see the table “OLE vs. OpenDoc”).

OLE objects can support a wide range of interfaces to functions for such things as memory management, name binding, data transfer, and object storage. Among the most important are the interfaces that provide a common way for an object to negotiate with the container for display real estate in the container’s window and for storage space in the container’s document. The infrastructure required to support these complex object interactions is so extensive that Microsoft has described OLE 2.0 as “one-third of an operating system.” Object storage, for example, utilizes a docfile, which is really a miniature file system contained within an ordinary MS-DOS file. Docfiles provide their own internal mechanisms for subdirectories, locking, and transaction (i.e., commit/rollback) semantics.

What doesn’t OLE do yet? Networking is the most glaring omission, and it’s the top priority for future OLE development. The next major iteration of OLE will appear in a distributed, object-based version of Windows called Cairo, which is due in 1995.

Apple’s OpenDoc

Apple, along with WordPerfect, Novell, Sun, Xerox, Oracle, IBM, and Taligent—collectively known as the Component Integration Laboratories—is also pursuing an object-oriented compound document architecture called OpenDoc. Designed as a cross-platform technology, the project lags behind OLE 2.0 considerably and won’t enter its alpha stage until about the time this article sees print. Apple expects to ship beta OpenDoc development kits this summer, in time for the Apple Worldwide Developer’s Conference.

The core technologies in OpenDoc are the Bento storage mechanism (named after the Japanese plates with compartments for different foods); a scripting technology that borrows heavily from AppleScript; and IBM’s SOM. In a Bento document, each object has a persistent ID that moves with it from system to system. Storage is not only transactional as in OLE, but it is capable of storing and tracking multiple revisions of each object. If there are several drafts of a document, only the incremental changes from one revision to the next will actually be stored. The upper limit to the number of extant revisions will be user-configurable.

This incremental approach will significantly reduce the disk space that’s needed to maintain multiple revisions of a document. Because the Bento system will be transactional and multiuser-safe, it will lend itself to the development
**KINGSTON PROCESSOR UPGRADES.**

**SAVE YOUR SYSTEM AND A BUNDLE.**

<table>
<thead>
<tr>
<th>Upgrade</th>
<th>Before</th>
<th>After</th>
<th>New System</th>
<th>System Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IBM-AT</td>
<td>With SX/Now! 25</td>
<td>PS/2 Model 57SX-045</td>
<td>IBM-P5/50, 502 and 60</td>
</tr>
<tr>
<td>SX/Now!</td>
<td></td>
<td></td>
<td></td>
<td>286-based systems from AT, Compaq, Epson, Hewlett-Packard, IBM, NEC, Toshiba and Zenith.</td>
</tr>
<tr>
<td>Landmark Speed 2.0:</td>
<td>8 MHz</td>
<td>35 MHz</td>
<td>22 MHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>544 Min.</td>
<td>1.51 Min.</td>
<td>1.54 Min.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$215</td>
<td>$1,545</td>
<td>$1,545</td>
<td></td>
</tr>
<tr>
<td>SLC/Now!</td>
<td>PS/2 Model 50</td>
<td>With SLC/Now! 50</td>
<td>PS/2 Model 90-0169</td>
<td></td>
</tr>
<tr>
<td>Landmark Speed 2.0:</td>
<td>15 MHz</td>
<td>114 MHz</td>
<td>84 MHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.34 Min.</td>
<td>:29 Sec.</td>
<td>38 Sec.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$425</td>
<td>$3,280</td>
<td>$3,280</td>
<td></td>
</tr>
<tr>
<td>SX/Now!</td>
<td></td>
<td></td>
<td></td>
<td>IBM-P5/50, 502 and 60</td>
</tr>
<tr>
<td>Landmark Speed 2.0:</td>
<td>59 MHz</td>
<td>84 MHz</td>
<td>84 MHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.95 Sec.</td>
<td>:39 Sec.</td>
<td>:38 Sec.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$495</td>
<td>$3,280</td>
<td>$3,280</td>
<td></td>
</tr>
<tr>
<td>486/Now!</td>
<td>PS/2 Model 75-25MHz</td>
<td>With 486/Now! SX/2</td>
<td>PS/2 Model 90-0169</td>
<td>486/Now!</td>
</tr>
<tr>
<td>Landmark Speed 2.0:</td>
<td>9 MHz</td>
<td>1.6 MHz</td>
<td>1.6 MHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 Sec.</td>
<td>:27 Sec.</td>
<td>:27 Sec.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$375</td>
<td>$1,500</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td>MCMaster</td>
<td>With MCMaster SX/2</td>
<td>PS/2 Model 90-0169</td>
<td>MCMaster</td>
<td></td>
</tr>
<tr>
<td>Landmark Speed 2.0:</td>
<td>1.6 MHz</td>
<td>247 Min.</td>
<td>1.6 MHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>:30 Sec.</td>
<td>$1,500</td>
<td>$1,500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$595</td>
<td>$3,280</td>
<td>$3,280</td>
<td></td>
</tr>
</tbody>
</table>

**Significant Savings, Equivalent Performance.**

Kingston's IBM designed SLC/Now! plus SX/Now!, 486/Now! and MCMaster processor upgrades make existing systems perform like new 386SX, 486SX or 486DX models. They provide the power needed for today's software, perform comparably to new systems and cost at least 70% less.

**Quality is Assured.**

Bench testing of each and every product with the original system diagnostics and certification by the National Software Testing Laboratory provides the maximum assurance of individual product quality and compatibility.

**Full Compatibility.**

Kingston's processor upgrades are tested to be fully compatible with today's most popular operating environments including MS DOS, Microsoft Windows, IBM's OS/2 and Novell Netware.

**More Information.**

Contact your nearby Kingston dealer or give us a call at (800) 835-6575 to find out which processor upgrade is best for you.

**Kingston Reliability.**

Like our memory products, every processor upgrade is individually tested prior to shipping, supported by free comprehensive technical assistance and backed by a five-year warranty.

---

**The Inside Name in Upgrades**

17600 Newhope Street, Fountain Valley, California 92708 (714) 435-2600 Fax (714) 435-2699

All Trademarks, Registered Trademarks and Logos are of their respective holders. Kingston and Kingston Technology are Registered Trademarks of Kingston Technology Corporation. MCMaster is a Trademark of Acta, Inc. Both SLC/Now! and SX/Now! are currently certified by The National Software Testing Laboratory. Certification for new introductions. MCMaster and SX/Now! is pending. (Developer mode only. Serial number is for use with other products.)

Circle 257 on Inquiry Card (RESELLERS: 258).
The ability of objects to be derived from and specialize more general objects is fundamental to any object-oriented system. Yet Microsoft deliberately excluded inheritance from OLE 2.0’s object model. The problem, according to OLE developers, is that it’s hard to specify a precise interface between a base object and a derived one.

For example, suppose an object inherits half of its behavior from the operating system and provides the other half itself. Now suppose that a new version of the operating system rewrites the base object while preserving its interface. In theory, the derived object should still work perfectly. This is the major selling point for object-oriented systems. IBM, for example, touts SOM (System Object Model) as a way to achieve binary reuse of objects.

But there can be hidden pitfalls, say OLE developers. Suppose the derived object defines a virtual method that supersedes a method in the base object. Suppose also that the original version of the base object called this virtual method once after all its data was initialized. What if the new base object called the virtual method before some piece of data was initialized? The interface wouldn’t be violated—parameters would still be passed correctly—but tacit assumptions made by the derived object’s programmer could lead to trouble.

Microsoft therefore came up with the notion of aggregation, whereby programmers must explicitly build in the pointers from a derived object to a base object. This approach allows the programmer to build in controls that would stop the object from inheriting something in a dangerous way. The programmer could, for example, force the derived object to check the revision number of the base object.

In IBM’s SOM, on the other hand, the dispatcher automatically uses the first instance of a base-class object that it can find. This approach requires more discipline on the part of programmers, who must try to ensure that the derived code they write interacts with base-class objects from one revision to another.

Apple’s Kurt Piersol is familiar with this dilemma, because OpenDoc’s object model is SOM. He believes, however, that talented programmers deserve the freedom that inheritance brings and can handle the responsibility that it demands. Jim Green, director of the DOE project at Sun Microsystems, agrees, and he notes that Microsoft’s is the only object system that imposes such strictness.

Who’s right? Only time will tell. Objects are not standard equipment yet. When there’s a broader base of experience, we’ll see whether programmers will run amok with inheritance and come begging for forgiveness like the prodigal son.

The team at Apple plans to make OpenDoc compatible with Microsoft’s OLE. If the plan succeeds, the OpenDoc system will be able to wrap OLE objects with a layer of message-translation software. An OpenDoc container would see an embedded OLE object as an OpenDoc object, and the OLE object would see its container as an OLE container. Apple says that the reverse translation should also be possible. In that scenario, OpenDoc objects function in OLE containers. The translation layers are being developed by WordPerfect, with help from Borland, Claris, Lotus, and others.

Can it work? It’s a tall order, but the fact that both OpenDoc and OLE are built with object technology makes the notion at least conceivable. Given that editing a document involves universal conventions such as “save” and “delete,” Microsoft and Apple are certain to express their interfaces in similar ways.

Dueling Object Models: SOM and COM

Underlying OLE and OpenDoc are two competing object models: Microsoft’s COM (Component Object Model) and IBM’s SOM. Each defines protocols that objects use to communicate with one another. How do they differ? Most visibly, SOM is language-neutral and supports inheritance, while COM is strongly biased toward C++ and eschews inheritance in favor of an alternative mechanism that Microsoft calls aggregation. See the text box “To Inherit or Not to Inherit?” for a summary of the inheritance/aggregation debate.

IBM first used SOM to support the class hierarchy of the Workplace Shell in OS/2 2.0. But that’s just one application of what is in fact a fully general system for defining object hierarchies and invoking object methods. When one SOM object invokes another, the SOM run-time engine intercepts the call, locates the target object, activates it, and passes parameters in a standard binary format.

SOM solves a problem that has long plagued OOP (object-oriented programming) languages. Such language systems interoperate poorly because no binary standard supports inheritance and method dispatching across compilers—never mind across languages. You can’t take a class library written in Borland C++ and extend it using Microsoft C++. Nor can you inherit from or extend Borland or Microsoft class libraries using COBOL, C, or Smalltalk. But you can do all these things if you...
The AP PROFESSIONAL ToolKit—We give you the tools, the solutions, the references... Right at your fingertips.

Authoring Interactive Multimedia
Arch C. Luther
January 1994
Paperback, $49.95, c. 400 pp.
ISBN: 0-12-460430-7

Authoring Interactive Multimedia is packaged with The IBM® Multimedia Tools Series® Multimedia Sampler CD-ROM. *

*Multimedia programs appearing as samplers on the CD-ROM may be ordered by calling the IBM Multimedia Tools Series at (800) 987-7771

Network SECURITY
Steven L. Shaffer and Alan R. Simon
December 1993
Paperback, $34.95, c. 496 pp.
ISBN: 0-12-038010-4

HANDBOOK OF NETWORKING & CONNECTIVITY
Edited by Gary R. McClain
December 1993
Paperback, $39.95, c. 400 pp.
ISBN: 0-12-638010-4

FRACTALS EVERYWHERE
SECOND EDITION
Michael F. Barnsley
August 1993
Hardcover, $49.95, 531 pp.
ISBN: 0-12-079061-0

The Fuzzy Systems Handbook
Earl Cox
Foreword by Lotfi Zadeh
February 1994
Paperback, $49.95, c. 630 pp.
ISBN: 0-12-194270-8
Includes one IBM disk with C++ source code.

The Mathematica® Programmer
Roman E. Maeder
Foreword by Stephen Wolfram
December 1993
Paperback, $44.95, 216 pp.
ISBN: 0-12-464990-4
Compatible with Mathematica Version 2.2 and its programming languages. Includes one disk containing Mathematica Notebooks and Packages.

Microsoft® VISUAL C++™
Windows Primer
Keith Gursanus
March 1994
Paperback, $39.95, c. 400 pp.
ISBN: 0-12-308650-7
Includes one 3 1/2" disk containing source code for all the programming examples found in the book.

WATCH OUT!
For the Best Tools for Newton Programmers in 1994...
Newton® Programming
Software Development with NewtonScript®
Julie McKeenan and Neil Rhodes
Certified Newton Instructors from the Apple Developer University

AVAILABLE FROM YOUR LOCAL BOOKSELLER
1-800-321-5068
e-mail: app@acad.com

Prices are in U.S. dollars and are subject to change without notice. 0VANLMLIST 26/14 12/93

Circle 273 on Inquiry Card (RESELLERS: 274).
make SOM, rather than C++ or some other OOP language system, responsible for inheritance and method dispatch.

This approach yields another important benefit: rapid development. I quit programming with one set of object-oriented libraries supplied for the Mac because I grew tired of waiting for lengthy compilations whenever I made the slightest modification to the root of the class hierarchy. Everything needed to be recompiled because the parts were in some way dependent on the root class.

SOM solves this “fragile base class” problem, according to IBM, by eliminating the need to recompile in many cases. You can add new methods and local variables to a base class without recompiling its derived classes, and the derived classes can continue to call methods of the base class as before.

This flexibility is essential if a system is to be extended cleanly. If you use the system’s window object and build your application around the features in it, you don’t want to have to recompile your entire application when IBM decides to add new features. IBM’s SOM ensures that the new features won’t get in your way. You may choose to use them in a later revision of your software, but there is no need to recompile the software to remain compliant with the base system.

This flexibility does come at a price, however. Using SOM means that compilers cannot optimize interobject communications. In conventional OOP implementations, compilers can sometimes place small objects in-line, effectively creating an instance of the object and removing the interobject communication code. A flexible object model like SOM must inevitably trade away such optimizations.

The SOM model was recently extended to work in a distributed manner on IPX/SPX, TCP/IP, and NetBIOS networks. DSOM looks the same as SOM to a programmer, but the DSOM run-time engine can match up objects with requests for their services even when those requests reach across process or machine boundaries.

How will IBM handle the naming of objects in a distributed system? DSOM provides its own, somewhat limited directory service, but for large-scale systems IBM plans to rely on the global directory services of the Open Software Foundation’s DCE (Distributed Computing Environment).

**Microsoft’s COM**

Microsoft’s COM, developed for OLE 2.0, tackles the same problems that IBM’s SOM does, yet in startlingly different ways. The most visible difference is that COM doesn’t explicitly support inheritance. Instead it offers another mechanism, called aggregation, that requires objects to explicitly include pointers to objects higher up in the hierarchy (see the figure “Inheritance vs. Aggregation”).

As an example, imagine you’re creating a spreadsheet object in a document, but you want it to have flexible column widths instead of the fixed columns provided by the standard object. With conventional OOP you’d inherit most capabilities (e.g., formula translation and constraint propagation) from the base class and then override the display function to implement variable-width columns. The compiler in C++, or the SOM runtime engine in the case of SOM, would redirect the display calls to your code while routing other calls to the ancestral object.

Microsoft’s OLE, however, won’t do such redirection automatically. You must explicitly expand your object’s table to include pointers to the reference class. In Microsoft’s terms, you “aggregate” the pointers into your object. Why is this necessary? The QueryInterface method in each OLE object only knows how to read local variables; it can’t search upward through an inheritance chain, because there isn’t one.

Microsoft’s architects chose this approach because they thought that it would be more resistant to the “fragile base class” problems that emerge when a base class is redefined. “It is significantly easier for programmers to not be clear about the actual interface between a base and derived class than it is [for them] to be clear,” says Bob Atkinson, one of the principal developers of COM and OLE. “In practice, the base-derived interface will not be well articulated, thus preventing the base-class provider from revising his product,” he notes.

But OLE developers didn’t want to rule out inheritance completely, so they allowed objects to effectively inherit functions by adding them to their internal dispatch table. In this scenario, the spreadsheet object you’ve created would contain your own display functions, along with pointers to all the functions in the main spreadsheet object.

**The Taligent Revolution**

Taligent (Santa Clara CA) is building a new, object-oriented operating system from the bottom up. Everything in the system, from device drivers to applications, will share a common object model. The company expects that this bold approach will produce a clean operating system that will be completely extensible.
IF YOU READ THIS AD, THEN YOU'RE ONE OF BYTE'S 500,000 READERS WHO IS:

- INFLUENTIAL
- AUTHORITATIVE
- TECHNICALLY-ADVANCED
- KNOWLEDGEABLE
- INNOVATIVE

AND MOST OF ALL . . . BUSY!

When you want to buy, turn to the BYTE Buyer's Guide in the back for fast access to buying direct from reputable suppliers. From computers to CAD, notebooks to networks, memory to mathematics, you'll find it in the BYTE Buyer's Guide.

Tell 'em you saw it in BYTE!
Before you decide what client/server platform is right for you, make sure you know what's true, and what’s Not True.

**Fact:** the OS/2® client/server solution preserves your current hardware and software investment, accessing your mainframes, minis and PCs when necessary and bringing their power and capacity to the desktop level. **Fact:** the Windows NT™ solution is based on PC servers and desktops and doesn’t embrace all your existing resources. That could mean porting applications and data. The only plus that offers is the cost of porting plus the cost of additional PC servers.

**Fact:** OS/2 2.1 runs DOS, Windows™ and more than 1,200 native OS/2 applications. With LAN Server 3.0 or Novell® NetWare,® OS/2 supports DOS, Windows, OS/2 and Mac clients. **Fact:** it’s not likely NT will support all your existing applications. It won’t run existing 32-bit applications like WordPerfect® 5.2 for OS/2 and Lotus® 1-2-3® for OS/2. It will require additional software to support DOS, OS/2 and even Windows clients. Worse yet, *Infoworld* sources report that Windows 3.x applications run 20% slower under NT than they do under OS/2 2.1!

**Fact:** OS/2 delivers powerful, reliable, client/server applications for data storage and retrieval (DB2/2®, Oracle 7®, InfoPump®), communications (Communications Manager/2, REMOTE OS™ TalkThru®), transaction processing (CICS, IMS Client Server/2 V2), comprehensive network management (LAN NetView®, CA-UNICENTER®,...
Fact: The NT strategy is still Not There, and neither are native client/server applications.

Fact: OS/2 is committed to the industry-accepted Distributed Computing Environment (DCE) standards the Open Software Foundation. Fact: NT is NoT.

Fact: NT still Needs Time to prove itself in the real world. Fact: OS/2 is used by millions worldwide. With OS/2, it's full speed ahead for your DOS, Windows and OS/2 applications—there's no need to buy DOS and Windows.

If you're looking for a cost-effective, secure, high function client/server solution today—Not Tomorrow—then OS/2 is for you. To order or to find out more about OS/2 2.1, call 1 800 3-IBM-OS2. In Canada, call 1 800 465-7999. OS/2 2.1 is also available at your local software dealer. And that's a fact.

Operate at a higher level.

This ad was created by UNTAS and got to this publication on time using DOS, Windows and OS/2 programs running on OS/2. IBM, OS/2 and NetView are registered trademarks and DB2 and "Operate at a higher level" are trademarks of International Business Machines Corporation. All other products are trademarks or registered trademarks of their respective companies. © 1993 IBM Corp.

Circle 253 on Inquiry Card.
Taligent engineers talk obsessively about frameworks, by which they mean structures that harness collections of objects. Conventional frameworks include Borland’s Object Windows Library, or OWL, and Apple’s MacApp. These, however, govern only the creation of applications that run under Windows and the Macintosh. They include classes for windows, controls, menus, and other GUI paraphernalia. By relying on these frameworks to handle simple, standard user interactions, programmers can concentrate on more complex and application-specific tasks.

Taligent’s frameworks, by contrast, will reach down into the bowels of the operating system. But with this unprecedented freedom will come an equal measure of responsibility. Programmers will have to tread carefully: If you want to add a derived class that takes control of a certain feature of the system, you have to be sure not to violate any of the assumptions built into the base class.

This principle holds true for any operating system, of course, but I have always found programming in frameworks to be like writing sonnets: There are many possible themes, but there are also some rules that just cannot be broken. Nevertheless, Taligent’s radical openness and malleability are alluring.

Complicating the future of Taligent is the company’s relationship with its parents, IBM and Apple. Taligent plans to release in 1996 its own operating system, which shares IBM’s SOM and its microkernel. But the company also plans to release a personality module that sits in IBM’s Workplace OS milieu. It is not clear yet whether, or how, Apple intends to move the Taligent technology onto the Macintosh platform.

Next Got There First

The furor surrounding the object-orientated futures of Microsoft, Apple, IBM, and Taligent can obscure the fact that NextStep delivers many of the same benefits today. It allows you to spin together reusable objects to build a slick user interface in no time at all (see the screen on page 144), and Next supplies powerful frameworks for database and 3-D graphics work.

Over the last five years, NextStep’s performance has improved dramatically, says Avadis Tevanian, manager of Next’s RISC business unit. A key challenge for developers was to optimize memory allocation so that objects were kept together in memory. Early versions of the system swapped excessively because they couldn’t achieve locality of reference with respect to objects.

The NextStep compiler now also performs some object-level optimizations. Each method is assigned a unique number, and objects can invoke a method by number rather than by name. This approach speeds up context switching and makes NextStep extremely responsive to the user.

NextStep also tackles the problem of distributing objects across a network. A technology called Distributed Objects simplifies the task of creating systems of objects that communicate across a network. A programmer makes an object available throughout the network by invoking it—that is, registering its name in the Network Name Service. Programmers who use Distributed Objects can avoid dealing with the lowest level of interaction with the machine, the network, and RPCs (remote procedure calls).

Next is now making Distributed Objects available on other operating systems, in a form called PDO—Portable Distributed Objects. PDO for HP-UX, which shipped in mid-November, contains the Objective C language compiler (i.e., the language in which NextStep objects are written) as well as code for handling distributed object requests. Next intends to ship PDOS for Data General, NCR, and other Unix platforms and eventually non-Unix operating systems, possibly including Windows NT.

Does the requirement to use Objective C limit the appeal of PDO? Not according to Ricardo Parada, software engineer with Pencom Software. “Nothing beats Objective C for objects,” he says. “NextStep is the platform that made me see that C++ is not good enough for OOP.”

At press time, Next and SunSoft announced a joint licensing agreement that will marry Sun’s developing object technology with the NextStep application environment. Next will freely publish a specification describing OpenStep, an operating system—indeed independent software layer encompassing NextStep APIs and application frameworks. Sun will license the OpenStep application layer from Next, along with development tools including Interface Builder, and will make these standard parts of Solaris. The OpenStep specification will be written in terms of Objective C, but it can also be implemented in C++. “We’ve been investing for three years building low-level object plumbing,” said Sun chairman and CEO Scott McNealy at the joint announcement. “OpenStep gives us the application framework we need to layer on top of that plumbing.”

In exchange for OpenStep, Sun will license that object plumbing to Next.

The CORBA Connection

Hewlett-Packard, Sun Microsystems, and DEC began experimenting with objects long ago. These companies have now joined with many others to fund an industrywide coalition known as the OMG (Object Management Group), which develops standards for object exchange. The OMG’s CORBA (Common Object Request Broker Architecture) lays the groundwork for distributed computing with portable objects. CORBA defines how objects locate other objects and invoke their methods.

If this sounds strikingly similar to IBM’s SOM, it should. SOM is CORBA compliant. If you’re using DSOM under OS/2 (or AIX), you’ll be able to invoke CORBA-compliant objects running on HP’s, Sun’s, or other architectures. Does this mean you will be able to edit an OpenDoc object created on the Macintosh from within a container document on a RISC workstation? Probably not. CORBA can guarantee only a low-level mechanism by which objects can invoke other objects. To interact successfully, the two objects also have to understand each other’s messages.

The OMG hopes to synchronize the efforts of many leading workstation vendors. SunSoft, for instance, is working with the OMG to transform much of its technology into open standards. SunSoft’s work in the realm of distributed objects has yielded a series of Solaris extensions that have been incorporated into the Common Object Services Specification, or COSS, which are now approved as OMG standards.

The naming service links an object to a human-readable name that a programmer or system can use to find the object on a network. The event notification service, which enables objects to synchronize their operations, supports client/server or peer-to-peer interaction. The association service joins objects together into collections. The properties service lets anyone bind annotations to objects. This object-level graffiti could support store-and-forward messaging or store configuration data.

Security in a World of Distributed Objects

The more that we link our computers together, the more difficult our security prob-
This is the program, and the platform, BASIC was built for. Together, CA-REALIZER* 2.0 and OS/2* 2.1 go above and beyond BASIC.

With CA-REALIZER, you get a visual programming tool that lets you develop visual applications with maximum impact. It's a structured superset of BASIC, extended to access objects and resources of both Windows™ and OS/2. You also get fully integrated Programmable Application Tools™. In short, it's a developer's dreamkit.

CA-REALIZER eliminates the need for cumbersome SDKs. A totally new and improved visual FormDev lets you edit multiple forms simultaneously, as well as adding items like scroll bars, spreadsheets, charts, animation and OLE objects. You can even import or export 1-2-3, Excel and Xbase files.

With its pre-emptive multitasking, OS/2 makes CA-REALIZER a faster BASIC to work with, allowing you to move on while the system completes the previous job. And the applications you create can be compiled into stand-alone OS/2 programs you can distribute royalty-free with the run-time module that's included. There's even an award-winning report writer at no extra charge.

Clearly, when it comes to BASIC, CA-REALIZER is anything but. To order or find out more about OS/2 2.1 or CA-REALIZER, call 1 800 3-IBM-OS2*.

In Canada, call 1 800 465-7999.

Operate at a higher level.
In a CORBA environment, ORBs ensure that only authorized objects can transmit messages. The access table specifies which connections are permitted.

Object-Based Security

IBM is working with the OMG and with other companies to add a layer of security software on top of the SOM and DSOM object managers. The challenge is to ensure that messages can reach objects only when the sender has the appropriate authorization. The goal is to provide a secure standard that meets or exceeds the Orange Book criteria formulated by the National Security Agency.

IBM's approach is to delegate authentication work to the ORBs (object request brokers) that make connections between the objects over the network (see the figure "Object-Based Security"). While it's possible to add a layer of protection to the objects themselves, this severely constrains an object's reusability in applications that do not require security. IBM plans to embed access control in the ORB, which will filter out unauthorized requests. Programmers can then create objects without worrying about security precautions.

Secure ORBs will maintain access tables that control which outside objects can access objects under its control. The ORB will be able to check the identity of the message sender by using public-key algorithms. It will also negotiate keys for encrypting messages. Messages will be decrypted before they are passed to their target objects.

Windows NT takes a similar approach with its built-in security. Each object's creator sets its access privileges. The object broker in the kernel controls the connections so that only authorized messages get through.

The U.S. government issues standards that specify degrees of security. At level C2, for example, a system guarantees that any object can be made secure at the discretion of its creator. Windows NT systems can be made C2-secure because all interactions must pass through the object dispatcher. The simplicity of the model makes it possible to analyze the system and ensure that there are no "trapdoors" available for anyone to exploit. Sun Microsystems, HP, and DEC also produce operating systems that are C2-secure or better.

Objects Are Closer Than They Appear

The transition to object-oriented operating systems will dominate the rest of this century. Programmers will need to rewrite huge quantities of code to exploit the benefits of these new systems.

The OLE 2.0-compatible applications that are now emerging are an important first step. OLE 2.0 is the carrot and stick that Microsoft hopes will ensure a supply of applications for Cairo when it emerges. The members of the OpenDoc consortium are pursuing a similar strategy that, unlike OLE 2.0, is not tightly coupled to the Windows platform. And Unix vendors, always advanced in their network orientation, are rapidly converging on interoperable CORBA-compliant distributed object systems.

Not everything must be described in the future tense, however. IBM's CORBA-compliant DSOM toolkit is shipping now, as is Next’s PDO. Adventurous and forward-looking developers can today explore the kinds of object technologies that will appear on the mainstream platforms of tomorrow.

Peter Wayner is a BYTE consulting editor based in Baltimore, Maryland. He can be reached on the Internet or BIX at pwayner@bix.com.
Get set for incredible 32-bit power. Get set for mission critical reliability. Get set for a range of advanced features. Get C Set++™ from IBM Programming Systems. C Set++ is the most complete object-oriented application development package you can buy for OS/2.

C Set++ lets you create the most advanced, high-performance applications imaginable. Its 32-bit C/C++ compiler lets you unleash all the power of OS/2, giving you industrial-strength code for your mission critical applications. It has an extraordinary code optimizer with a full set of options—even a switch to optimize for the new Pentium™ processor. Plus there's a full set of class libraries, including application frameworks for PM, container classes and classes for multitasking, streams and more.

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

With C Set++, it's easier than ever to set your sights on success. To order or to find out more about OS/2 2.1 or C Set++, call 1 800 3-IBM-OS2. In Canada, call 1 800 465-7999, ext. 460.

Operate at a higher level™.
Ren·ng.
Visualization and flythroughs - at your fingertips! MicroStation offers photo-realistic rendering to every designer, right in the software. It's easy to make your image reflect your imagination.

Windows. It talks and talks Windows. Behind MicroStation lies the user-responsive programming you look for in good Windows software. Version 5 gives you the ultimate in integration of CAD, engineering, and business applications.

MORE POWER TO YOU.

Modeling. Model any surface you can imagine in MicroStation. NURBS surface modeling combined with 3D Boolean operations gives you astounding flexibility in creating and modifying freeform models.

Draughting. MicroStation gives you first-rate drafting power - without the limitations of old technology. Enjoy the advantages of contemporary features like creative patterning/ketching, preview, standard text editing, fonts, and context-sensitive Hypertext help.

Read & write AutoCAD .dwg

Workspaces. Choose the design environment that matches your profession or your CAD expertise - even AutoCAD. Complete with custom interfaces, drafting styles, and design environment management. CAD has never been so streamlined!
Usability. What does computer-aided drafting have to do with the way you think? Everything. MicroStation software works for you. It understands the drafting process so well that it infers what you’ll do next.

Graphical User Interface. MicroStation’s easy-to-use interface includes pull-down menus, dialog boxes, tear-off tool palettes, and tool settings window. Choose your interface—Windows or Motif—on any platform. Transparent Modelless Operation. The software supports the way you naturally work, maintaining command execution while you fine tune: change element attributes or command parameters, manipulate views, change the dimensioning system, and more.

Powerful View Manipulation. MicroStation supports up to eight active views that can be moved, sized, and overlapped to fit your design. Zoom and area at any scale. Move around your design fast with built-in dynamic panning.

Workspace Editor. Tailor pull-down menus, dialog boxes, and tool palettes—even disable commands—with a graphically oriented toolset for customizing your chosen interface.

Text Capabilities. A convenient text editor lets you easily edit single-line or paragraph text. Choose from TrueType, PostScript, AutoCAD SHX, and MicroStation fonts. ASCII text files can be imported and exported.

Multiple Undo/Redo Commands. Undo mistakes and perform “what-if” designs in a flash with unlimited undo and redo.

Plotting. Plot raster and vector information by view or defined areas, at any scale. Visually preview the plot before plotting, saving time and materials.

Online HELP. MicroStation’s HELP remains active, tracking the command you’re currently using, so there’s no searching through manuals for assistance.

Associative Patterning and Hatching. Associate patterning with graphics. Change graphics and the patterning updates. Flood-fill hatching/patterning intelligently fills an area, detecting boundaries and holes with a single pick.

Associative Dimensioning. Dimensions are associated with the geometry, not with a point in space, so that when you change the geometry, the dimensions automatically update.

Custom Line Styles. Create space-saving custom line styles and place railroad tracks, trees, isobars—anything—just as you would place a line.

Multi-lines. Define line string elements comprising up to 16 parallel lines of varying symbology and store them in a style library recall. Architects can use multi-lines for fast and easy placement and intersection cleanup of walls and partitions.

2D Boolean Operations. Quickly modify, measure, and hatch multiple 2D shapes with integrated Boolean operations.

Mass Properties. Calculate area and of your model: surface area, volume, mass, centroid, moments and products of inertia, principal moments and directions, and radii of gyration.

Define relationships among graphic entities with intuitive drawing modes such as tangent, parallel, perpendicular, midpoint, intersection, and end

MicroStation V5. CAD software that puts you in charge.

Call 800-345-4856 for a free brochure on MicroStation Version 5 and the name of an Intergraph representative in your area.

MicroStation INTERGRAPH

Novell's UnixWare Personal Edition is real UNIX. Included is the X11-based Graphical Desktop Manager, Novell NetWare support and DOS/Windows support.

**A SELECTION OF OUR FEATURED PRODUCTS:**

<table>
<thead>
<tr>
<th>Product</th>
<th>List Price</th>
<th>IF Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>UnixWare Personal Edition</td>
<td>$249</td>
<td>Call for Lowest</td>
</tr>
<tr>
<td>• The ultimate graphical UNIX environment.</td>
<td></td>
<td>Lowest Price</td>
</tr>
<tr>
<td>• Available on CD-ROM, tape and diskette.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAN Manager for UNIX</td>
<td>$1,295</td>
<td>From $995</td>
</tr>
<tr>
<td>• Let your PC join forces with UNIX.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge Builder</td>
<td>From $3,995</td>
<td></td>
</tr>
<tr>
<td>• The world's premier GUI database application builder.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prime Time Freeware Software Development Kit</td>
<td>$60</td>
<td>$60  III</td>
</tr>
<tr>
<td>• The software development system for the rest of us.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete UnixWare Product Line and UNIX Documentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Available at unbeatable prices</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**AS ALWAYS ONLY INFORMATION FOUNDATION OFFERS THESE EXTRAS:**

- Free product support
- Free Click-Start™ Training
- No question money-back guarantee

**INFORMATION FOUNDATION**

Information Foundation is a value-added OEM for Novell's complete UnixWare product line. We also sell software tools, UNIX documentation and compatible UNIX peripheral hardware to make your move to UNIX even easier.

IF is changing the way the world buys UNIX.

**CALL: 1-800-GET-UNIX**

1200 17th Street, Suite 1900
Denver, Colorado 80202
Phone: 303/572-6486
Facsimile: 303/572-6484
E-mail: sales@if.com

Circle 268 on Inquiry Card (RESELLERS: 269).
Personality Plus

FRANK HAYES

The new breed of operating systems won't just do the same old things better. Instead, they'll offer capabilities that we've never expected before. Some of these (e.g., microkernels and objects) will live deep in the bowels of the systems, and users may never know they exist. But one new capability will affect almost every desktop computer user: the ability to run foreign applications.

Currently, add-on software lets Mac and Unix users run DOS and Windows applications. But in the generation of operating systems now emerging, the ability to run foreign software will be a standard part of the system and will work well. Your choice of operating system will no longer drastically limit your choice of applications. The collision of user interfaces that occurs when Mac, Windows, and Unix applications all share the same screen will take some getting used to. Still, multiple operating-system personalities are here to stay, and soon they'll be as standard as mice and menus.

What won't be standard, though, is the way in which operating systems implement their ability to run nonnative applications. OS/2, Windows NT, Unix, Workplace OS, and the Mac will all take distinctively different tacks. These differences will affect how well you are able to take advantage of the wider range of applications that the extra personalities will support.

There are two competing sets of requirements. The mission of a foreign personality is to run existing applications, so it must support them as fully and faithfully as possible. But the needs of those applications may conflict with the design of an advanced operating system. Specialized device drivers may be at odds with the need for security. Memory management schemes and windowing systems may conflict. Business issues (e.g., the cost of licensing code and threats of legal action) also affect the design of foreign personalities. But the biggest potential issue is performance: A personality must run applications at an acceptable speed.

The Emulation Equation

For one computer to run software intended for another (e.g., a Mac running DOS software), the computer must perform instructions that it doesn't natively understand. For example, a Mac's 680x0 processor must execute binary code that was intended for a PC's 80x86 CPU. The 80x86 comes with its own instruction decoder, registers, and internal architecture; it executes each instruction through hard-wired circuitry or by executing a microcode routine within the CPU.

The 680x0 doesn't understand 80x86 code, so typically it has to collect each instruction, decode it to determine what it's intended to do, and perform the equivalent routine using external 680x0 code rather than internal microcode. Because the 680x0 also doesn't come equipped with exactly the same registers, flags, and internal arithmetic and logic units as an 80x86, it must also imitate those elements, either in its own registers or in memory. And it must accurately reproduce the results of each instruction, which requires 680x0 routines specifically written to make sure that the emulated registers and flags will be exactly the same as they would be on a real 80x86 after executing each instruction.

For the CPU, it's not hard work, just exacting and very tedious—the sort of job at which computers excel. But it's also very slow work, because the microcode inside a
real 80x86 runs at a much faster clip than the external 680x0 instructions that must emulate it. In the time it takes the 680x0 to perform one 80x86 instruction, a real 80x86 CPU might be able to execute dozens of instructions. The result: A DOS program running under pure emulation on a Mac is certain to be incredibly slow compared to one running on a PC.

The problem isn’t the Mac, though—Macintosh software being emulated instruction-by-instruction on a Unix workstation runs like molasses, too. The emulation equation is easy to understand: The processor’s ordinary performance, minus all the overhead of emulation, will equal how much work it can do. Thus, unless the processor performing the emulation is spectacularly faster to compensate for the emulation overhead, the software running under emulation will simply be very, very slow.

166

The problem isn’t the Mac, though—SunSelect’s Wabi vs. Insignia Solutions’ SoftWindows

SunSelect’s Wabi (Windows Application Binary Interface), which will be bundled with many Unix workstations, uses the workstation’s normal X Window System display protocols for creating the images called for by a Windows application and Unix’s usual facilities for handling files, memory, and other resources.

Wabi is based on technology acquired by SunSelect from Praxsys Technologies, but it functions much like other personality translators. While working its way through the code in a Windows application, Wabi decodes and mimics individual 80x86 instructions until it encounters a call to a DOS or Windows function. Then the emulator switches to native mode, performing the DOS or Windows function by making the appropriate calls to X, Unix, or other facilities. The technical challenge comes in translating the parameters of each Windows call to the appropriate format for Unix and then translating the results from the function call into the appropriate information to be returned in the appropriate Windows data structures.

The first release of Wabi claims to support the Windows 3.1 API, with DDE and OLE supported only as external DLLs that must be interpreted by Wabi’s 80x86 emulator. Networking is limited to access to remote file systems and printers. SunSelect says improved network support and native versions of DDE and OLE will come in a future release of Wabi.

Windows applications running under Wabi have the look of an X-based Unix GUI such as Motif or OpenLook, rather than that of Microsoft Windows. And instead of running the entire Windows desktop environment within a window, as Insignia Solutions’ SoftPC and SoftWindows currently do, Wabi opens a new window on the Unix desktop for each Windows-based application. Using a standard X display means both text and graphics can be cut and pasted between Windows and Unix applications (although most Unix applications can’t automatically convert to and from the Windows bit-map format).

However, SunSelect isn’t religious about its X implementation of Windows. To make sure TrueType fonts are properly handled for the Windows applications, the company has licensed font-handling technology from BitStream. As a result, when a Windows application issues a call to display text in a particular TrueType face, Wabi converts the request to X calls but also provides the appropriate fonts for the display.

Wabi can’t currently handle plenty of Windows-related features, including multimedia extensions, ODBC (Open Database Connectivity), MAPI (Messaging API), and networking beyond access to remote file systems and printers. Are those limitations Wabi-killers? SunSelect doesn’t think so, arguing that Wabi’s purpose is to run the popular Windows applications Sun’s customers have asked for, not to convert Unix into a close copy of Windows. The current list of “Wabi-certified” applications is short. Only 13 packages from Lotus, WordPerfect, Microsoft, Borland, and other major Windows software vendors are guaranteed to run under Wabi.

According to SunSelect’s director of research and development, Andy Halford, another 50 packages seem to work fine, but they haven’t been run through the Wabi testing and certification program. Software that uses APIs Wabi doesn’t support may fail to install or exit gracefully with an option to close files—or even cause Wabi to abort.

But a Microsoft-backed competitor thinks Wabi’s approach is far too limited. The day before SunSelect unveiled Wabi, Microsoft launched a preemptive strike by announcing it would license Windows source code to Insignia Solutions. The product that Insignia produced from that agreement, SoftWindows, runs Windows applications on Unix workstations, but there’s the similarity to Wabi ends.

SoftWindows is actually Windows 3.1 and MS-DOS, recompiled for Unix. Initially, SoftWindows fully supports OLE, DDE, and DLLs; Insignia says it is now working on multimedia and other extensions. The image that appears in a
SPECIAL Advanced Operating Systems

SoftWindows window is that of a complete Windows desktop, and because the source code is the same as the original 80x86 version, every nuance of Windows is preserved. When SoftWindows' 80x86 emulator reaches a Windows function call, it doesn't simply mimic the function. It actually performs it, at full processor speed, with appropriate calls made to Unix instead of DOS.

Because it uses authentic Windows source code, SoftWindows is able to run a far wider range of Windows applications than Wabi. By comparison, says Insignia, Wabi offers very little. But according to SunSelect, Wabi does claim one major advantage over SoftWindows: blinding speed. Executing every line of authentic Windows code for each function creates an awful lot of overhead, particularly because Windows was designed as a 16-bit application running on top of MS-DOS and was built to perform its own memory management and other advanced functions. By contrast, Unix is a 32-bit operating system that has finely tuned memory management and other facilities.

SunSelect argues that by using Unix to mimic Windows rather than slavishly performing every line of the authentic code, Wabi can outperform genuine 80x86-based Windows. A demonstration performed at SunSelect's original Wabi announcement appears to bear out the claim. Running the Wintact benchmark, a PC running the Intel version of Solaris with Wabi performed 50 percent faster than an identical PC running Microsoft Windows, according to SunSelect.

In response, Insignia points out that Wintact is just one benchmark, and it's strongly geared to graphical functions—the kind of functions where Wabi would be expected to do well. Insignia claims it uses a battery of benchmarks to make sure its RISC Unix versions of SoftWindows will perform at least as well as a 25-MHz 486-based PC in every area. The company says it has not yet benchmarked SoftWindows against Wabi but that the two initially look "competitive."

Ironically, SunSelect is an Insignia customer. The company sells an enhanced version of Insignia's SoftPC as SunPC, and SunSelect acknowledges that for SPARC customers who need more complete PC emulation, that's the way to go. But for those who need to run only the top Windows applications, says SunSelect, Wabi is a better solution.

The choice between SoftWindows and Wabi comes down to whether a customer wants to run full-scale Windows or full-speed Windows applications.

Lessons Learned
Apple learned its lesson from the Apple II experience. With the Mac, Apple...
When he retires, he plans to do something he's wanted to do since he went to college: go back to college. "If you stop learning, you stop living," is how he puts it.

Although retirement's a few years away, he's saving for it today with U.S. Savings Bonds. You can do the same.

U.S. Savings Bonds are the safe, easy way to save for retirement. They're backed by the full faith and credit of the United States. They'll be there when you retire — or even sooner if you need them — and they're guaranteed to grow. You can buy them for just a few dollars each payday through your employer's U.S. Savings Bonds Payroll Savings Plan or for as little as $25 each at your bank.

Whatever your retirement plans, start saving for them today with U.S. Savings Bonds. They're the easy way to save — and the safe way to invest.

For more information, ask your employer or bank, or write: U.S. Savings Bonds Division, Department of the Treasury, Box 933 M, Washington, DC 20226.

For a recorded message of current rate information, call 1-800-4US BOND.
worked hard to discourage programmers from "going to the metal" or otherwise departing from a strict set of programming guidelines. (Apple's programmers weren't immune to the temptation to program on the metal, though. Some Apple telecommunications software for early, relatively slow Macs programmed the hardware directly.) The result of that discouragement was that Mac applications software was much less likely to break the rules than PC software. With fewer hardware dependencies, Apple has been able to evolve the architecture of the Mac over time.

The biggest reason programmers used the Mac's "toolbox" of GUI library routines was not a stick, but a carrot. The toolbox routines were so complex and powerful that using them was significantly easier than writing your own version of the code. Microsoft Windows also included a powerful GUI ABI, as did Microsoft and IBM's OS/2 Presentation Manager and Unix GUIs based on the X Window System. When Windows rocketed to popularity in 1990, the tide turned for emulation. Finally, a large body of applications software that spent a large part of its time in a GUI ABI could be mimicked.

With the technical barriers down, there are pressing business reasons why vendors believe multiple personalities are a crucial part of any successful new operating system. DOS, Windows, and Mac programs pack the shelves in software stores; obtaining shelf space for a new incompatible type of software is practically impossible. More important, users have plenty of Windows and Mac software, and they're not about to give up the software they know well, no matter how impressive a new operating system promises to be. In fact, for an increasing number of business customers, the ability to run particular PC applications (e.g., Lotus 1-2-3 and WordPerfect) is becoming a standard requirement for desktop computer purchases, even if the purchase also requires technical applications available only under Unix.

Luckily, the modularity of the new generation of operating systems makes it far easier to support multiple personalities. Unlike older operating systems, which often consist for all practical purposes of a single large block of code divided into arbitrary parts, newer systems are modular, with clearly defined interfaces between the parts. That makes it much easier to design additional modules that bundle together processor emulation and GUI library translation. So the pieces have all come together, both technological (software style, processor speed, and modular operating systems) and business (popular "must-run" software packages). Multiple personalities are the wave of the future for operating systems.

Who's Got What?
Among the advanced operating systems that will specifically incorporate multiple personalities are IBM's OS/2 2.x and Workplace OS; Microsoft Windows NT; the PowerOpen Association's PowerOpen; and versions of Unix from Sun Microsystems, IBM, and Hewlett-Packard. In addition, some companies are repackaging their user interfaces as personality modules, and still other vendors offer emulation and personality-translation products that can run as applications. continued
EXISTING AND FORTHCOMING OPERATING SYSTEMS OFFERING MULTIPLE PERSONALITIES

<table>
<thead>
<tr>
<th>Vendor</th>
<th>OS/2 2.x[1]</th>
<th>Workplace OS[1]</th>
<th>Windows NT[1]</th>
<th>PowerOpen[1]</th>
<th>Unix (with Wabi)[1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM</td>
<td>IBM</td>
<td>IBM</td>
<td>Microsoft</td>
<td>PowerOpen Association</td>
<td>SunSoft (Solaris), IBM (AIX), Hewlett-Packard (HP-UX), UL (SVR4.2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Availability</th>
<th>Now</th>
<th>Future (this year)</th>
<th>Now</th>
<th>Future</th>
<th>Now</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Personalities available</th>
<th>DOS, Windows 3.1</th>
<th>DOS, Windows, OS/2, AIX (Unix), others</th>
<th>DOS, Windows 3.1, Win32, OS/2 1.x, Posix</th>
<th>Macintosh, AIX (Unix)</th>
<th>Windows 3.1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Look and feel</th>
<th>OS/2 or complete Windows environment within a window</th>
<th>OS/2 Workplace Shell or Unix CDE</th>
<th>Windows</th>
<th>Motif: Mac desktop in a self-contained window</th>
<th>Motif or OpenWindows</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Applications supported</th>
<th>Windows 3.1 applications and device drivers</th>
<th>Unknown (prerelease)</th>
<th>DOS and Windows applications that do not require access to hardware; character-based 16-bit OS/2 applications</th>
<th>RS/6000 AIX, System 7</th>
<th>13 Windows applications from major vendors &quot;certified&quot;; others may run</th>
</tr>
</thead>
</table>

1 OS/2 2.x is based on code licensed from Microsoft. OS/2 for Windows incorporates no Microsoft code.
2 Additional proposed personalities include Mac and BSD Unix. Currently a product in development.
3 Posix support requires recompilation of source code.
4 Mac support via Macintosh Application Services.
5 Wabi Windows personality was reverse-engineered from Windows API. Wabi has been licensed to IBM, Novell, and HP and will be available with every Sun workstation and copy of Solaris for Intel.

THIRD-PARTY PERSONALITY SOFTWARE

<table>
<thead>
<tr>
<th>Macintosh Application Services[1]</th>
<th>Liken[2]</th>
<th>Equal Application Adapter[3]</th>
<th>SoftPC[4]</th>
<th>SoftWindows[6]</th>
<th>Merge[7]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor: Macintosh Application Services[1]</td>
<td>Apple</td>
<td>Andataco</td>
<td>Quorum Software Systems</td>
<td>Insignia Solutions</td>
<td>Insignia Solutions</td>
</tr>
<tr>
<td>Availability: Future (this year)</td>
<td>Now</td>
<td>Now</td>
<td>Now</td>
<td>Now</td>
<td>Now</td>
</tr>
<tr>
<td>Operating systems supported: Unix (PowerOpen, others)</td>
<td>Unix (Solaris, HP-UX)</td>
<td>Unix (Solaris, Silicon Graphics)</td>
<td>Mac and Unix (many varieties)</td>
<td>Unix (Solaris and HP-UX now; AIX, Silicon Graphics, and DEC OSF/1 in March)</td>
<td>Unix (80x86 versions)</td>
</tr>
<tr>
<td>Personalities available: Mac</td>
<td>Mac using X Window System widgets</td>
<td>Complete Mac desktop in a window</td>
<td>Motif or OpenWindows</td>
<td>Windows, character-mode DOS in a window</td>
<td>Complete Windows environment in a window</td>
</tr>
</tbody>
</table>

1 "Statement of direction" from Apple.
2 Requires a copy of System 6.6.7. Emulates 680x0 CPU and Mac hardware environment.
3 Reverse-engineered from System 7 specifications. Runs Mac applications but does not mimic entire Mac environment.
4 Emulates 80x86 and PC hardware environment.
5 Based on Windows source code licensed from Microsoft.
6 Microsoft Windows can be run over Merge.
7 Perhaps the most familiar multiple-personality operating system is also the one that opened the floodgates by showing that the ability to run other systems' software can be a big plus. OS/2 2.0 ran DOS and Windows 3.0 applications, and version 2.1 improved on this, upgrading to Windows 3.1 software and making the Windows windows a regular part of the desktop.

At first glance, IBM developers would seem to have had a comparatively easy task in adding the Windows personality to OS/2. After all, like Windows, OS/2 runs on 80x86 CPUs, so no processor emulation was required. In addition, IBM had access to actual Microsoft Windows source code and the right to use it, for a licensing fee, in OS/2. So IBM’s work largely consisted of integrating the Windows code into OS/2.

But it still wasn’t easy. The requirements of the two environments created difficult problems, some of which IBM has never satisfactorily resolved. For example, Windows incorporates its own memory manager. So does OS/2. Unable to modify the Windows code to use OS/2’s memory management services directly, the OS/2 developers settled on using the Windows memory manager within the OS/2 memory manager. Windows’ manipulations of memory can spill over into the OS/2 swap file. Similarly, OS/2’s “seamless Windows” mode required major work on the display drivers to enable the
Accessing a Unix application from your PC no longer means you have to leave the world of Microsoft Windows. That's because NCD has brought its leading X server technology to your PC.

It's called PC-Xware, and it's a Windows application. So it allows you to access both graphical X and character-based Unix applications in the same way you currently access, say, Excel. Or Word. And since the complexity of Unix is masked behind Windows icons, displaying a Unix application on your PC requires nothing more than a point and a click.

What's more, only PC-Xware integrates fast X access with the tools needed to get Windows and Unix not just working together, but complementing one another.

For beyond its powerful PC X server and VT320 emulation, it has a 100% Windows-based TCP/IP stack, plus NCD's XReme serial protocol.

Which means your PC can access all your hosts and all your applications without the need for extra software. And if you're also after Unix files, PC-Xware even has integrated file transfer and NFS options.

If all this sounds like something you could get friendly with, call NCD today at 1-800-793-7638 and ask for PC-Xware.
two window systems to share screen real estate.

Windows NT offers five operating-system personalities: DOS, Windows, an advanced 32-bit version of Windows, OS/2 1.x, and a Unix-like personality that meets the IEEE’s Posix.1 specification. NT runs on several different CPUs, including the Mips R4000/R4400 and DEC’s Alpha, as well as the 80x86. To run DOS and Windows applications on non-80x86 platforms, NT incorporates emulation technology licensed from Insignia Solutions, which also makes the DOS emulator SoftPC for the Mac and Unix workstations. (NT’s OS/2 personality is not supported on non-80x86 processors.)

Naturally enough, to provide the ability to run Windows applications, Microsoft used its own Windows source code, modified and recompiled for each CPU that NT runs on. The 16-bit Windows and DOS personalities run on top of the 32-bit Windows (Win32) NT subsystem. On 80x86 machines, where the CPU is not emulated, DOS and 16-bit Windows applications run in V86 mode, and 16-bit calls are “thunked” (converted to 32-bit versions) and serviced by Win32.

NT’s major trade-off in DOS and Windows support is that, in keeping with NT’s security and reliability goals, device drivers and other DOS and Windows programs are not allowed access to the hardware. As a result, some DOS and Windows programs simply won’t run under NT. (In contrast, OS/2’s DOS and Windows support allows more complete DOS and Windows support, but for that capability trades away robustness.)

NT’s OS/2 support has special limitations compared to the DOS and Windows personalities, but it is still a thoroughly usable version. It is available only on 80x86 NT, does not support the PM GUI, and is designed to handle only software written for OS/2 1.2 and earlier versions, which limits applications to 16-bit versions. In practice, though, NT’s OS/2 personality can run current versions of many OS/2 packages—particularly server applications, which don’t require PM.

In contrast to the OS/2 personality, NT’s Posix personality isn’t actually mimicking an existing operating system at all. Although there are versions of Unix (on which Posix is modeled) for each CPU that NT runs on, NT’s Posix can’t run shrink-wrapped Unix software; it requires programs to be recompiled before running.

The Unix Strategies

While Windows NT can’t run Unix binaries, some Unix vendors are convinced they need the ability to run Windows software. That ability has been available for several years through third-party software like SoftPC (now available with Windows), which runs on Macs and Sun, HP, IBM, Next, and Silicon Graphics Unix workstations. On 80x86-based computers, Locus Computing’s Merge also enables DOS applications to run under Unix. Merge runs a standard copy of Windows on top of the DOS environment.

In addition, Insignia’s new SoftWindows was scheduled to begin shipping in December. SoftWindows uses a recompiled version of the Windows source code to speed up Windows applications running on Sun, HP, IBM, DEC, Next, and Silicon Graphics Unix workstations. If that approach sounds familiar, it should: It’s almost exactly the same approach used for non-80x86 versions of Windows NT. But while SoftWindows and NT are conceptually close cousins, NT can also run 32-bit Windows code, while SoftWindows is limited to running 16-bit Windows applications.

However, the most aggressive approach to bringing Windows and Unix together comes from Sun Microsystems’ SunSelect division, which has developed Wabi. While SoftWindows uses recompiled Windows source code from Microsoft, Wabi is an attempt to reverse-engineer Windows based on its functional specifications, with all operating-system-related functions (e.g., display, memory management, and interprocess communication) handled by Unix. Instead of the Windows desktop, each Windows application running under Wabi appears in its own screen window and uses the Motif or OpenLook screen appearance rather than that of Microsoft Windows.

The result is a mixed success. SunSelect initially guarantees that Wabi can run only the most popular Windows software, including Lotus 1-2-3 and Ami Pro; WordPerfect; Microsoft Word, Excel, PowerPoint, and Project; Borland Paradox and Quattro Pro; Aldus PageMaker; Harvard
XVision 5™
The market-leading Microsoft® Windows™ PC X Server, is packed with smart features that make it your best connectivity solution for running and displaying X Window and VT320 applications.

Desktop Command Center
Navigate through the whole range of enterprise-wide operating environments. Networked host connections, log-on procedures and application launching are quick and simple icon movements.

Smart Installation and Configuration
Installation is automatic with XVision 5. Built-in system intelligence detects underlying network transports and configures itself accordingly.

Automatic Graphics Speed Optimization
XVision 5 dynamically adjusts to take best advantage of your graphics hardware.

Automatic Font Substitution
Expert system technology locates the “best match” whenever a font requested by an application is unavailable on your PC.

Workstation Functionality
XVision 5 adds to X Server capability by including bi-directional file transfer, local PC printing of UNIX files, keyboard mapping and VT320 terminal emulation.

Easy-to-Use
Extensive on-line help and new smart interactive diagnostics make XVision 5 the easiest PC X Server to use.

XVision 5™
The Smart PC X Server from VisionWare®

US Headquarters
1-800-949-8474
Tel: (415) 325-2113 • FAX: (415) 325-8710

Corporate Headquarters
57 Cardigan Lane • Leeds LS4 2LE • United Kingdom
Tel: +44 532 788858 • FAX: +44 532 304676

Circle 270: Call me, I'm Interested; Circle 271: Send literature; Circle 272: Resellers circle on Inquiry Card.
Graphics; CorelDraw; and Procomm Plus. The company says that the list of "certified" applications will grow. In the meantime, while some noncertified applications will run, others may not install, or may fail while the application is running due to use of unsupported API calls.

SunSelect says its focus is on running popular applications rather than mimicking Windows in its entirety. But all Windows applications function in a complex environment, with subtleties that may show up only when Wabi's developers tackle support for applications outside the most-wanted list. In addition, Windows will continue to be a moving target; SunSelect may be hard-pressed to keep up with future changes required by new versions of Windows software.

However, Wabi has one huge advantage in any popularity contest for Windows-on-Unix software: SunSoft is making Wabi available with every copy of its Solaris version of Unix, and SunSelect has licensed the product to IBM, HP, and Novell to include in their versions of Unix. If all these vendors include Wabi in their systems as Sun does, Wabi will be shipped with more than 70 percent of all Unix workstations.

Not to be outdone, Apple is working on its own Mac personality translator to run on Unix systems. The first version, Macintosh Application Services, will run on PowerPC-based workstations running the PowerOpen version of Unix. MAS will let PowerOpen workstations run both Unix applications and shrink-wrapped software intended for 680x0-based Macs. (MAS should not be confused with the new PowerPC-based Macs, which also use processor emulation and GUI translation to run 680x0 Mac software.)

MAS will appear as a "Macintosh window" on PowerOpen-based workstations. Although Apple says that MAS will be compatible with X, Mac applications running under MAS will still have the distinctive Mac look and feel.

In addition, Apple has announced that it will eventually support other Unix workstations. Apple hasn't released details of its plans, and they clearly fall under the category of future product development. However, Sun, HP, and IBM have already said they hope to use the forthcoming Apple technology to let their Unix workstations run unmodified shrink-wrapped Mac software.

In the meantime, two ISVs (independent software vendors) are already emulating the Mac on Unix systems—although with limits. Andataco's Liken is a pure processor emulator; it runs on Sun and HP workstations and mimics the Mac's 680x0 CPU, as well as the Mac hardware environment. However, Liken doesn't try to copy the Mac's toolbox GUI libraries; for that, you need a copy of System 6.0.7.

In contrast to Liken, Quorum Software Systems' Equal is designed to mimic both the 680x0 processor and all Mac system calls, so that Mac applications can run on Sun and Silicon Graphics Unix workstations. Like Wabi, Equal puts each Mac application in its own window, using X to display Motif- or OpenLook-style window decorations. Also like Wabi, Equal currently has a limited set of "certified" applications. Initially, it includes only the Mac versions of Microsoft Word and Excel, although Quorum plans to expand the list of certified software early this year to include Microsoft PowerPoint, QuarkXPress, and other popular Mac software. (According to Quorum, many "uncertified" Mac applications run with no problems.)

Closing the circle is IBM's Workplace OS, the OS/2 successor based on the Mach 3.0 microkernel. Standard Workplace OS personalities will include Unix and OS/2 (along with its DOS and Windows personalities). But IBM hints that other personalities may also be available for the system. Because the Workplace OS interfaces are being developed in close communication with Taligent, the IBM/Apple joint venture to develop an object-oriented operating environment, both Taligent and the Mac GUI are likely candidates as Workplace OS personalities.

Who Wins, Who Loses

The ability to run Windows and Mac software is no longer a minor consideration when it comes to advanced operating systems. But beyond that simple point of agreement lie a welter of strategies for putting the multiple-personalities idea to work—and some of those strategies are diametrically opposed to others. A careful examination of the strategies operating-system vendors are using makes it apparent that there's no single correct way to implement multiple personalities.

In the case of Unix, the personality translator is typically designed to float along the surface of the operating system, like any other application. For more recent operating systems like Windows NT and Workplace OS, the personality module is much more closely linked to the operating system, although it is still highly modular. And for OS/2, with its simpler, less modular structure, the personality capability appears to be deeply embedded in the operating system.

But while operating-system vendors are juggling their approaches to run the largest number of popular applications most effectively, the biggest impact of the trend toward multiple personalities may be on applications software developers. Windows and Mac applications are likely to sell slightly better than before. The big winners will be those Windows applications that are already the most popular, because the ability to run them will be...
What Makes A Desktop Projector™

It’s not just the innovative, lightweight design. Or the remarkably easy-to-use controls. It’s not even the brilliantly vivid computer and video images it so effortlessly projects—even in well-lit meeting rooms.

It’s all of this and more.

In fact, one look at Proxima’s Desktop Projectors series of LCD projectors and you’ll know that a new breed of computer peripheral has arrived. It’s the ultimate way to present information and share data.

Look better, work smarter
Now you can use the same computing tools you already use at your desk to enhance the productivity of your meetings. With Proxima’s Desktop Projectors, everyone can see, share, and shape information together. That’s what we call Desktop Projection. It helps build consensus in meetings; lets workgroups create project schedules, budgets and other documents more quickly; and leads to faster, smarter decisions.

And that saves you time and money.

Of course, you can also project brilliant presentations that captivate your audience. Not only do Desktop Projectors let you incorporate sound, motion, and our amazing Cyclops cordless mouse, but they eliminate the need for slides, flip charts, and transparencies.

Any computer, any application
Proxima’s Desktop Projectors connect just like a monitor to any PC or Mac and work with your favorite productivity-enhancing software. Starting as low as $4,995, and weighing as little as 18 pounds, there’s a model for almost any budget or application—from high-performance color to multimedia projection.

So whether it’s a sales presentation, management discussion, or training session, Proxima’s Desktop Projector series lets you project the power of your computer in the meeting room.

For more information or the dealer nearest you, call us today.

1-800-447-7694

A Desktop Projector?
Projecting the power of your computer in the meeting room.
Windows NT and Workplace OS: Plug It In

While Unix personality modules are designed to function as if they were applications, both Microsoft’s and IBM’s entries in the portable 32-bit operating-system sweepstakes take a more integrated approach. Microsoft Windows NT and IBM’s forthcoming Workplace OS have been specifically designed to support emulation of multiple operating-system personalities, although the difference between the two systems’ approaches is striking.

Windows NT supports five operating-system personalities: MS-DOS, 16-bit Windows, OS/2 1.x, Posix, and 32-bit Windows. All five personalities are implemented as NT “environment subsystems”; each runs in its own protected user space. The Win32 subsystem handles display, keyboard, and mouse support for the other four personalities.

DOS and 16-bit Windows applications run via VDMs (virtual DOS machines), each of which emulates a complete 80x86 computer running MS-DOS. In NT, a VDM is a Win32 application; thus, like a typical Unix personality module, NT DOS and 16-bit Windows applications effectively float in a layer directly above the Win32 subsystem.

The OS/2 and Posix subsystems are a different matter. As full-scale NT subsystems themselves, they communicate with the Win32 subsystem for user input and output, but they also communicate directly with the NT Executive for other operating-system services. The OS/2 subsystem can run many current character-mode OS/2 applications, including OS/2 SQL Server, and it supports named pipes and NetBIOS.

But the Posix subsystem is remarkably limited, despite direct access to kernel services. Posix applications must be compiled specifically for Windows NT; NT does not support binary code intended for any other Posix-compliant operating systems, such as Unix. In addition, NT’s Posix subsystem does not directly support printing, does not support network access except for remote file systems, and does not support any facilities of the Win32 subsystem such as memory-mapped files or graphics.

Compared to NT, IBM’s forthcoming Workplace OS uses a more straightforward organization. While some NT personalities go through the Win32 subsystem and others deal directly with the NT kernel, all Workplace OS personalities have direct access to kernel services. Workplace OS currently supports three personality servers: an OS/2 server for OS/2 applications, an AIX server that mimics IBM’s version of Unix, and an MVM (multiple virtual machines) server for DOS and 16-bit Windows applications.

Workplace OS is built on a version of Mach 3.0. The IBM microkernel supplies only a very limited set of services; it is essentially a software backplane into which other modules, called servers, connect. The personality servers function exactly like any other Workplace OS servers. Each runs in its own protected memory space and communicates directly with the microkernel and, through it, other servers.

However, all personality servers are not created equal. IBM initially plans two versions of Workplace OS, one the OS/2 Workplace Shell, the other, Unix CDE (common desktop environment). In each case, the dominant personality will do double duty, providing both the capabilities required for its own applications and the desktop GUI and default execution semantics for the other personalities. On a standard Workplace OS system, the OS/2 (or Unix) personality is dominant. The other personality servers, known as alternative personalities, don’t contain code to provide these services.

However, dominance is entirely arbitrary in Workplace OS. The Workplace OS could be given a Windows look and feel, although IBM has no plans to do so. IBM says the server interfaces for Workplace OS will be published, so constructing dominant and alternative personalities will be practical for ISVs (independent software vendors). Additional personalities can also be added by IBM or other vendors; although none have been announced, a Mac personality is rumored as a future addition.

In practice, announcements and demonstrations are currently the limit of Workplace OS’s functionality, because it is a product in development rather than a shipping package like NT. In recent demonstrations, for example, Workplace OS’s Unix and DOS personalities were both character-based, and users could only hot-key between them and the OS/2 GUI.

Technically, both Windows NT and Workplace OS use modular subsystems to support multiple operating-system personalities. Paul Giangarra, lead architect for Workplace OS, is enthusiastic about the idea of other software vendors developing additional personalities (or, alternatively, personality-neutral services). Microsoft’s director of business development, Bob Kruger, says the whole reason NT includes Posix support is to demonstrate that subsystems can be added, either by Microsoft or other vendors, that connect directly to the NT Executive without running as Win32 applications.

In fact, the two approaches seem very comparable at a technical level. Then why does Workplace OS’s approach to multiple personalities seem so robust, promising the potential ability to run every significant desktop operating system, while NT’s non-Windows personalities seem thoroughly undeveloped? One reason may be that it’s easier to create a robust plan than a working operating system with robust implementations of multiple personalities.

But there’s also clearly a difference in business philosophy. IBM is pursuing multiple personalities, while Microsoft appears to be discarding them. “How many people are actually going to write a Posix application?” asks Kruger, and he downplays NT’s ability to run OS/2 applications: “At the end of the day, people will buy Windows NT because it runs Windows,” Kruger insists. It’s true that with good support for Windows applications, NT already has many of the benefits that multiple personalities promise. But only time will tell if a Windows-only philosophy will help or hurt NT in its competition with other advanced operating systems.
Which new standalone or networked software applications and upgrades should you buy?

Does the software you're considering live up to vendor claims? Will your people be able to learn it?

Since 1983, buyers making high-stakes purchases have been using National Software Testing Laboratories (NSTL) for authoritative, state-of-the-art evaluation of PC software. NSTL originated the concept of testing microcomputer products. Today NSTL's benchmarks and methodology are universally regarded as definitive.

Software Digest, an NSTL/BYTE publication, gives you monthly access to NSTL's comprehensive software test results. So you can make smarter, easier buying decisions.

Our tests flatten the playing field in each software category. So products show their strengths and weaknesses in head-to-head, feature-to-feature competition designed and analyzed by NSTL's test experts.

Each report compares product costs, speed, features, versatility and compatibility in a real-world, applications-based environment like the one you work in every day.

The result: clear-cut winners that give you the best value for your money. Concisely and clearly described — without ads, distractions, or outside influences of any kind.

Every 64-page issue addresses a noteworthy applications software package or operating system that involves significant expense or investment in a learning curve. For example —

- Group scheduling
- Windows-based peer-to-peer LANs
- SQL Servers
- Project Management
- Virus Protection
- Presentation graphics
- Multiuser databases
- Integrated packages
- Network management software
- LAN E-mail
- Graphical spreadsheets
- Communications

Software Digest's comparative features section is so comprehensive that vendors consult it before designing upgrades. Shouldn't you consult us before buying them?

Get full control of the planning and buying process — subscribe today.

YES, please enter my subscription to Software Digest for one year (12 monthly issues) at $44.50, and send my free binder upon payment. If I elect to include payment now, add two additional issues to my subscription at no cost. I must be completely satisfied with Software Digest or I will receive a full refund of my entire investment.

MAIL TO: Software Digest, P.O. Box 551, Hightstown, NJ 08520-0551

NAME
COMPANY NAME
COMPANY ADDRESS
CITY/STATE/ZIP
PHONE
PAYMENT INFORMATION:
☐ Check enclosed ☐ Two free issues
☐ Please bill me P.O. # required
☐ Charge my: ☐ Visa ☐ MasterCard ☐ AMEX
ACCOUNT NUMBER
EXPIRATION DATE
SIGNATURE
Orders outside North America: Please add US $20 for airmail delivery.

SOFTWARE DIGEST IS NOW PART OF THE BYTE FAMILY OF PUBLICATIONS!

Get full control of the planning and buying process — subscribe today.

PHONE
1-800-257-9402
1-609-426-5434

MONEY-BACK GUARANTEE
If at any time you are not completely satisfied with your subscription, you will receive a full refund of your entire investment.

Circle 291 on Inquiry Card.
A Better OS/2 Than OS/2?

Ironically, the first major operating system to demonstrate the commercial value of supporting multiple personalities is now demonstrating a new way to support them. OS/2 was a serious disappointment to development partners Microsoft and IBM when it was first released. When it was first introduced, analysts predicted that within five years, OS/2 would account for more than half the sales of business PCs, displacing MS-DOS as king of the desktop. Instead, early versions of OS/2 sold fewer than a half-million copies per year—a tiny fraction of expectations. And with OS/2’s downfall came the collapse of the close relationship between IBM and Microsoft.

So when IBM relaunched OS/2 in 1992, Big Blue needed an edge. It found that edge by beefing up OS/2’s ability to run DOS-based applications software and adding support for Windows applications. While OS/2 1.x offered only a single window for running DOS software, version 2.0 let users run several DOS sessions at once. Windows support in version 2.0 was initially limited to running Windows 3.0 on a full screen, but OS/2 eventually supported both “seamless” Windows applications (each appearing in its own desktop window) and, in version 2.1, support for Windows 3.1 applications.

OS/2’s DOS and Windows support came through VMX (multiple virtual machines), an OS/2 subsystem that could imitate a series of DOS PCs. In contrast to the modular approach to multiple personalities used by Unix, Windows NT, and Workplace OS, OS/2’s DOS and Windows support was firmly embedded in the operating system’s code, which seriously limited its flexibility in adding new operating-system personalities.

What proved to be most important, though, was simply that DOS and Windows support was there. Despite a dearth of OS/2-specific software, OS/2 sold some 2.5 million copies since OS/2 2.0 appeared—far more than in its previous history. While that was less than one-quarter of Microsoft’s annual sales of Windows, it represented an astonishing comeback for OS/2 and provided convincing proof that the ability to run popular software could prove to be the difference between success and failure for a new operating system.

The comeback came at a high price. OS/2’s Windows support used source code that was provided to IBM by Microsoft as part of the companies’ technology-sharing agreement. To use the Windows code, however, IBM was required to pay a royalty to Microsoft for every copy of OS/2 that the company shipped. Although IBM never made public the details of the license, the company has reportedly paid Microsoft $20 per OS/2 copy, or more than $50 million since launching OS/2 2.0. Also, that royalty fee pushed OS/2’s list price to more than $200.

But a new version of OS/2 changes both the economics and the technology of its Windows support. Code-named Ferengi when it was under development at IBM’s Personal Software Products Division in Boca Raton, Florida, the new version is officially named OS/2 Special Edition for Windows, or OS/2 for Windows for short. As its name suggests, it functions as an upgrade to OS/2 for users who own Microsoft Windows. To install, it requires a system with DOS 5.x or higher and Windows 3.1. Once in place, OS/2 for Windows loads the actual Windows environment, modifying it on the fly, so that Windows support is virtually identical to that under previous versions of OS/2.

The business impact of OS/2 for Windows is clear: Because it incorporates no Microsoft Windows code, IBM pays no royalty to Microsoft. As a result, the list price of the package is less than half that of conventional OS/2.

The technical impact may be just as dramatic, at least for IBM’s development team. In effect, OS/2 for Windows lifts up Windows and slips an OS/2 jacket around it. That approach will pose a major challenge for IBM developers with each new release of Windows; developers will have to work feverishly to upgrade OS/2 for Windows to tweak the new Windows binaries correctly. Still, their efforts may be no greater than the work required to integrate a new version of the Windows source code would have been.

Whether IBM’s new OS/2-jacket approach to Windows support will have as great an impact on OS/2 sales as the improved DOS and Windows support of OS/2 2.0 remains to be seen. What is clear is that OS/2 for Windows effectively turns OS/2’s DOS and Windows inside out.

bundled with a large percentage of Unix workstations in the form of Wabi. Ironically, because they are so popular, the additional software sales may not make a big impact on them.

And the big losers? They’re likely to be single-user productivity applications written specifically for Unix. Unix software developers already face major problems. Popular Unix workstations sell in the hundreds of thousands, not millions (like the Mac) or tens of millions (like the PC). Few software vendors carry any Unix applications at all. The combination of low volume and limited distribution means that Unix software vendors will be hard-pressed to compete against similar Windows or Mac programs. That could spell the end of the line for applications that don’t take advantage of the special features of Unix—or any other advanced operating system.

In the end, the real impact of multiple personalities will be on users, in the form of easier access to better software and more freedom of choice in operating systems. That may not be great news for all operating-system or applications vendors. But for users who have ever needed software they couldn’t run, multiple personalities are an important step toward sanity.
Your software programs were barely speaking.
Then something clicked.

If you're tired of playing matchmaker to software applications (even ones from the same vendor), you'll be pleased to hear this. There is a product that does it for you, now. Prodea Synergy™ makes the programs you already have, and what you've built with them, work together. A few points and clicks, and applications will exchange just about everything but valentines.

Mr. R. Lee Allen of Schering-Plough, a company already using Prodea Synergy, put it less romantically although no less enthusiastically. "It's not like anything out there before. It's more than OLE or DDE. It transcends both languages and APIs."

You should also know that what you build is easy to pass on to others, without worrying about hot links, paste links or file location. Prodea Synergy runs under Windows; costs $495 and has a 30-day money-back guarantee. For a limited time you also get a $200 introductory cash rebate. Call us at 1-800-PRODEA-1. Your software programs will never look at one another the same way again.
Experience the Difference

Whether you are building or buying a PC, the only components to consider are those from American Megatrends, the BIOS people known for their world famous AMIBIOS. Now, with hardware, you can get the same compatibility and performance that has made the AMIBIOS world famous. With high quality motherboards and add-in products from American Megatrends, you can make the difference between an ordinary PC and an outstanding personal computer. So experience the dramatic difference our expertise can make and demand only quality American Megatrends components in your personal computer.

American Megatrends, Inc.: 6145-F Northbelt Parkway, Norcross GA 30071
Sales: 1-800-892-6843, Fax: (404) 263-9381, Fax-Back: (404) 246-8787
UK Office: Crawley, West Sussex - (44) 293-536-356
France Office: Noisy Le Grand - (33)-1-43042220
Singapore Office: Singapore - (65) 339-0992

Circle 242 on Inquiry Card (RESELLERS: 243).
Your network buy for today's business technology market.

McGraw-Hill TechNet


- 4–Architectural Record
- 28–Chemical Engineering
- 32C–BYTE, Data Communications, Data Communications International, LAN Times, UnixWorld
- 39–Electrical World
- 41–ENR, Construction News Publishing Network (11 magazines, 4 newspapers)
- 46–Global Finance
- 66–The Physician & Sportsmedicine, Postgraduate Medicine
- 114–Modern Plastics, Modern Plastics International
- 117–Power, Power International
I 

Roundup

Paths to Platform Independence

Building applications that run on the Mac, under Windows, in the Workplace Shell, and on the X desktop—from a single set of sources

STEVE APIKI

Portability tools won’t forever settle the rivalry among the major computing platforms. Debates will continue to rage over whether the Macintosh is really easier to use than Windows, on the merits of Unix compared to Windows NT, or on the future of OS/2. But if you’re a developer building applications using a multiplatform toolkit, you won’t have to continue to bet your livelihood on the outcome.

Multiplatform toolkits provide an API and a set of libraries that allow you to develop an application one step removed from the underlying operating system. All four toolkits I’ll review here provide these libraries for Windows, the Mac, X/Motif, and OS/2 Presentation Manager; some support many more platforms. When you build your application on top of the footing provided by these tools instead of directly on the underlying GUI, your software can run in a more-or-less native manner on whatever platforms the toolkit supports.

Common Groundwork
Fundamentally, all GUIs share a common groundwork: Whether you are running on a Mac or on OS/2, there are always elements like windows and dialog boxes. And all native GUI APIs provide ways to control these elements, as well as provide methods for handling other graphical entities like icons and bit maps. So all these toolkits must, at the very least, abstract these capabilities. But there are also fundamental differences among GUI operating systems, such as differences in file structure and platform-specific features like the Windows MDI (Multiple Document Interface) or the Mac’s single-system menu bar. Effective abstraction means providing a single API that allows an application to act differently on each platform, to look and act the way you expect native applications to look and act.

I used each of these toolkits to build the guts of an application I’ve been wanting to write for some time, a simple spreadsheet-like tool that handles text formatting for tables. These packages really are toolkits—besides the library itself, each product (ex-

Programming with C++/Views means working within a complete development environment, based on a C++ class browser. C++/Views 3.0 is much more sophisticated than the last version (2.1), with a resource editor for persistent objects and much better class navigation. However, it’s currently only available on Windows.

WNDX is a superset API that provides full GUI object support and even lets you choose an interface style that’s independent of the host environment (if you’d like). However, WNDX’s OPUS (shown here) lacks many of the layout features that a resource editor requires.

XVT-Design adds a strong resource editor and prototyper to an already solid API. XVT doesn’t have the most sophisticated or elegant programming model but working in it will come naturally to developers familiar with the Mac or with Windows.

Although it looks like the other applications design tools presented in this collection, Zinc Designer is not a code generator in the conventional sense. Instead, it’s a tool for editing objects inside Zinc’s persistent object database, one of which you ship with every application you build with Zinc.

172 BYTE JANUARY 1994
C++/Views provides a tool for building applications elements (e.g., menus and dialog boxes) graphically and for hooking code to these graphical elements. I built the graphical structure of the table editor using the resource editor or prototype each development environment provides. After doing the initial development under Windows, I ported the applications to the Mac, OS/2, and X/Motif (OSF/Motif from Integrated Computer Solutions running on Solaris 2.1).

I found that each of them will serve: All of them let you build real GUI applications with fairly sophisticated features and let you take an application across platforms with only a few tweaks. The difference is where each package chooses to make the trade-off between the ease with which you can get to that final port and the level of platform-specific customization you can provide when you’re through.

The high-level classes in C++/Views can mask the structure of the underlying GUI. Although there is an event class for handling system-specific events, I never had to worry about these low-level events when building the table editor. Instead, I just built member functions like paint() and mouseDown() to override the default members of the window class from which I derived my view window and responded to those events inside those functions.

Despite its high level of abstraction, C++/Views makes concessions to more procedural techniques when it makes sense. To open a standard file status dialog box, for example, you call a static member function of the file status dialog box class, which simply constructs a modal file dialog box and returns when the dialog box is complete.

C++/Views is currently shipping in two distinct versions: 2.1 and 3.0. The differences between the two are significant enough to have an impact on the way you build your applications. Version 2.1 totally lacks resources; you have to build menus, dialog boxes, and other objects that are usually built from resource templates from scratch, programmatically. Although C++/Views provides classes (e.g., dialog box and menu-handling classes) that reduce some of the work involved, this is still a serious lack.

Version 3.0 fixes this problem (and goes well beyond) by adding persistent object storage, which not only gives you a mechanism for storing these menu and dialog box objects but also gives you a reposito-
that’s sending you messages is a Windows-
style scroll bar attached to the window
frame or a Motif-style proportional scroll
bar. WNDX takes a different approach by
emulating non-native window elements on
all the platforms it supports—if you
want to work with a Motif-style interface,
WNDX will create it for you even if you
are on Microsoft Windows. This is a slick
feature, and it works well, but unless you
want an application that will look and feel
exactly the same on Motif as it does under
Windows, you are probably better off
sticking with native controls, which
WNDX also supports.

Ironically, although WNDX can add
non-native behavior, it’s difficult to get to
some native functions. For the table editor,
I wanted a view window with horizontal
and vertical scroll bars attached to the win-
dow frame, an interface feature that both
the Mac and Windows support directly.
However, there is no style that lets you do
this under WNDX, and I ended up having to
float scroll bars near the edge of the
window to emulate this behavior in my
program. Since I couldn’t get system scroll
bar widths on the WNDX for Mac beta
version I tested (a shortcoming WNDX
says will be addressed shortly), the scroll
bars I tried to draw in the usual scroll bar
area didn’t quite fit or look like Mac scroll
bars.

In addition, WNDX’s full customiza-
tion extends to icons; therefore, it pro-
vides a set of icons to which you can refer
inside the library (other resource template
information is stored in an ASCII file that
ships with your completed application).
The icons can look a little out of place,
for example, in a Windows MDI window.
If you want to add native icons, you have
to tack them on in a platform-dependent
manner.

The positive side to customization is a
rich set of built-in windows objects, like
2-D lists that work almost exactly like
Macintosh lists. I couldn’t use lists as a
base for the table editor because I wanted
a grid that appeared to be infinite; how-
ever, the WNDX list supports almost every
other behavior I wanted for the table editor
and would be good for simple spread-
sheets.

In the design of the WNDX library, al-
most all Window behaviors are controlled
through attributes. WNDX elements have
some degree of object orientation: WNDX
elements that share common attributes are
plug-compatible since you get and set all
attributes through a common interface. But
I found working within this framework a
little disorienting for two reasons: First, be-cause the attribute list is so large, it’s
hard to find the attribute you want to set
when you aren’t an experienced WNDX
programmer, and second, I found it un-
natural to initiate what I would think of as
an action (e.g., moving a window) by set-
ing an object’s position attribute. How-
ever, the WNDX API is large, and in ad-
dition to handling every GUI event, there
are many cover functions (e.g., WND_-
Move()) that mask the attribute setting
calls. Once you get a handle on the API,
programming WNDX is straightforward.
The main() function handles and dis-
patches events to other parts of the sys-
tem; you trap those events through call-
backs and then you respond.

You can create resources and set up
callbacks using WNDX’s OPUS proto-
typing tool. OPUS was probably the weak-
est prototype among those provided with
these libraries. There’s little layout support
in dialog boxes (i.e., no alignment or spac-
ing capability), and OPUS doesn’t build
make files for its projects. You have to
run an external mkmake utility that builds
a simple make file from the sources them-
selves.

XVT Software’s XVT doesn’t real-
ly have any razzle-dazzle fea-
tures—no object orientation, no low-
level customization, and no emulation of
non-native controls. But it has what I’d
consider most important: an obvious and
comprehensive API, a great design tool,
and third-party support that the other
products don’t approach.

If you’re already familiar with Mac or
Windows programming, you probably
won’t find a more comfortable API than
XVT’s. The programming model of XVT
is close to that of the Mac, and I was able
to transition more easily to XVT from full-
time Windows programming in C than to
any other cross-platform tool.

XVT’s resource handling is also the
simplest; you build resource templates for
XVT’s resource format using a simple re-
source description language, or by using
the design tool, XVT-Design. Once a re-
source is built, you use CURL (XVT’s re-
source compiler) to build a native binary
format that gets attached to the executable
file. XVT’s greatest shortcoming in re-
source handling is a lack of support for
bit-map formats that can move between
platforms; an upcoming release of XVT
should address that problem.

XVT-Design is an easy-to-use resource
tool and prototyping tool that builds en-
tire projects, including URL (Universal
Resource Language) files (for resource
compilation by CURL), source files, and
make files. You can attach common event
handlers like XVT standard dialog box
functions directly within XVT-Design, and
you can also type entire procedures di-
rectly into the editor, although I found it
easier to edit templates later in a more stan-
dard fashion.

XVT-Design can automatically include
File, Edit, and other standard menus in
your resource file. XVT-Design also has a
built-in Font menu that goes nicely with
XVT’s transparent handling of system-
indepedent fonts.

Besides fonts, XVT also handles help
information in a portable, standardized
way. However, the format of the help file
is rudimentary (it handles only one level of
help, and there’s no real index), so you
may be better off skipping this standard
feature.

Most cross-platform toolkits don’t ab-
tract memory handling very well, so mov-
ing between a 32-bit flat model to a seg-
mented pointer architecture can be messy.
If you know you are going to need large
memory objects (as I’d like to be able to
handle for the table editor), you can use
XVT’s global allocation functions to get
handles to memory that can extend past
64 KB. This is slow under 16-bit Win-
dows, but the protection from faults when
moving from platform to platform is worth
the trouble for a few large objects.

Had XVT Software released its prom-
ised PowerObjects custom controls in time
"You asked for a powerful and affordable tool to develop client/server applications. That's why I developed System Architect 3.0."

Developers and project teams looking for a CASE-based tool for client/server application development will find the answer in System Architect™ 3.0. This latest version of the CASE price/performance leader includes all the features of expensive tools for a fraction of the cost.

To quote CASE Trends Magazine: “Popkin Software and Systems have delivered on their promises by offering inexpensive, easy-to-use products that deliver results.”

System Architect 3.0.
SA 3.0 simplifies the development of client/server applications by supporting multiple methodologies including Information Engineering, Gane & Sarson, Yourdon, IDEF, OOA&D, SSADM IV, Shlaer/Mellor, and Ward & Mellor. It also features an integrated data repository you can customize. And it runs under MS Windows® or IBM’s OS/2 PM.

Flexibility And Functionality.
The ideal combination of flexibility and functionality has made SA the undisputed price/performance leader. As the needs of developers have changed, so has the scope of SA’s features and options:

SA Screen Painter: Allows repository-based development of GUI screens and menus or character-based screens.
SA Object-Oriented Version: Supports Booch ‘91 and Coad/Yourdon.
SA Reverse Data Engineer: Reverse engineers SQL databases, including SQL Server, SYBASE, DB2, Informix, and Oracle.
SA Schema Generator: Generates DDL and SQL triggers from entity models for Oracle, Informix, Ingres, PROGRESS, Paradox, dBASE III, DB2, SQL Server, SYBASE, and other SQL and 4GL databases.
SA Project Documentation Facility: Enables the automatic generation of deliverables with desktop publishing quality from SA Encyclopedia.

Put Your Project Team In A Class Of Its Own.
System Architect 3.0 makes your project team more productive because it lets your users really work together. It does this with a range of capabilities including:

Network Version – Allows multiple team members to work concurrently on a project while sharing the SA Repository by locking diagram and data dictionary records.
Network Security – Allows Project Managers to uniquely identify and classify personnel with appropriate levels of authorization.
Access Control – Allows team members to check-out, check-in, or freeze encyclopedia objects with defined authorization.
Version Control – Allows project encyclopedias, and their related files, to be saved and stored with appropriate version-identifying data. (Available in version 3.1)

Learn More About System Architect 5.0.
Call us at 1-800-REAL-CASE, ext. 138. Or fax us at 1-212-571-3436. Ask how you can qualify for a free 30-day evaluation copy.

Circle 287 on Inquiry Card.
A portable development tool has to cover your requirements for platform support. XVT and Zinc have the most complete coverage, but if you don't need to handle some of the more exotic platforms, WNDX and C++/Views cover the most popular desktop systems.

<table>
<thead>
<tr>
<th>Libraries</th>
<th>C++/VIEWS</th>
<th>WNDX</th>
<th>XVT</th>
<th>Zinc Application Frameworks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows</td>
<td>C++/Views 3.0</td>
<td>WNDX 2.04 for Windows</td>
<td>XVT Win 3.02</td>
<td>Zinc Application Frameworks 3.5</td>
</tr>
<tr>
<td>Macintosh</td>
<td>C++/Views 2.1</td>
<td>WNDX 2.04 for Macintosh</td>
<td>XVT/Mac 3.02</td>
<td>Zinc Application Frameworks 3.5</td>
</tr>
<tr>
<td>X/Motif</td>
<td>C++/Views 2.1</td>
<td>WNDX 2.04 for X/Motif</td>
<td>XVT/X/Motif 3.02</td>
<td>Zinc Application Frameworks 3.5</td>
</tr>
<tr>
<td>OS/2</td>
<td>C++/Views 2.1</td>
<td>WNDX 2.04 for OS/2</td>
<td>XVT/PM 3.01</td>
<td>Zinc Application Frameworks 3.5</td>
</tr>
</tbody>
</table>

Tools

<table>
<thead>
<tr>
<th>Resource editor</th>
<th>Windows (version 3.0) only</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual prototype/designer</td>
<td>Windows (version 3.0) only</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Class browser/editor</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Language

<table>
<thead>
<tr>
<th>Compiler support</th>
<th>Windows</th>
<th>Macintosh</th>
<th>X/Motif</th>
<th>OS/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows</td>
<td>Microsoft C/C++ 8.0, Borland C++ 3.1, Symantec C/C++</td>
<td>Microsoft C/C++, Borland C++ 3.1, Watcom C/86 9.5, OS/2 PM</td>
<td>Microsoft C/C++, Borland C++ 3.1, Syman tec C/C++</td>
<td>Borland C++ for OS/2, IBM C/SET</td>
</tr>
<tr>
<td>Macintosh</td>
<td>MPW 5.2, Think C 5.0, Symantec C++ 6.0</td>
<td>Apple Macintosh</td>
<td>Apple Macintosh</td>
<td>Apple Macintosh</td>
</tr>
<tr>
<td>X/Motif</td>
<td>Sun HP-UX, SCO</td>
<td>Apple X/Motif</td>
<td>Apple X/Motif</td>
<td>Apple X/Motif</td>
</tr>
<tr>
<td>OS/2</td>
<td>Borland C++ for OS/2</td>
<td>Borland C++ for OS/2</td>
<td>Borland C++ for OS/2</td>
<td>Borland C++ for OS/2</td>
</tr>
<tr>
<td>DOS</td>
<td>None</td>
<td>Microsoft C/C++, Borland C++ 3.1, Watcom C/86 9.5, MetaWare High-C/3.0</td>
<td>Microsoft C/C++, Borland C++ 3.1, Watcom C/86 9.5, MetaWare High-C/3.0</td>
<td>Microsoft C/C++, Borland C++ 3.1, Syman tec C/C++</td>
</tr>
</tbody>
</table>

Portable feature support

<table>
<thead>
<tr>
<th>Portable feature support</th>
<th>Resource/porable data mechanism</th>
<th>Version 3.0: persistent objects</th>
<th>ASCII data file</th>
<th>Native resources built from common scripts</th>
<th>Persistent objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printing/print dialog boxes</td>
<td>Yes</td>
<td>Windows, Macintosh, OS/2 PM only</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Help</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Icons</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Strings</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bit maps</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Toolbar</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Custom controls</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Native standard dialog boxes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Undo support</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Platform-specific tools

<table>
<thead>
<tr>
<th>Platform-specific tools</th>
<th>Windows</th>
<th>Mac OS/2 PM</th>
<th>Drag and drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create DLLs</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Multiple screen support</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Pricing

|---------|---------------------------|-----------------|--------------|

* No direct support; supported through third-party tools

* Source for custom controls, style guides, examples, and tutorial

* C++ support from Power++, currently prerelease

* Supported by XVT PowerObjects

* All prices listed include design tools, libraries, and documentation

* Designer and libraries also sold unbundled

* Zinc installations require an engine and one key per platform

N/A = not applicable.
How Do You Know You've Got The Right Software Protection?

Your software protection strategy shouldn't be a hit or miss proposition. But with so many conflicting claims about one vendor's product being better than another, we can understand why you might want to leave it to chance.

The fact is, what really makes one protection scheme better than another is the level of security it provides. For more than a decade, we have been pioneering seamless, reliable security systems for your applications and data. Software Security's many patents are evidence of our continuing ingenuity in developing ways of protecting your intellectual property. Our latest advances in software distribution, network license control, and "metering" are worth looking at.

But that's only part of the story. We offer a wide range of developer tools including our very highly secure AEGIS System™ which requires only a few minutes to implement. In addition, we understand the importance of our relationship with our customers and are fully committed to the best developer support program in the business.

If you are serious about protecting your software, contact Software Security and ask for an evaluation kit. It contains everything you need to explore all of our outstanding protection methods. So call today and see why there's a big difference between the bull's-eye and the bull.
for this evaluation, I would have based my
table on a spreadsheet PowerObject. As it
was, I ended up building a more limited
table in my own code.

Where XVT falls shortest versus C++/Views and Zinc is in customization. The
C++-based systems, both of which pro-
vide source code, are readily customized,
while XVT's C-based library is not. As I
wrote this review, XVT Software was
nearing release of Power++, its C++ prod-
uct. Power++, unlike XVT++ (XVT's ear-
lier C++ product), is a high-level applica-
tion framework that will eventually
form a foundation for PowerObjects. It
won't yet bring XVT into the highly ab-
stracted realms occupied by C++/Views
and Zinc Application Frameworks.

Nevertheless, XVT today is the most
straightforward and stable path between
Windows and Mac programming and pro-
gramming to an abstract GUI. Pending im-
provements like portable bit maps and
PowerObjects will make XVT an even
stronger contender.

Both Zinc and C++/Views are based
on C++, but the similarities end right
about there. While C++/Views takes a very
high-level, abstract view of the problem
domain, Zinc uses the benefits of C++ to
provide powerful customization features
and an extensible, extremely flexible API.

Zinc abstracts low-level features such
as devices, window objects, and events; it
does not abstract event handling for every
window object. In fact, direct handling of

events are the model in Zinc—you han-
dle system events, logical events sent by
Zinc, and even use events sent through the
event queue to communicate with other
objects inside your program.

This abstraction of features like events
and devices makes handling custom be-
haviors on different platforms easy; you
can get a logical event from the system
that tells you to redisplay a window, or
you can translate the actual WM_PAINT
message that it represents when you're
running on Microsoft Windows. You can
build a single executable file that can han-
dle DOS graphics and DOS text simply
by setting the appropriate virtual display;
all the other code in your system remains
intact.

It's not all low-level. Zinc does provide
powerful, high-level classes like toolbars,
and a system-wide help system that allows
you to maintain context-sensitive help just
by assigning help contexts to objects. Zinc
also has the most complete collection of in-
put objects, like formatted strings and oth-
er windows objects that can verify entry.
And Zinc's window objects are true ob-
jects, so they connect together as easily as
Lego blocks. For example, you can build a
scrolling list box with text objects, then
use the same code to present a list box that
includes bit maps. You just have to hand
bit-map objects to the list box instead.

One of Zinc's most powerful features
is its object repository, which stores re-
source-type and other objects in a persist-
ent object database. The Zinc Designer,
Zinc's analog to a resource editor, actu-
ally instantiates these objects as you work
interactively with the design. The database
is hierarchical, which lets you store multiple,
linked copies of objects, say one menu ob-
ject in English and another in Spanish, for
later retrieval. In upcoming releases, Zinc plans to add
unicode support to accom-
modate double-byte lan-
guages.

Unfortunately, all this
flexibility gives Zinc a steep
learning curve. It's always
hard to find the handle on
C++ application frame-
works, because it takes
some time to know where
you should look for the en-
try point in a class hierar-
chy. C++/Views addresses
this to some extent with the
browser, but there is no
similar feature in Zinc.

I got most of my sample
application done using Zinc, but I confess
that I never knew whether I was using the
best design to handle a problem or whether
I'd used the right class or done things the
easiest or most efficient way. Keeping
track of events and grappling with the class
hierarchy was a daunting task. If you have
the time to learn it well, Zinc is potentially
the most powerful package in this col-
clection; however, don't expect to become
skilled at Zinc programming quickly.

Cross-Platform Picks
Choosing a cross-platform development
environment is not a trivial undertaking.
Once you've made the choice, you will
have to commit a great deal of develop-
ment effort to building code that is com-
pletely dependent on the toolkit and the
toolkit's future. But that investment is
made worthwhile by the elimination of
learning new native APIs and by the ef-
fort saved in not having to maintain mul-
tiple code bases.

The payoff to this investment makes
learning even a complex package like Zinc
potentially worthwhile. Or, if you're look-
ing to C++ to provide an elegant, design-
focused development model, C++/Views
would be an excellent choice. But I'm go-
ing to finish only one version of my table
editor, and I'm going to do it in XVT.
XVT's simple API, strong tools, and strong
industry-support guarantee that the time
and money invested in shifting to a plat-
form-independent GUI will pay off in re-
duced effort down the road.

Steve Apiki is senior developer at Appropriate So-
lutions, Inc., a Peterborough, New Hampshire-

based consulting firm specializing in cross-plat-
form development. He is also a BYTE contributing
editor. You can reach him on the Internet or BIX at
apiki@bix.com.

---

About the Companies

Llant Software
(C++/Views)
959 Concord St.
Framingham, MA 01701
(800) 237-4873
(508) 872-8700
fax: (508) 626-2221
Circle 976 on Inquiry Card.

XVT Software, Inc.
(XVT)
4900 Pearl East Circle
Boulder, CO 80301
(800) 678-7988
(303) 443-4223
fax: (303) 443-0969
Circle 978 on Inquiry Card.

The WNDX Corp.
(WNDX)
1550 8th St. SW,
Suite 305
Calgary, Alberta,
Canada T2R 1K1
(403) 244-0995
fax: (403) 244-1030
Circle 977 on Inquiry Card.

Zinc Software, Inc.
(Zinc Application Frameworks)
405 South 100 E
Suite 305
Boulder, CO 80301
(303) 443-4223
fax: (303) 443-0969
Circle 979 on Inquiry Card.

---

Steve Apiki is senior developer at Appropriate So-
lutions, Inc., a Peterborough, New Hampshire-
based consulting firm specializing in cross-plat-
form development. He is also a BYTE contributing
editor. You can reach him on the Internet or BIX at
apiki@bix.com.
Opening Night for Premiere 3.0

If you've got the hardware to handle it, the newest version of Adobe Premiere delivers powerful tools for multimedia productions

BOB LINDSTROM

Adobe Premiere was a landmark program when it came out in December 1992. As one of the first video creation and editing tools for the Macintosh, it introduced a whole new audience to the possibilities of desktop video and helped boost the legitimacy of Apple's QuickTime video standard.

Premiere's greatest strength has always been its intuitive interface. Video editors can place graphics, animations, digital video, and digital audio onto rows of independent tracks. Premiere then assembles the tracks into an integrated video production, complete with transitions and special effects. It is an ideal tool for producing inexpensive multimedia presentations and training videos, but it also works effectively as an off-line video editor that mocks up a final cut in digital form and then generates an EDL (edit decision list) to take to a professional studio. No matter which way you use Premiere, version 3.0 will have you producing digital video faster, more efficiently, and more creatively than ever before.

While some Premiere enthusiasts may be disappointed that this enhancement is not overflowing with major new features, others will admire the streamlined interface, the improved performance and image quality, and a few brand-new goodies that make a very good product even better.

The Way It Works

Using the familiar multitrack audio/video interface that is fast becoming the standard for multimedia presentation software, Premiere lets you mix several audio tracks and cut between two digital video/graphics tracks in the style of an analog A/B Roll videotape-editing system (i.e., two players feeding into a single

In creating a Premiere movie, you start by assembling video, audio, and graphics in the Project Window. You then drag-and-drop clips onto a track in the Construction Window. Note the time line across the top of the window. Premiere saves the SMPTE time code that identifies the clip. You select special transition effects from the Transitions screen and place them on an effects track of the Construction Window. From the Audio Clip Editing Window, you can edit a sound file and drop the finished clip onto an audio track. Premiere combines all the digital audio tracks into a single soundtrack. Gradient-filled titles are created in the Title Window and added to the Superimpose track. You can preview your work before committing it to tape or disk. When you're finished, Premiere assembles all the elements into an integrated digital movie or generates an EDL in one of several common formats.

January 1994 Byte 179
Adobe Premiere 3.0 provides up to 99 video and 99 audio tracks for placing and synchronizing video, audio, graphics, and text in elaborate QuickTime movies.

clips with an internal capture board. Premiere remembers and saves the SMPTE time code that identifies the clip. When you've finished assembling your audio/video materials, titles, and transitions in Premiere's multitrack Construction window, the program automatically generates an EDL in one of several common formats, including Sony BVE, Grass Valley, CMX 3400, or any format supported by a Premiere Plug-In extension.

The admission cost for all this video magic is a relatively powerful Macintosh system. Premiere 3.0 requires a Mac with a 68040 processor, 4 MB of free RAM (6 to 20 MB is recommended), an 80-MB or larger hard drive, System 6.0.7 or higher, QuickTime 1.6 or higher, and 32-bit QuickDraw 1.2 or higher.

The list price for Premiere 3.0 is $695. A CD-ROM-based deluxe edition is $795; it includes QuickTime tutorials, Adobe Acrobat Reader software, video clips, and Adobe's Type On Call font CD-ROM. Current Premiere owners can upgrade to the floppy disk version for $179 or the CD-ROM version for $249.

Even More Tracks
With version 3.0, Premiere wizards will be able to develop enormous projects. The program now includes up to 99 audio tracks and 99 video tracks.

The gain on each audio track can be controlled separately for refining the mix. When you create a movie, Premiere combines all the digital audio tracks into a single soundtrack. The miracle of digital sound mixing is very apparent: The audible results are clean and noise-free, even when a dozen tracks are being mixed together. While few users will exhaust all these audio resources, the additional tracks let Premiere produce unusually complex, layered soundtracks.

Similarly, the additional video tracks, actually added as Superimpose tracks, provide the power to concoct extensive visual overlays, animations, titles, and other tricks, each with individually controlled motion paths, display transparency levels, and video filters. More video tracks add up to increased flexibility when designing Chromakey-like mattes.

Another new feature, the virtual clip, exploits the abundance of video tracks. Any multitrack segment can be defined as a virtual clip and subjected to as many as eight levels of processing and transition effects. You could, for example, define a dissolve between two video segments as a virtual clip, add a motion setting to that clip, and then wipe from the dissolving clips to a third clip. The virtual clip takes Premiere 3.0 a quantum leap forward in producing intricate video effects.

Better Video
Even if you aren't prepared to challenge MTV with a virtual-clip crazy quilt, the new tools and features in Premiere 3.0 can improve the fundamental video quality of all your work. When you are using a QuickTime-compatible video-capture board to store digital video from within Premiere, the video Waveform Monitor and Vector Scope contain new tools to fine-tune the quality of your capture.

A lineup of on-screen sliders gives you the usual controls over hue, color saturation, brightness, contrast, sharpness, black level, and white level. The Waveform Monitor charts the luminance and color saturation. The Vector Scope shows the hue and saturation levels. The best way to exploit these new tools is to play back a color-bar pattern from your input source and then adjust the sliders to maximize the quality of your source video capture.
The best sound is not in the cards.

PORTABLE Sound Plus

Perk up your presentations. Make training more effective. And, put some guts into your gaming pastimes. Anytime. Anywhere. In fact, if you are not a card carrying member of the computer set, you have to hear PORTABLE Sound Plus from DSP Solutions. You know, those real smart people who make simple sound solutions.

PORTABLE Sound Plus is the first portable external sound peripheral to deliver 16 Bit CD quality music with stereo audio capabilities. And, since you just plug into your IBM PC or compatible, desktop or laptop parallel port, you do not need an engineering degree or even a screwdriver.

When you compare PORTABLE Sound Plus to any other external sound peripherals, you will see why anything else is just noise. PORTABLE Sound Plus is based on advanced Digital Signal Processing technology, so you will enjoy the greatest compression capability with the highest quality sounds. Here is something else that will be music to your ears. PORTABLE Sound Plus comes complete with everything you need including a high fidelity speaker and built-in microphone. There is an "Audio-in" for a CD or tape player and a "Line-out" for external powered stereo speakers. Even a built-in smart parallel port pass through so you can keep printing.

Whether you take your work across the hall or across the country, with PORTABLE Sound Plus, you have all the cards you need to play right in your hip pocket. The hinged design lets you flip up the unit if you are short on desk space or lap space. And, the power will always be with you whether you use rechargeable or non-rechargeable AA batteries. PORTABLE Sound Plus also comes equipped with an AC/DC power converter.

As a bonus, you will get all the software you need to communicate. Like Lotus Sound™ an OLE server for Windows 3.1. WinReader for Windows 3.1, a handy text-to-speech utility. DSP Solutions' DOSTalk and DOSReader text-to-speech applications. Show & Tell For Kids™ for Windows – an easy to use MultiMedia Authoring program. It is also Sound Blaster and AdLib compatible.

Why compromise on quality, portability, compatibility or affordability? When all the cards are on the table, PORTABLE Sound Plus from DSP Solutions is your ace in the hole. Suggested retail is only $198.95.

To order or obtain more information about PORTABLE Sound Plus, write or call DSP Solutions, or, contact your local dealer.

Sales Office: 550 Main Street, Suite J, Placerville, California 95667. Telephone: (916) 621-1787. Fax (916) 621-2093.

PORTABLE Sound Plus is a trademark of DSP Solutions, Inc. All other product names are trademarks or registered trademarks of their respective owners.

Circle 136 on Inquiry Card.
just as if you were using analog instruments in a video studio. If you lack the color-bar display, a Source Video preview window lets you make adjustments to please your eyes.

Veteran Premiere users may also notice an improvement in the quality of transitions and motion effects. The program is now able to apply subpixel motion (down to 1/8 pixel) and field rendering to all effects to guarantee the smoothest possible movement with no image breakup. Even convoluted digital effects can now be executed, with polished results that are worthy of an expensive, professional video generator.

Fine-Tuning the Interface
A bundle of features have been put into version 3.0 to ease the inevitable strain of juggling cutting-edge multimedia technology. Throughout the product, large and small refinements to interface and function make Premiere easier to use.

When you are using a computer-controlled deck and SMPTE time codes to digitize video clips, Premiere has a batch digitizing mode. Just identify your clips by their SMPTE time codes, and Premiere will digitize and save the lot while you duck out for a quick, or not-so-quick, beverage break.

In past versions of Premiere, you could get lost in the morass of preferences and variables. With 3.0, you can create presets for all program settings and save them to disk. For example, you can use one preset when you’re developing for CD-ROM, load another for digitizing, and apply still another when creating multimedia presentations. And you won’t have to guess whether you covered all the bases: Set it up right once, save the preset to disk, and your preferences will always be correct.

Thumbnail images of clips are viewable in all windows in a range of user-selectable sizes and configurations. Similarly, click-and-drag operations are more convenient because you can now select multiple items and drag them together. More important, however, the Preview function has been accelerated and expanded. You’ll find yourself spending less time staring unproductively at the Mac while waiting to see the test results from your latest digital edit.

If you are working on only one segment of a movie, you can update the portion of the preview that has been altered without touching the rest of the sequence. Previews can also be played from disk at full frame rates.

When you ultimately get around to the Make Movie process, the system creates the final product without unnecessarily reprocessing the effects and transitions. Movies that contain no digital transitions or effects can be processed almost immediately.

While these convenience features may not be as attention-getting as some of the other improvements in 3.0, the time-saving improvements are like manna from heaven for Premiere users with short deadlines and a tendency toward impatience. This new version will get you to the final product quicker than ever.

Premiere Screening
So how does it work? Premiere performed superlatively using video clips that I captured with New Video’s high-end Eye-Q system, a full-screen, full-motion audio/video capture and compression setup. Furthermore, it used Eye-Q’s QuickTime acceleration and video display features transparently.

My one warning: You need a very powerful hardware configuration to make the most of Premiere. Don’t take the 4-MB RAM requirement or even the 6-MB recommendation seriously. When I took my system down to 8 MB, I experienced frequent program errors when previewing brief video creations. Worse, I also experienced several system crashes, including one that corrupted the hard drive—all apparently due to memory shortages.

Premiere was otherwise bullet-proof, performing like a trooper even when I threw multiple audio and video tracks at it. I was especially impressed with its speed and quality when mixing down 10 or more audio tracks. Just be sure to have plenty of RAM. I’d recommend at least 16 MB.

Another point that can’t be overstated is the need for lots of hard drive storage. The Eye-Q board can compress video down to 9 MB per minute, but even at that, it’s not going to take long to fill a disk. Trust me—after spending a few hours with Premiere, those 1-GB hard drives will start to look very tempting.

Finally, generating a few seconds of video, mixing several audio tracks, and calculating a couple of digital transitions took 3 to 4 minutes on my Centris 650. If time is an issue (and time is always an issue), you’ll want the fastest Mac you can get when running Premiere.

But if you have the hardware and storage space to back up its remarkable power, Adobe Premiere 3.0 is a masterpiece at the cutting edge of multimedia technology. There is enough functionality, flexibility, and sheer fun here to keep even a hypercharged creative mind going for years.

Bob Lindstrom (Eugene, OR) is a nationally syndicated columnist and composer. He is a former creative director for Dynamix. He can be reached on BIX to “editors.”
**Digital-Media Power**

Silicon Graphics' new Indy workstation is low on price but high on graphics performance, and it works with both Macs and PCs

**BEN SMITH**

I usually avoid spending words on ease of installation. After all, you install a workstation once; you run it every day. I'm making an exception for the Indy, however. In taking a second look at Silicon Graphics, Inc.'s new low-cost workstation, I found the Indy exceptionally easy to set up and use, as well as entertaining. In a month of hands-on use and testing, I also found it as fast and capable with graphics, sound, and video as I'd expected. (For hardware details on how the Indy achieves its performance, see "Apple, SGI Blaze Video Trail," September 1993 BYTE.)

The fun begins as soon as you open the Indy's shipping box. Next to the keyboard and mouse, you'll find red, blue, and yellow rubber balls—for juggling—and a colorful poster that shows how to assemble your system. If you resist an attempt at juggling, you can easily have the system up and running in under 15 minutes.

**Serious Fun**

The system comes with software loaded. Press the power button on the front of the compact system, and you'll soon find yourself on an introductory musical-video tour of what SGI and the Indy can do. The theme is "serious fun," and the three juggling balls show up as video icons that lead you through a pleasing collage of graphics, video, sound, and voice, all forms of data that can be used seriously in what SGI terms digital-media communications.

The IRIX log-in screen has icons for each user. Besides root, guest, and tutor there are two accounts that will attract your attention: EasySetup and OutOfBox. You click on EasySetup to give your system a name and network address and to set up the account for the major user. OutOfBox restarts the colorful introductory tour. The guest account holds all the demo applications; the tutor account gets you up to speed with SGI's new Indigo Magic user interface and its associated work spaces, buttons, windows, and icons.

The Indy is a new system with a significant amount of new hardware and an entirely new design of the operating-system interface. In fact, the operating system is different right down to its core. IRIX 5.1 is an SGI-enhanced release of Unix System V release 4.1 with all of its capabilities for memory-mapped files, dynamic shared libraries, and run-time linking, plus more facilities for real-time event handling.

**More for Less**

Compared to the Indigo, SGI's original venture into the general-purpose computing market, the Indy is visually less cute and more practical. From an ergonomic point of view, the Indy is even quieter than the quiet Indigo, and its compact workstation form factor fits the desktop better than the Indigo's mini-tower.

More important, the Indy is faster at general computing operations while costing substantially less than the Indigo it replaces in SGI's workstation line.

Even more so than with the Indigo, SGI has priced the Indy for commonplace computing—desktop publishing, computer-based communications, database access, and graphical image manipulation. Prices start at $4995 for a diskless workstation with 32 MB of RAM, 8-bit video, and a 15-inch monitor. The hardware emphasis is on 2-D graphics, rather than the 3-D graphics performance that SGI built its reputation on.

The Indy's main memory expands to 256 MB, and there are two bays for mass storage devices. Drive options include hard drives of up to 1 GB in capacity and a 21-MB floptical drive that can read and write MS-DOS and Mac 3½-inch high-density disks. The base model comes with an 8-bit color display system and a 15-inch monitor.
**Reviews Digital-Media Power**

**Performance Results**

BYTE's benchmark results are indexed. On the Unix benchmarks, a Sun SparcStation 1 running SunSoft 4.3 = 1. The results below show SGI's Indy to be roughly 6.5 times faster overall than the SparcStation. For individual low-level portable benchmark tests, a 60-MHz Pentium with a 256-KB cache, a 64-bit data path, and 24 MB of RAM running MS-DOS with a 32-bit DOS extender = 1. The results put the Indy at roughly 1.5 times faster than the Pentium.

<table>
<thead>
<tr>
<th>TEST</th>
<th>INDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic test (double)</td>
<td>8.7</td>
</tr>
<tr>
<td>Dhrystone 2 (w/o register variables)</td>
<td>4.5</td>
</tr>
<tr>
<td>Exed throughput</td>
<td>5.2</td>
</tr>
<tr>
<td>File copy (30 seconds)</td>
<td>16.2</td>
</tr>
<tr>
<td>Pipe-based context switching</td>
<td>2.2</td>
</tr>
<tr>
<td>Shell scripts (eight concurrent)</td>
<td>2.9</td>
</tr>
<tr>
<td>Portable Benchmarks</td>
<td></td>
</tr>
<tr>
<td>Numeric sort</td>
<td>0.89</td>
</tr>
<tr>
<td>String sort</td>
<td>0.43</td>
</tr>
<tr>
<td>Bifield operations</td>
<td>1.48</td>
</tr>
<tr>
<td>Emulated floating-point</td>
<td>2.20</td>
</tr>
<tr>
<td>Simple math</td>
<td>2.15</td>
</tr>
<tr>
<td>Transcendental math</td>
<td>1.25</td>
</tr>
</tbody>
</table>

level benchmarks. The Unix benchmarks show the Indy to be 6.5 times faster than a Sun SparcStation 1 running SunSoft 4.3. The low-level benchmarks show the Indy to be roughly 1.5 times faster than a 60-MHz Pentium with a 256-KB cache, a 64-bit data path, and 24 MB of RAM.

All SGI systems are source code compatible. Models like the Indy that come without high-end graphics processors use their CPUs to create effects done in hardware on the graphics boards of other SGI systems. The Indy is not a Reality Engine-capable machine (see “Damn the Torpedoes!”, November 1993 BYTE), so many of these effects are done with system software rather than in the hardware. But with its R4000 CPU running at 100 MHz, even these advanced effects are in reach.

**Beyond the Macintosh**

Despite the hoopla about the advanced digital-media communications features of the Indy (and Apple's AV Macs), networks that support videoconferencing and the conferencing software are just emerging. It will be a year or two before those capabilities will be an important consideration.

The current need for a system like the Indy is in digital-image manipulation, as in prepress image computing, where traditional machines have been either very expensive or computationally inadequate. (If you want time to juggle, try manipulating 100-MB images on even the most fully configured Mac Quadra.) Adobe has ported both Illustrator and Photoshop to SGI's hardware using Quorum's Latitude porting tools. Even without taking advantage of the pixel manipulation-specific operations of the SGI, they have achieved at least twice the performance as on a Quadra.

Coupling the Indy's relatively low price for high-powered pixel operations with its abilities to communicate with DOS and Mac machines over Ethernet ports (and read DOS and Mac media), Indy is a perfect match for Photoshop, with its tens of thousands of graphics and prepress professionals. Optimize Photoshop and its associated third-party tools for the Indy, bundle the two, and you should end up with heaven for graphics professionals.

Users moving onto the Indy from the Mac will find the Indy's user interface not only similar but superior to the Mac's. Of course, you will now be working on a Unix workstation, but you'll seldom be aware of it, since Unix is so attractively dressed. The hidden advantage is that you get real multitasking and can connect directly to large Unix servers for managing files and heavy-duty computing.

**Grievance List**

Playing back video images captured from the Indy's digital camera caused a core dump and a hang session. I also had problems with some network operations between the Indy (running IRIX 5.1) and an older Indigo (running IRIX 4.03), but none between either machine and other Unix workstations. And I was disappointed that the voice-command software was not yet part of the operating system. By the time you read this, SGI should have resolved these problems and shipped the developer tool kits as well.

The power button is on the front panel, and while it's easily accessible, it's too exposed. Only too often, I accidentally brushed against the button and shut down the system. An intermediary confirmation, like that provided on Next computers, would avert unwanted shutdowns. As it is, one accidental brush of the button and you reboot your system, risking loss of data in open files.

**About the Product**

<table>
<thead>
<tr>
<th>Indy (base price)</th>
<th>$4995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon Graphics, Inc.</td>
<td></td>
</tr>
<tr>
<td>2011 North Shoreline Blvd.</td>
<td>Mountain View, CA 94043</td>
</tr>
<tr>
<td>(800) 800-7441</td>
<td>(415) 960-1980</td>
</tr>
<tr>
<td>Circle 1078 on Inquiry Card.</td>
<td></td>
</tr>
</tbody>
</table>
Another element of concern is the lack of any S-video or NTSC video-out port. While the Indy provides both composite video and S-video input ports, you will have to purchase an optional GIO-bus (graphics I/O) video expansion card at $3395 for video out.

Digital Media for the Common World
When you buy an Indy, hard copy documentation is an option. You shouldn't miss it, however. While the Indy has the usual Unix man pages (and the X Window System application xman for reading them), there's also a complete set of SGI-specific documentation in an inviting digital-media format (and available with the Help button in the user environment). In fact, the SGI documentation is the finest example of electronic publishing I've seen.

SGI Insight documents start as FrameMaker files. An SGI-developed program takes FrameMaker's MIFF files and produces SGML (Standard Generalized Markup Language) files. Among the SGML markup instructions are hypertext jumps, external references to image files, sound, and animation. A second program takes the SGML files and compiles them into InSight files. SGI's InSight documentation viewer interprets the links and pointers, turning text into sophisticated hypertext. You end up with a documentation set that not only is easy to search and navigate but also includes images, video, sound clips, and buttons that launch associated elements of the documented applications.

According to Jim Clark, founder of SGI, the future of 3-D computing and digital media is the general consumer market (see "Roots and Branches of 3-D," May 1992 BYTE). With low-cost systems like the Indy, that prediction can become a fact. Before the time a data superhighway is in place, we have a chance to develop a great repository of valuable interactive digital material. We have tools to import existing text and develop it into sensually rich interactive documents.

The 500 cable channels of the near future need not be wasted on interactive versions of the Mickey Mouse Club. By generating images and animation, we now have real opportunities to enrich the world with high-bandwidth consumer communications. And because the Indy is so affordable, you can be part of the process.

Ben Smith is a testing editor for the BYTE Lab and the author of Unix Step-by-Step (Hayden Books, 1990). You can reach him on the Internet at ben@byteph.byte.com.

---

**You Need Tree City USA**

City trees add the soft touch of nature to our busy lives. They cool our cities, fight pollution, conserve energy, give wildlife a home, and make our neighborhoods more liveable.

The trees on city property, along streets and in parks, are an essential part of the urban forest. To keep these trees healthy and abundant, your town needs an organized program for their care...an annual action plan to plant and prune the city's trees, and to maintain their health.

You can make a difference — by planting and caring for trees in your yard and in your neighborhood, and by encouraging your city government's community forestry program.

Support Tree City USA where you live. For your free booklet, write: Tree City USA, The National Arbor Day Foundation, Nebraska City, NE 68410.

---

*The National Arbor Day Foundation*
FINALLY, COMPUTER SCIENCE EMBRACES THE LAWS OF MOTION.

Toshiba continues to drive PCMCIA technology: A 2.01 compliant Type II slot expands your options for storage, fax/modems, networking, and the future.

Compact and lightweight — less than 4.4 lbs. The Portégé T3400CT has been engineered to the extremes of portability without compromising usability.

The new AccuPoint™ isometric pointing device works in conjunction with click and drag buttons located comfortably beneath the thumbs.

INTRODUCING THE NEW ULTRAPORTABLE PORTÉGÉ.

Toshiba engineers haven't just redesigned the portable computer, they've reinvented it: The Portégé™ T3400 Series. Never before has a computer so perfectly balanced mass and speed.

Now you can travel with a system smaller than a notebook, yet graced with the feel of a full-size system. Portégé is driven by the full force of an i486™ SX/33 processor, and shines with Toshiba's renowned color active matrix or high-contrast backlit monochrome displays. Toshiba designers have even created the optional Port Replicator for simple, single-point connection to your desktop environment. See how far Toshiba has taken every aspect of portable computing. And think where it can take you.

Call 1-800-457-7777 for the dealer nearest you.

THE SHAPE OF THINGS TO GO.™
Toshiba discloses the secret to longer life. The ultra-lightweight Li-ion battery, with up to 8 hours of battery life, is the ultimate in power-per-ounce.

**T3400CT**
- 7.8" color TFT-LCD active matrix display
- 256 color SVGA
- 7.9" x 9.9" x 1.8"
- 4.4 lbs.

**T3400**
- 8.4" STN monochrome display
- 4.1 lbs.

**Both Models**
- 33MHz SL Enhanced i486™SX
- 120MB HD
- 4MB RAM (expandable to 20MB)
- Lithium-Ion battery
- Type II (5mm) PCMCIA 2.01 slot

- AccuPoint™ integrated pointing device
- Integrated BitBLT graphics accelerator
- VL-local bus video
- Ports: serial, parallel, FDD, Port replicator, and VGA adapter

- Windows™ 3.1, DOS™ 6.0, CommWorks™ for Windows

In Touch with Tomorrow

TOSHIBA

© 1993 Toshiba America Information Systems, Inc. All products indicated by trademark symbols are trademarked and/or registered by their respective companies.

Circle 117 on Inquiry Card.
They’re exactly the same, but somebody just paid $100,000 for the one on the right.

When you use illegally copied software, you’re committing a federal crime and risking a fine of up to $100,000. How can you and your company stay legal? It’s easy with our Software Management Guide. You’ll receive SPAudit for DOS and Macintosh,” comprehensive auditing software, a video and procedures for establishing and enforcing a policy that will keep your organization’s software legal. And, at only $80, it’s a real bargain when you consider what some people pay.
Programmers currently using Microsoft's Visual C++ will find the new version for NT familiar. The tools and libraries are almost identical. They will also find that Microsoft Visual C++ development system 32-bit Edition for Windows and Windows NT isn't flawless, but it does provide an abundance of tools and on-line documentation that helps programmers take advantage of Windows NT's capabilities.

Distributed on a CD-ROM, VC++/NT comes with two complete compilation environments, one that runs under NT and one that runs under Windows 3.1. However, the latter can create only executable files that use the Win32s subsystem, so you can't build Win16 executables. The full NT development environment is over 70 MB, although you can cut down on the space needed by leaving out some features or by running the compiler from the CD-ROM. In addition, the CD-ROM includes over 70 MB of documentation.

Like its 16-bit cousin, the NT version uses Visual Workbench to integrate tools by providing access to the compiler, debugger, profiler, code browser, and programming aids called application wizards. But VC++/NT improves on its predecessor by including all the tools and API documentation formerly available only in the Windows NT SDK (Software Development Kit).

The Programming Environment
To test the Windows NT programming capabilities, I built a Win32-based telephone database manager that uses the Windows interface. The program allows access to multiple databases, performs various searches, and can output formatted reports. It takes advantage of the new features of the Win32 API by using multiple threads: A thread is spawned to format the database, and each document has a background thread that keeps an index up to date. Whenever you modify the database, the thread wakes up and updates its information in the background.

The Visual Workbench allows easy access to the definitions of functions and variables, documentation for the operating-system calls, and the debugging and applications development tools. With practice, you'll be able to navigate through the system comfortably.

The Workbench's editor is flawed, however. In any environment, an editor is one of the most important programming tools, and in VC++/NT the editor serves as the glue that binds the entire system together. Unfortunately, it's underpowered and difficult to replace. It is not programmable, doesn't provide flexible control of key bindings, and has a fixed strategy for syntax highlighting. If you're a programmer who spends a long time customizing your favorite editor to make it an efficient tool, you will probably not be satisfied with these shortcomings, and the environment doesn't provide much support for using an alternative.

You can add your own editor to the tools menu and use it on files. But once you begin debugging, browsing, and navigating through your application to look up definitions, you must switch to the built-in editor, because there is no interface for sending status messages to an alternative one. Windows programming generally requires you to spend most of your time making incremental modifications in the midst of debugging and testing, so you will spend a lot of time in the built-in editor or lose the convenient interaction of the various tools.

I hope Microsoft improves the editor in future releases or provides better support for integrating third-party offerings.

Nevertheless, the Visual Workbench has some good features. One is the high degree of control it gives you when you build programs. Menus provide easy access to the different options available in the compiler and linker. In addition, the dialog boxes show the list of corresponding arguments that will be sent to the tools.

The Wizards
A distinguishing feature of VC++/NT is the set of wizards—programming tools that generate code you can use as a start toward an application. With practice, you can construct simple applications quickly using wizards. I used them to produce the interface to my multithreaded database browser.

To build an application using the wizards, you first open the AppWizard. It produces a generic application framework by displaying a window with a list of possible menu options for you to invoke or delete, depending on your application. Next, you design dialog boxes, menus, and other graphical resources in the App Studio. Then the ClassWizard allows you to tie these pieces to your code: It produces the appropriate procedure stubs for you to fill in. In the case of the database browser, I used App Studio and the ClassWizard to add dialog boxes (to ask the user for such things as search criteria and output formatting preferences), as well as to set various menu options and do some on-screen formatting.

When you write code to handle various situations, you can use the Wizards to generate the code for things like dialog boxes and menus.

App Studio, a programming tool that edits resources associated with an application, here is modifying a menu structure (top). You can change menu properties in the dialog box shown in the bottom foreground.
events, you interact with the internal state of the application. The world is divided up into documents containing objects, and the user can see any number of views of the document. You can modify objects based on system or user events; periodically, the objects will be asked to refresh their visual representation.

The wizards assume various idioms supported by MFC (Microsoft Foundation Classes) 2.0, which provides class definitions for Windows objects and the connections needed for Windows event handling. If you create your own data structures, you must conform to the wizards’ assumptions about idioms. For example, documents are saved by passing a serialize object to every object in the document. Each object in the document is responsible for saving or restoring itself by writing to or reading from the serialize object.

Unlike in some other programming environments, the wizards don’t keep the interface and the guts of the application separate. After the wizards produce their code, you live within the application and are not shielded from it in any way. Whether you like that strategy is something of a personal preference; some programmers prefer to have more abstraction, while others like to see all the code together. Given the path VC++/NT has chosen, I found that the code it produced was easy to work with. It is well structured and well commented, and modifying the code is straightforward.

A more curmudgeonly lot of programmers object to having tools build their applications at all. These programmers may accept visual-resource editors, but they will not be in control of all the code. Thus, many of the tools in VC++/NT won’t interest them much, but they will find the abundance of source code to be a real help. They can work with or modify it to their liking, using it as a model when they forge their own path. Although the wizards rely on MFC extensively, MFC can still be useful to programmers who choose to perform their own sorcery. The classes, which come with full source code, provide a variety of useful data structures and access to complicated subsystems like OLE.

Multithreaded Applications
Adding threads to programs that use MFC can be a problem, because the classes are not reentrant; that is, they cannot be used by different threads at the same time. There is a reentrant C library, however, so threads are free to use the standard C functions when that version of the library is linked in. If you want to use threads in a program relying on MFC, you first need to recompile the MFC library itself to use the reentrant C library. Then the threads can use the C library functions and walk over internal data structures, as long as they stay away from the MFC. (Microsoft plans a reentrant version of MFC in the next release of VC++/NT.)

In my case, the restriction wasn’t too onerous because I was using threads to handle time-consuming operations on basic data structures. In my application, some of the menu choices invoke handlers that spawn a thread; they immediately return, leaving the thread to continue working in the background. One separate thread is invoked when each document is opened. The thread hovers in the background until the document is closed, waiting on a semaphore. When it wakes, the thread checks to see if it was awakened in order to terminate; if not, it knows that the database has been modified and the index must be updated. If you have a more ambitious use of threads in mind, such as using them to modify different parts of the GUI simultaneously, you’ll need to abandon MFC or wait for a subsequent release.

Other Tools
The VC++/NT debugger is also integrated into the Visual Workbench. It has the usual features for stepping through the source code being executed, and a flexible facility for specifying breakpoints. The debugger allows you to examine data structures and expression values in a dialog box called Quick Watch. You can add a value that you examine in Quick Watch to a watchpoint window in Workbench. Expressions in the watchpoint window are updated whenever you suspend an execution. Also, the support for multiple threads is handy. You can suspend and resume them individually and switch the active focus among them.

The on-line documentation in VC++/NT is extensive and very useful, and I found myself spending a lot of time in it. It comes with a browsing utility that is an improved version of the standard help-file browser. The documentation isn’t flawless: it’s plagued by some unclear language and typos in both text and sample code. Caves aside, after you have had some experience navigating through the documentation, you’ll find it a terrific resource.

Another tool that was much updated in the move to NT is Spy++, which lets you explore the threads, processes, and windows that are currently active in the system. It’s a useful tool for seeing how a multithreaded application is executing.

The Compiler
Although you’ll spend most of your time interacting with the programming environment, the heart of the system is the compiler. Microsoft has improved its compiler somewhat by adding support for Pentium optimization, but the main difference is the move to a flat 32-bit address space. As in previous versions of Visual C++, the compiler produces code that is efficient in both space required and execution speed. As the graphs show, compilation speed is on a par with that of Watcom C/C++, the fastest product in BYTE’s recent roundup of C++ compilers (see “C++ Does Windows,” September 1993 BYTE). The compiler is also heavily dependent on the amount of memory in the system: I strongly second Microsoft’s recommendation of at least 20 MB of RAM.

You also need adequate disk space. The compiler takes up 60 MB to 80 MB, and each application you’re working in takes its share. Just the basic application framework, when compiled in debugging mode, chews up 6 MB with all its subsidiary files.
Select any 5 books for $4.95 only
(Values to $184.75)
when you join the The Computer Book Club®

As a member of The Computer Book Club...

you'll enjoy receiving Club bulletins every 3-4 weeks containing exciting offers on the latest books in the field at savings of up to 50% off of regular publishers' prices. If you want the Main Selection do nothing and it will be shipped automatically. If you want another book, or no book at all, simply return the reply form to us by the date specified. You'll have at least 10 days to decide. If you ever receive a book you don't want, due to late mail delivery of the Bulletin, you can return it at our expense. And you'll be eligible for FREE BOOKS through the Bonus Book Program. Your only obligation is to purchase 3 more books during the next 2 years, after which you may cancel your membership at any time.

All books are hardcover unless otherwise noted. Publishers' prices shown. If you select a book that counts as 2 choices, write the book number in one box and XX in the next. A shipping/handling charge & sales tax will be added to all orders. ©1994 CBC

BY104
When you compile for distribution, the executable file shrinks below 150 KB, but if you have several projects in progress at once, you'll use a lot of hard disk acreage.

Microsoft has added some new features to the compiler to better support the NT environment. In particular, it has added direct language support to allow the C/C++ programmer to deal with threads more easily. There is a direct call for creating a new thread (_beginthread) and passing arguments to it; the construct is mapped to the appropriate API calls by the compiler. You can specify that static or global data is to be thread-specific by using the C++ extended declaration facility: Specifying the declaration _declspec(thread) int foo tells the compiler that each thread is to have a private instance of the variable. Local variables do not need special treatment because each thread has its own stack.

One significant problem with the compiler is that it does not support strict ANSI compatibility. Microsoft chose to support only the functionality of cfront 2.1, adding exception handling via preprocessor macros and the compiler. The C++ exception-handling mechanism in cfront 3.0 and the use of templates are not supported. This decision has unfortunate consequences for the C++ programmer who is familiar with the ANSI dialect or who wishes to use sample code that relies on it. Templates are such a useful mechanism that C++ programmers are increasingly encouraged to use them; it's a pity that they're not available in VC++/NT. Microsoft says that an updated version of VC++/NT, due later this year, will support both cfront 3.0 exception handling and templates.

### 32-bit Changes

In moving from the 16-bit to the 32-bit version, programmers face a variety of changes. Some are caused by the switch to a new API, and some by the updated programming environment.

The Win32 API has a lot of new features, ranging from Bézier curves and security support for multiple threads. An application that uses threads effectively performs time-consuming operations in the background and lets you carry on with your programming. But these benefits don’t come free: You’ll often need to restructure the structure of your application to take advantage of threads. The compiler can’t do much to help you with that.

The Visual C++ environment has also been upgraded with new features in the NT version. A major improvement is that the package now includes tools and documentation formerly available only in the Windows NT SDK. One of the tools is the help compiler, which converts annotated RTF files that you can produce with Microsoft Word or other tools into the HLP files that the NT help system understands. In addition to the SDK additions, new monitoring tools let you watch the interactions between threads and DDE communication. The profiler has also been improved with a better interface.

Since the Win32 API is the only one supported, you need to recode applications relying on Win16 API features. For example, the Win16 communication API has been replaced; NT programs communicate through a serial port with the same calls that handle file I/O. All support for DOS has been dropped, and applications can no longer access INI files directly. Most other changes in the API are to functions that formerly returned 16-bit values packed into a 32-bit word. The on-line documentation summarizes the various changes.

Microsoft also dropped the QuickWin environment that supported DOS programmers with a simple Windows API. You must either use the Console API or move entirely into the Windows environment. VBX custom controls are gone, too.

### Is the 32-bit Version for You?

Should you switch to the 32-bit version? It depends on what environment you’re moving from and whether you plan to take advantage of the Windows interface.

If you currently write programs using simple-stream I/O or full-screen text I/O, the NT version will let you either take the plunge into Windows programming or settle for the Console API’s more limited functionality. To test the latter, I ported Unix and Win16 applications. The Unix programs consisted of two-stream I/O filters that manipulated a phone database, performing lookups and converting the database into a formatted form for printing. The Win16 application was a text browser.

I found the consoles fairly simple to manage: The API consists of a few dozen functions that let you create a console, control the cursor, do simple I/O, and catch
some kinds of events, like mouse-clicks. Consoles are also handy for debugging GUI applications, because the program can output status messages and accept debugging input even when the primary graphical interface is not working or is incomplete. While it's simple to port applications to the Console API, programmers who don't need more than that from their development environment will have little reason to favor VC++/NT over its competitors. And if strict ANSI compatibility is important to you now, you would be well advised to look elsewhere.

On the other hand, the audience Microsoft is really aiming at is the current body of Windows 3.1 programmers. They will find much to like about VC++/NT, particularly if they've been using its predecessor. One of the highest priorities in designing NT was making it easy for programmers to port their 16-bit Windows applications quickly and easily. By following the Win16 API closely and porting MFC 2.0 to NT, Microsoft has done most of the porting work for you. What remains is to get rid of the segmented memory assumptions, fix some data-structure packing issues, and move to a somewhat changed API.

To ease the transition, Microsoft supplies PortTool. It runs through a Win16 program and identifies places where the API has changed or where there are 16-bit declarations that are no longer valid. PortTool is not integrated into the Visual Workbench. To access it, you have to invoke it manually or add it to the Tools menu. You can use it to go through your program interactively, or it can process files and add comments where it found potential problems. Microsoft supplies source code, so you can tailor the program to your needs if you are planning to use it repeatedly. While it's hardly a panacea, PortTool is a useful tool for finding trouble spots.

The bottom line: VC++/NT is the programming environment to beat—every other NT compiler will inevitably be compared to it. Although there are some flaws and weaknesses, Microsoft has succeeded in delivering an integrated package with the tools and documentation that allow a Windows NT programmer to take full advantage of the operating system.

Oliver Sharp is an associate at Heuristic Research, Inc., an optimization software developer in Berkeley, California. He is completing his Ph.D. in computer science at the University of California—Berkeley, investigating compilation for parallel architectures. He can be reached on BIX c/o "editors" or on the Internet at oliver@heuristicrsc.com.

HOW DO YOU GET A JOB WITHOUT EXPERIENCE? AND HOW DO YOU GET EXPERIENCE WITHOUT A JOB?

Most young people have one answer to this problem. They avoid it until they're out of college. But they could be getting solid work experience while they're still in college. With your company's help. And ours.

We're Co-op Education. A nationwide program that helps college students get real jobs for real pay, while they're getting an education.

But we can't do it without you. Those real jobs have to come from real companies. Like yours.

For more information on how you can participate in this valuable program, write Co-op Education, Box 775E, Boston, MA 02115.

Not only will you be giving students a chance to earn money and pick up the most valuable kind of knowledge, you'll be giving yourselves a chance to pick up the most valuable kind of employee.

Co-op Education.
You earn a future when you earn a degree.
THE ZEOS® CONTENDA... DON'T GET CAUGHT WITHOUT IT!

What a dream! The ZEOS Contenda sub-notebook is small enough to tuck away in your briefcase and so light you'll forget you have it! It's the perfect traveling companion.

All your business and home needs conducted in a bundle just shy of four pounds. Write letters and memos. Create presentations.

Keep in touch with associates through the send/receive fax modem. Organize your files, calendar, planner and more...keep track of all appointments!

What's more, with a standard 80MB hard drive, memory up to 10MB and your choice of a 386SL-25 or 486SL-25 Intel processor, the Contenda has plenty of power to run Windows. You'll also find you can work longer because the processor is intelligent enough to power down the memory, disks, modem and more when they're not in use. In addition, the compact package includes a built-in trackball and...
At An Ideal Fare...$995.

high-resolution backlit screen. It's a traveler's dream come true:
The world at your fingertips in a mighty and tiny portable bundle. Don't get caught without it!

AWARD-WINNING SERVICE, TOLL-FREE SUPPORT & WARRANTIES

We're the only company to win PC Magazine's Readers' Choice for Service & Reliability—for both desktops and notebooks—twice! We're here for you 24 hours a day, 365 days a year, and always a toll-free call away. All ZEOS systems come with a One Year Limited Warranty and a 30-Day Money-Back Guarantee. So call us now at 800-554-5226!

FAVORITE OPTIONS

<table>
<thead>
<tr>
<th>MEMORY UPGRADES</th>
<th>386SL: 2MB to 4MB</th>
<th>$99</th>
<th>486SL: 4MB to 8MB</th>
<th>$198</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMUNICATION</td>
<td>FastLynx File transfer software</td>
<td>$79</td>
<td>Internal 96/48/24 send/receive fax modem</td>
<td>$49</td>
</tr>
<tr>
<td></td>
<td>Internal 96/96 send only fax modem</td>
<td>$49</td>
<td>Xircom Ethernet adapter (10BT or Coax)</td>
<td>$349</td>
</tr>
<tr>
<td>ACCESSORIES</td>
<td>External 3.5&quot; floppy disk drive</td>
<td>$99</td>
<td>Extra battery</td>
<td>$99</td>
</tr>
<tr>
<td></td>
<td>Custom nylon carrying case</td>
<td>$79</td>
<td>Custom leather carrying case</td>
<td>$129</td>
</tr>
<tr>
<td></td>
<td>DC-DC adapter</td>
<td>$49</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Choose from one of our money-saving packages or build one to your exact specifications. Many other options available. Call for details.

CALL NOW TOLL FREE 800-554-5226 24 HOURS A DAY


STANDARD WITH EVERY ZEOS CONTENDA

- 25MHz 80386SL or 80486SL Intel CPU
- RAM expandable to 8MB for 486SL, 16MB for 386SL
- (486SL) IDE hard drive upgrade to 120MB
- Display: 640 x 480 VGA backlit, 23 dot pitch, Sharp 74" diagonal, up to 64 shades of gray
- 256K (386SL) or 512K (486SL) video RAM
- 486SL version includes 33V technology for added battery life
- PI local bus for Windows acceleration, high-speed floppy drive controller, built-in math coprocessor
- Supports simultaneous display with an external SVGA color monitor
- Replaceable and rechargeable NiMH battery
- 80-key keyboard with embedded numeric keypad and easy-to-use built-in trackball
- Serial, parallel and video ports, plus ports for optional internal fax modem and external floppy drive
- Fully-featured power management
- 9.7" x 6.1"; 3.9 lbs.
- FCC Certified Class B
- Complete ZEOS Customer Satisfaction Package.

PACKAGE 1

386SL Contenda: $995
Lease $42/month

486SL Contenda: $1495
Lease $63/month

- 2MB RAM (386SL); 4MB RAM (486SL)
- 80MB IDE hard drive

PACKAGE 2

386SL Contenda: $1295
Lease $55/month

486SL Contenda: $1795
Lease $65/month

- 4MB RAM
- 80MB IDE hard drive
- External 3.5" floppy disk drive
- Microsoft DOS 6.2 and Windows for Workgroups 3.11
- Plus Lotus Organizer

PACKAGE 3

386SL Contenda: $1595
Lease $67/month

486SL Contenda: $2195
Lease $79/month

- 4MB RAM (386SL); 8MB RAM (486SL)
- 80MB IDE hard drive
- External 3.5" floppy disk drive
- Custom leather carrying case
- Extra battery
- Choice of internal fax modem
- Microsoft DOS 6.2 and Windows for Workgroups 3.11
- Plus Lotus Organizer

Circle 126 on Inquiry Card.
It’s all there, word for word, an unedited electronic library containing the full-text of articles (except graphics) exactly as they are published in McGraw-Hill magazines and newsletters. And because it’s from McGraw-Hill, the world’s leading provider of information services, you also get unparalleled excellence and reliability of content.

Plus, you can search the entire McGraw-Hill database (over 45 leading publications) faster with more user-friendly ease than any other text. There are no cumbersome indexes, no summary words to look up and learn...so you can get right into your hunt for the information you need about companies, people, and products on any topic.

Make the connection to McGraw-Hill Publications Online today. For more information and our latest, complete list of publications, contact Andrea Broadbent at (609) 426-5523. Or fax this coupon to (609) 426-7352. Or send it to the address below.

Available through • Dialog* • NewsNet®
• Dow Jones News/Retrieval® • Lexis/Nexis®
• F.T. Profile (U.K.)
New Mac Blazes Technology Trails

The Mac Quadra 840AV packages more speed with new video and voice technologies

TOM THOMPSON

It's easy to become complacent with the incremental speed increases and bits of new technology Apple gives each new Macintosh generation. There's a good technical reason for the slow pace. Drastic hardware and operating-system changes tend to cause software compatibility problems for Mac end users, a bad scene that Apple wants to avoid. Remember the SCSI DMA that didn't quite work, and the serial compatibility problems with the Mac IIx? Or the more recent troubles with the Express Modem driver for the PowerBook Duo? All involved Mac design improvements that unfortunately got in the way of a lot of existing software. So you can hardly blame the company for keeping big changes to a minimum.

Thus, Apple's new AV Macs caught me off guard. The Quadra 840AV and Cen­

tris 660AV sport major improvements in hardware design, including a DSP (digital signal processor). They also offer several significant technologies ready to go: built-in video I/O, voice recognition, and a TTS (text-to-speech) engine. (For more details, see "Apple, SGI Blaze Video Trail," September 1993 BYTE.) The new Mac AV features are neat, capably implemented by Apple's engineers, but they also provide opportunities for a lot of the old stuff to go wrong. With this in mind, I took a serious look at a Quadra 840AV.

Test Drive
The Quadra 840AV that I tested arrived from Apple equipped with a 230-MB hard drive, a dual-speed CD-ROM drive, and 16 MB of RAM. Apple also threw in a POTS (plain old telephone system) Geo­Port adapter. The best compatibility test I can think of is to use the Quadra as my daily work machine. So I connected it to a spare Ethernet drop in my office, switched on File Sharing, and copied to it the contents of my Mac Iici's hard disk. The BYTE Macintosh benchmark suite followed, copied from a Mac file server.

The BYTE benchmark tests show that the Quadra 840AV is one fast Mac. At 40 MHz, it outpaces the 33-MHz Quadra 800 easily on the CPU, FPU, and video tests (see the graph). But the Quadra 840AV trailed the Quadra 800 on the disk tests, and the new SCSI Manager 4.3 is to blame. It handles I/O redirection, implements SCSI DMA, and provides some SCSI-2 command features, but it appears that this new flexibility adds overhead to hard disk I/O. If you use third-party drives, check that the driver software supports the new SCSI Manager; you will eliminate potential compatibility problems and ensure high throughput.

As you'd expect, the slower disk performance affected application benchmark results. The Quadra 800 edged just ahead of the 840AV on several application tests. If you use desktop publishing and scientific applications, though, you will get better performance from the 840AV.

The tests also indicate that the SCSI DMA feature doesn't help performance, for the same reason that it wasn't much use on the Mac IIx: The single-threaded Mac OS can't use it effectively. SCSI DMA won't help until the Mac OS undergoes a major overhaul, probably with the arrival of the microkernel.

Considering the radically new hardware that Apple has added to the Mac AV design (e.g., nine dedicated DMA channels for SCSI, serial, Ethernet, and sound), I expected to run into a lot of compatibility problems. I was pleasantly surprised to discover that this isn't the case. All my applications, including Claris's MacWrite Pro 1.0v4, Adobe's Illustrator 5.0 and Photoshop 2.5, Telnet 2.5, Lotus's cc:Mail 2.0, Aladdin's StuffIt Deluxe 3.0.6, and Symantec's Think C 6.0, worked just fine. So did my usual herd of indispensable Control Panels and Extensions, including Now Software's Super Boomerang 4.0.1p and WYSIWYG Menus, Adobe Type Manager 3.6, and Berkeley Systems' After Dark 2.0x.

Because of the new DMA serial drivers built into the 2-MB ROMs and the new nine-pin GeoPort connector that replaces the modem connector, I paid special attention to serial communications. On-line sessions using AppleLink 6.1 and America Online through a networked Shiva Net-Modem and a locally connected Global Village Teleport Gold modem worked fine.

Plain Speaking
PlainTalk is speaker-independent voice-recognition software, and it handled my Southern drawl fairly well. However, nearby conversations and sometimes my own typing made enough racket to confound it. To work reliably, PlainTalk requires a quiet environment—something not available to your average business worker.

In addition to effective speech recognition, PlainTalk's other strength is in providing the means for physically challenged folks to perform useful work. The TTS allows visually impaired people to "read" files, for example. Using TTS, PlainTalk, and the proper scripts, a blind person can
New Mac Blazes Technology Trails

Quadra 840AV Performance Indexes

<table>
<thead>
<tr>
<th>Worse</th>
<th>Low-Level</th>
<th>Better</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>6.61</td>
<td>4.67</td>
</tr>
<tr>
<td>FPU</td>
<td>6.69</td>
<td>4.66</td>
</tr>
<tr>
<td>Disk</td>
<td>3.39</td>
<td>4.68</td>
</tr>
<tr>
<td>Video</td>
<td>7.60</td>
<td>10.71</td>
</tr>
</tbody>
</table>

Running at 40 MHz, the Quadra 840AV is the fastest Mac yet. A new SCSI driver, however, puts hard drive performance slightly behind that of a Quadra 800 that BYTE tested previously. Slower drive performance spills over into some of the application test results.

You activate PlainTalk through the Speech Setup Control Panel. Switching on voice recognition launches two invisible applications, SR Monitor and SR North American English. The disadvantage to implementing voice recognition this way is that it takes 30 or 40 seconds before the PlainTalk service becomes available. The advantage is that when you switch PlainTalk off, the two applications silently quit and you recover the memory they used.

The memory savings are considerable. Using voice recognition along with the high-quality female voice option consumes nearly 4 MB of system memory. Small wonder that the review unit came with 16 MB of RAM instead of the standard 8 MB. With File Sharing, PlainTalk, System 7.1, and some favorite Control Panel and Extensions loaded, I had only 8 MB of free RAM left. Although you can save memory by using compressed versions of the voices, quality suffers.

A special microphone handles voice input. You place the mike atop your monitor and plug it into the Quadra 840's sound-input port (unless you're using the Apple 14-inch AudioVision monitor, which has the mike built in). The mike's focal point is approximately 30 inches in front of it.

Through the Speech Setup Control Panel, you select a phrase that alerts PlainTalk that you are directing commands at the computer. When PlainTalk recognizes such a command, it consults a command dictionary. If there's a match, it triggers an Apple Event. Otherwise, the computer utters a polite "Pardon me?" The command might launch a single application, or it might start off an AppleScript (the Mac OS's batch command language) that executes a whole cascade of preprogrammed activities. A bundled Speech Macro Editor lets you edit the command dictionary and add your own commands and AppleScripts.

Adding a new application to launch is just a matter of adding an alias file to the Apple Menu Items folder. You invoke the new application with an Open command—"Open Excel," for example. PlainTalk then creates an "open" Apple Event addressed to the Finder, which searches its menus for the stated item. Since the Finder Apple Menu is built from objects in the Apple Menu Items folder, the requested application is there and launches.

If you want to develop more complicated operations, you need AppleScript, UserLand Frontier, or another scripting language. Apple bundles the AppleScript editor with the Quadra 840AV.

Voice-command possibilities also depend on applications that are Apple Event
savvy, since the scripting languages use this IAC (Interapplication Communication) protocol. The number of applications supporting Apple Events was initially small but is growing rapidly and now includes Aldus PageMaker 5.0, QuarkXPress 3.2, Microsoft Excel 4.0, WordPerfect 3.0, and Aladdin’s Stufflt Deluxe.

To experiment with voice control and scripting, I used a beta version of SITcomm, Aladdin’s new terminal emulator application. Since most of SITcomm’s interface accepts Apple Events, I could log onto BIX, for example, without any scripting at all. I could just say “Open SITcomm” to launch the application, “BIX” to load the terminal settings and phone number from the internal address book, and “Connect” to actually connect to BIX. However, this isn’t a very practical way to control your Mac via voice commands. Instead, I created an AppleScript to painlessly sign me onto BIX with just a single voice command.

With the AppleScript editor, I recorded a BIX log-on session using SITcomm, switched off the editor’s recording mode, and then went back to tinker with the resulting AppleScript. Adding the new voice command with the Speech Macro Editor, I could then trigger the finished AppleScript by saying, “Connect to BIX.” It would then launch SITcomm, select the service, dial the number, and handle the log-on exchange.

With the Mac OS providing the heavy-duty technology to generate Apple Events from spoken commands, and with vendors writing Apple Event–savvy applications, you play the role of switchboard operator, making the connections between the Mac OS and applications by writing AppleScripts. There’s a huge opportunity here for developers to complete these connections by writing scripts for businesses.

**Phone, Fax, and Video**

The Quadra 840AV’s DSP uses a real-time operating system that can perform several signal-processing tasks simultaneously. One such task is the sound preprocessing for PlainTalk. Other programmed functions that the DSP can handle are telephony, modem, and fax operations. A bundled Telephone application lets the Quadra act as a phone, and, with the Apple AudioVision monitor, you can actually use the system as a speakerphone. Telephone can also answer the phone, play a recorded message, and then record a message from the caller—but you’ll need lots of hard disk space to record digitized messages.

continued
Live Video on the Mac

In testing the new Mac Quadra 840AV, I used Sony PCS-V2 and VideoLabs Flexcam cameras to obtain live video. Both provide only a composite video signal, and each has its own separate power-supply "brick," with the usual entourage of a power cable and a supply lead to keep track of.

Sony's PCS-V2 is a flat box with a fixed-focus, tiltable video camera, speaker, and microphone. It's designed to sit on top of your monitor, but this assumes the monitor has a flat area several inches wide along the top. Apple's AudioVision monitor has a steeply sloping top, so I had to put the PCS-V2 on the Quadra 840AV's housing instead. I looked at a preproduction version that is actually an inch deeper than the final version will be.

VideoLabs' Flexcam looks like a Martian tripod from H. G. Wells's War of the Worlds: A wide base sprouts a long, limber neck that ends in an eyeball contraption. This section contains a focusable video camera and two microphones for stereo sound recording. The PCS-V2's captured images looked better than the Flexcam's, but the Flexcam has the advantage that you can aim it at practically anything, including papers on a desktop (a form of scanning), and you can adjust the focus.

Using Apple's bundled Video Monitor application, I could observe the view behind me through my office door with either camera while I was working. You can observe the view in windows ranging from 160 by 120 pixels, to 320 by 240 pixels, to full screen (640 by 480 pixels), but the image looks grainy on the largest screen. The live video image is 16 bits deep.

Apple manages this feat by splitting VRAM (video RAM) into two frame buffers when live video is in use. The computer-generated screen goes into one buffer, and the live video into another. The video circuitry then melds the two buffers together at the I/O display hardware. To capture the Mac Desktop and live video simultaneously, you need an application, such as the Video Monitor or VideoFusion's FusionRecorder, that understands where the live video resides in the system.

The Express Modem software provided with the POTS GeoPort adapter implements a 9600-bps V.32 modem. (I found this odd. The DSP should have the horsepower to provide 14.4-Kbps modem capabilities—a speed folks using AppleTalk Remote Access need for high-speed connections from the field.) I was able to connect reliably to AppleLink, America Online, and BIX using the GeoPort. The software bundled with the adapter also includes Apple's Fax Sender software, which lets you "print" a document from within any Mac application to a fax.

But the DSP has only so much processing power. I couldn't, for example, fax or connect by modem with PlainTalk active. Fortunately, you get alerts that indicate the problem, and you can switch PlainTalk off during faxing or a communications session. (There's a market here for an Fkey that would toggle these services with a keystroke.) This is a nonissue if you're using an external or networked modem.

The functions provided by the DSP help launch a preemptive strike against Microsoft's proposed API for connecting computers to office equipment. Apple's answer is that the computer becomes your office equipment. Based on the results I've seen so far with faxing, calling, and communicating, Apple's got the better idea.

Besides the usual gaggle of ports (serial, ADB [Apple Desktop Bus], Ethernet, video, and sound I/O), the Quadra 840AV also has four video I/O ports: in and out ports for both composite video and S-video. With the right software, video capture to a QuickTime movie is practically plug-and-play. I connected a portable VCR's output to the Mac's composite video input, fired up a video-capture application from VideoFusion (a demo version of the program comes bundled with the Mac), watched the incoming live video in a screen window, and clicked on the program's record button. The FusionRecorder program captures digital video to memory or hard disk and applies compression to the captured data once you stop recording. If you need editing features, VideoFusion offers an upgrade to the full-blown QuickFlix application for $89.

To test video output, I connected a composite monitor to the output jack. The Monitors Control Panel offers the option of NTSC or PAL video output, and you can also redirect the Desktop to the output port. This way, you can use a VCR to record a demo tape, or set up a large-screen monitor to display work to a classroom or lecture hall. I found the output on the monitor decent and nearly flicker-free, thanks partly to convolution algorithms that minimize the effects of video interface.

New and improved
The Mac Quadra 840AV represents Apple's fastest Mac to date. Although the new SCSI driver hurts hard drive performance slightly, it will also support future—and faster—SCSI PDS (Processor Direct Slot) boards and buses. In spite of major hardware changes, software compatibility is excellent. But then, the current Mac OS doesn't fully exploit all the new hardware (e.g., the SCSI DMA), either. Nevertheless, the Quadra 840AV represents a stable platform on which vendors can carefully start using the new features. I also expect to see some of this stuff in PowerPC Macs, so the AV Macs help show developers the way to working with the future RISC-based Macs.

The PlainTalk and video technologies are both well conceived and well implemented. Neither is by any means perfect, but the Quadra 840AV shows a good first effort. More important, they are enabling technologies: Along with the programmable DSP, they will allow developers to push the Mac in new directions, redefining what a Macintosh is and what it can do. It will be interesting to see what appears in the next few months.

About the Product

Mac Quadra 840AV
(with 230-MB hard drive and 8 MB of RAM) $4099
Apple Computer, Inc.,
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Circle 1076 on Inquiry Card.

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is an Associate Apple Developer. Contact him on AppleLink as T.Thompson, or on the Internet or BIX as tom_thompson@bix.com.
Only one magazine has been taking readers to the front lines of the microcomputing revolution since its inception almost two decades ago—BYTE!

Now you can relive the most glorious moments with this unrivaled chronicle of the evolution of this empowering technology. Here—and only here—you’ll find the groundbreaking articles and features that BYTE alone had the vision to publish, including:

- Kernighan and Ritchie on C
- Stroustrup on C++
- Seminal pieces by Wozniak
- Articles covering the most important operating systems developments
- BYTE Awards from 1989-1992
- First-announcement product advertisements

You won’t want to miss this invaluable new “best of” collection. Of course, all the bits of microcomputing’s most significant magazine count—but, from time to time, some bits of BYTE change the world. Get them all with The Best of Byte.

Available at your local bookstore or call toll-free 1-800-822-8158
COLOR MONITORS

We test high-resolution monitors with displays ranging from 15 to 21 inches to find the highest image quality and the best values

ANDREW J. FRONING

The monitor is arguably the most important component in determining how effectively you work, especially if you use a graphical environment that relies on clear displays of text, images, a multitude of data points, or many open windows. Fortunately, today you have more choices than ever for high-resolution monitors, whether you run general business applications or make presentations to packed conference rooms.

To pick the best of today’s offerings, we tested 70 color monitors ranging from 15 to 21 inches, with resolutions and refresh rates sharp enough for today’s more demanding graphical applications for PCs and Macs. To search for the best image quality, we ran more than 40 tests on each monitor to measure overall quality, sharpness, and distortion. We ranked the monitors for how easy they were to set up, adjust settings for, and use. Finally, we determined how much power each monitor consumed.

Our test sample consisted of 28 15-inch, two 16-inch, 31 17-inch, one 20-inch, and eight 21-inch color monitors. The average cost of a 15-inch monitor was $610, or half the average price of a 17-inch monitor. Prices more than doubled again for 21-inch monitors, which averaged $2736. The least expensive monitor we tested was the Megatron MegaImage L15MG, a 15-inch display that lists for just $279 (but received the lowest overall score in our quality tests). By contrast, 21-inch monitors from Mitsubishi and Nanao, at $2999, carry the highest price we saw (the Nanao F760iW was a runner-up for Best Overall in its category; the Mitsubishi Diamond Pro 21 FS was not ranked).

To be considered for testing, monitors had to have a display resolution of at least 1024 by 768 pixels. Fifty-nine monitors supported horizontal resolutions high-
What to Look for in a Monitor

PICTURE TUBE
Most monitors use three electron guns to produce color images. In its Trinitron displays, Sony uses a single electron gun shooting three beams. We didn't find that one electron-beam implementation always produced better quality than another.

POWER CONSERVATION
Power management circuitry reduces energy consumption when the computer system is idle. Look for the Energy Star logo.

CONNECTORS
For PCs, monitors include 15-pin mini-D-sub connectors. If you run a Mac, your monitor should come with a 15-pin D-sub connector. For specialized video adapters or for bridging monitors, make sure BNC connectors are available.

SCREEN SURFACE
A nonglare coating reduces the visual distractions on the monitor caused by light sources such as windows and overhead lighting. An antistatic surface reduces the accumulation of dust on the screen but shows fingerprints readily.

EMISSION SHIELDS
These shields provide additional protection against VDT emissions. Look for products offering Sweden’s MPR II level of protection.

CONTROLS
Look for controls mounted on the front bezel of the monitor with easily identifiable markings.

PEDESTAL
Be sure a monitor can pan and tilt smoothly and offers a good range of movement to make it easier to adjust the display position for comfortable viewing.

We saw only five picture-tube manufacturers represented (Hitachi, Mitsubishi, Toshiba, and Sony). Quality varied according to differences in the individual tubes and the electronics (e.g., the microprocessors that handle the incoming video signals) that each monitor vendor integrated with the tube.
For general-business PC and Mac applications that don’t require the highest resolutions or largest display areas, 15-inch monitors offer a good balance of size and price. On average, 15-inch monitors sell for half the cost of 17-inch monitors and offer approximately 92 square inches of viewing area—about 38 square inches less than a 17-inch display. However, if a 15-inch monitor and a 17-inch monitor operate at the same resolution, you won’t see any net difference in “image real estate.” That’s because larger screens produce larger images, not more image space. So, for example, the two monitors will display the same number of rows and columns in a spreadsheet, but the spreadsheet cells on the 17-inch monitor will be bigger.

Running a monitor at high resolutions increases space for displaying large spreadsheets and other documents (see “Is Bigger Better?” on page 218). However, there are trade-offs. Using a 15-inch monitor at 1024-by-768-pixel resolution results in substantially smaller characters than using the same monitor at 800 by 600 pixels. Unless the monitor is exceptionally sharp, we don’t recommend 15-inch monitors for resolutions exceeding 800 by 600 pixels. (Nevertheless, in making our Best Overall, High Quality, and Low Cost selections, we conducted our image quality and sharpness tests in the 1024-by-768-pixel resolution to provide the toughest tests of these monitors’ display capabilities.) The Sceptre CC-615GL stood out as the winner in the Best Overall and High Quality categories. It scored above average on all but one of the quality tests, the contrast ratio test.

The Sceptre CC-615GL offers a straightforward combination of digital and analog controls. Individual push buttons for vertical and horizontal size and position control the placement of the image. Pressing any three of these buttons simultaneously enables pincushion adjustments.

Zenith Data Systems’ ZCM-1540-UT offers real operational cost savings. Make sure that the monitor will function with your “green” PC or with an external software package such as Windows screen blankers. Our tests also showed that simply using the standard Windows utility to blank the screen (totally blank—no flying appliances) reduces power consumption by an average of 23 percent, even for monitors not equipped with power management systems.

**ENERGY STARS BURN DIMMER**

The EPA (Environmental Protection Agency) awards an Energy Star label to monitors that use 30 W or less of power in their standby mode, and many of the monitors we tested carry the EPA’s blessing (see the Roll Call on page 224). So far, no technology can dramatically reduce the current draw of monitors while they are fully active. But a power-down mode can drop current draw from approximately 100 W to less than 30 W. The EPA estimates that people use their monitors only 20 percent of the time the displays are on, so power-down savings could be considerable.

The EPA’s guidelines cover only power-level targets, not the ways manufacturers can reach these levels, so manufacturers have created a number of different power management “standards.” One of the first monitors with power conservation features came from Nanao. The F series of products feature a microprocessor-controlled system that watches Windows activity. If the monitor senses a blanked Windows screen, the control system initiates a partial shutdown of the high-voltage systems in the monitor, keeping only the CRT and microprocessor warm. When you press a key or move the mouse, the monitor turns on again. If no activity occurs within a user-definable period, the monitor enters a second level of power reduction, called the suspend state, which lowers power consumption to around 4 W. Standby mode refers to the intermediate shut-down level.

There are trade-offs between these states. While the suspend state uses very little power, the monitor requires 8 to 10 seconds to power back up. The standby state uses about 30 W, but the monitor returns to a full image in just a couple of seconds.

But implementations that require the monitor to constantly check on the CPU make it tricky to match monitors and computers. VESA has proposed DPMS (Display Power Management Signaling), a set of power management standards for communication between computers and monitors. DPMS governs the signals used to initiate power reduction in monitors. It relies on Intel and Microsoft’s APM (Advanced Power Management) specification to define the names, broad definitions, and recovery times of reduced power levels. The chart below details the APM conventions, along with typical values for the monitors we tested.

<table>
<thead>
<tr>
<th>APM STATE</th>
<th>ON</th>
<th>STANDBY</th>
<th>SUSPEND</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power saving Recovery time</td>
<td>None</td>
<td>Minimal (to under 40 W)</td>
<td>Substantial (to under 4 W)</td>
<td>Maximum</td>
</tr>
<tr>
<td></td>
<td>Not applicable</td>
<td>Short recovery (2 to 4 seconds)</td>
<td>Longer recovery (8 to 12 seconds)</td>
<td>System-dependent</td>
</tr>
</tbody>
</table>

DPMS uses the presence or absence of sync and video signals to control power levels. Using these rules as the common starting point, manufacturers of computers and monitors can use whatever technology is available to regulate the power consumption.

If you are considering purchasing a new monitor, an energy-saving display can offer real operational cost savings. Make sure that the monitor will function with your “green” PC or with an external software package such as Windows screen blankers. Our tests also showed that simply using the standard Windows utility to blank the screen (totally blank—no flying appliances) reduces power consumption by an average of 23 percent, even for monitors not equipped with power management systems.
finished as a runner-up to the Sceptre in both the Best Overall and High Quality scorings. It boasted the third-lowest power consumption in its category at just 66 W (the average was 81 W). On both the screen contrast ratio and misconvergence tests, however, this monitor scored in the lower half of all 15-inch monitors. Contrast ratio is useful in determining how monitors can work well in high ambient-light environments. The misconvergence test may indicate a problem in correctly aligning the electron beams. High levels of misconvergence may result in discolored characters or lines.

Mitsubishi’s Diamond Scan 15FS also rates runner-up status for both Best Overall and High Quality. This monitor uses multiple-function digital controls. You select a function using a pair of up/down push buttons; an LED indicates the function selected.

Controls for vertical and horizontal size and position also serve as cushioning adjustment controls. Separate sets of up/down push buttons set brightness and contrast. A status indicator lights when limits on these controls are reached.

Other products deserving attention come from KFC and CTX. The KFC CA1507 offers controls that let you adjust image size and position, correct image tilt and pincushioning, recall factory mode settings, and set the power-down delay interval.

However, the KFC CA1507 suffers from noticeable moiré patterns when displaying full-color screens. It also shows local regulation effects—a shifting of the border outward when displaying bright blocks of graphics, like the status lines under Windows. On the other hand, its image-quality score was well above average.

We rated the CTX 1560LR excellent in image quality and scored it well above average in virtually all the quality tests. However, its high power consumption, tested at 96 W, lowers its overall score. Compare its rating to the Sceptre CC-615GL’s 63.6 W.

### Need the clearest display?

#### HIGH QUALITY

The flat screen on this 15-inch monitor garnered consistently high scores in our image-quality tests. The CC-615GL had the best score in its class in the legibility test. It exhibited an extremely low amount of misconvergence: 0.054 mm versus the class average of 0.107 mm. This contributed to its excellent results in the sharpness tests. Only its contrast ratio score of 5.4 was below the class average (5.7). The lackluster performance in the contrast ratio test may concern those working where there is a high level of ambient light.

### Are you cost-conscious?

#### LOW COST

KFC packs quite a lot into this $495 product. The 15-inch CA1507 offers resolutions as high as 1280 by 1024 pixels at 60 Hz noninterlaced. The trade-off for low cost is only average quality scores. The monitor provides a full set of image-adjustment controls, including pincushion, image rotation, and power management. It uses the VESA DPMS power management control signals to meet Energy Star requirements.
Vertically Flat.

Look at the screen on a Sony Trinitron* monitor. See how little glare there is? How sharp the details are? That's because the screen is flat from top to bottom. Screens on ordinary monitors aren't, not even the "flat-square" ones. And the difference shows.

Sony Trinitron monitors also have a Super Fine Pitch™ Aperture Grille for crisp text and bright images. Multiscan* technology for compatibility with most major graphics standards. And they're available in 14", 17", or 20" sizes.

So never settle for anything less than a Trinitron monitor from Sony. The ones with flat screens from top to bottom. For better images from edge to edge.

Call 1-800-352-7669 (ext. 103) anytime for more information by mail or fax.
How We Tested

We tested monitors with a combination of hardware and software tools that were designed to examine every aspect of screen quality, power consumption, and ease of use. To do this, we conducted more than 40 separate visual inspections on each monitor. All tests were performed at a standard resolution of 1024 by 768 pixels using a VESA-compliant vertical refresh rate of 70 Hz. VESA considers this to be the lowest recommended vertical refresh rate at this resolution to avoid screen flicker. We used #9GXE video adapters by Number Nine in Compaq Deskpro 66M computers for our test bed.

The eye is superb at seeing differences in video quality, but the brain is poor at remembering them, so we used a video splitter to send test-screen images to three sample monitors as well as to the monitor under test. The three control monitors represented the low, middle, and high range of quality in our test sample.

The video splitter took the video signal from the computer, amplified the signal, and split it into four channels. The test monitor received one channel, and the control monitors received the remaining three channels. Because all four monitors showed the same image simultaneously, we could easily compare the test monitor’s image quality to that of the best and worst monitors we evaluated.

IMAGE QUALITY

Our overall display quality score was based on a number of screen tests. To gauge image quality, we used 26 different screen images in Sonera Technologies’ DisplayMate Professional to help us examine quality characteristics ranging from blooming (in which brighter images become larger and more unfocused than darker images) to local regulation (i.e., distortion caused by high-intensity images, frequently seen under Windows at the status bar). Each monitor was given a score of from 1 to 10 based on how it displayed each of the 26 screen images. We summed these results and gave each monitor a final score based on that total.

To measure image sharpness across the entire display area, we wrote a custom utility using Microsoft Visual Basic. This program produces images of boxes and lines at the selected Windows resolution of 1024 by 768 pixels. The box test produces 1- and 2-pixel-thick red, blue, and green boxes at the outside edges of the screen. We examined each monitor’s ability to display these boxes with a black line between the boxes.

A second series of images measures the ability of each monitor to display fine vertical and horizontal lines. Again, we tested with red and green lines separated by a black line. We rated each monitor using a set of precise scoring guides that instructed the tester to assign point values based on the screen image. We averaged the scores for the 28 measurement points that made up this test.

DisplayMate Professional also provided a systematic approach to measuring geometric distortion. Distortion manifests itself as oddly shaped screen images. The image may appear as a trapezoid or a barrel shape, with the tops or sides of the display area not parallel or at right angles. We measured the length of a series of lines displayed on the monitor, and the program calculated the percentage of distortion. Prior to testing, we used the monitor’s controls (if any) to visually correct any existing distortion.

TWO IMPORTANT QUALITY GAUGES

Convergence is the monitor’s ability to precisely illuminate specific phosphor dots. To create a white dot, the electron beams must accurately converge on a single color triad. Misconvergence displays itself as white areas or lines that have a tinge of red, blue, or green. We measured misconception with an optical gauge manufactured by Klein Optical (Portland, OR). Using red, blue, and green prisms, the instrument reconverged a white line displayed on the test monitor. We calculated the amount of misconvergence from the amount of correction required. Lower amounts of misconvergence received higher scores.

We measured contrast ratio—in other words, the amount of contrast between the light and dark areas on the display—because this is one of the keys to visual clarity. Contrast differs from brightness as it represents the difference in the luminance levels among objects. While brightness is important for discerning a black cat on the floor of a darkened room, contrast is necessary to find a polar bear in a snowy storm. We used a Tektronix J1823 Narrow Angle Luminance probe to measure the luminance levels between a bright white square in the center of the image and the unilluminated border surrounding the square. A higher ratio provides greater contrast, which makes the monitor more usable in conditions of high ambient light.
Nanao, the technical leader in monitors has done it again. In addition to being the top choice of today’s CAD/CAM, DTP and Windows users, Nanao’s award-winning FlexScan monitors now have a remarkable energy-saving system – PowerManager.

PowerManager works with all green computer systems including VESA DPMS (Display Power Management Signaling). But users don’t have to own a new green computer in order to take advantage of the PowerManager to save energy. Our PowerManager works with any existing PCs with a screen saver software, including Windows 3.1 and After Dark. Activating when the blank screen of the screen saver appears, PowerManager cuts operating power to less than 8% of total consumption. It also automatically powers the monitor down to a stand-by mode when the computer is turned off. The PowerManager can save users as much as $63 per year on utility bills (Source: E Source). PowerManager has placed Nanao at the forefront of the Environmental Protection Agency’s Energy Star Program.

PowerManager is now the standard feature of our 15", 17", 20" and 21" monitors. All Nanao energy-saving monitors feature superior Invar Shadow Mask and Trinitron CRTs with non-flicker ultra-high resolution. Their ergonomic features include compliance with MPR-II/TCO low radiation emission standards and anti-reflective treatments. Best of all, they can power down. So when you’re not working, neither are they.

Nanao FlexScan monitors. Intelligently designed. Incredibly useful. And now, built to help protect our environment by reducing energy consumption.

*Nanao USA CORPORATION
23535 Telo Avenue, Torrance, CA 90505
(310) 325-5202

NANAO
Superior In Every Detail
Circle 92 on Inquiry Card (RESELLERS: 93).
How We Tested (continued)

The tests just described look at specific quality characteristics. Our legibility test, however, provided a real-world measurement of monitor quality. Using Microsoft Word for Windows, we constructed a document featuring six standard typefaces at point sizes from 4 to 14 points. We then determined at what point size the text samples were both readable and legible. We judged text to be readable if it could be discerned without strain from a standard reading distance of 24 inches. We considered text to be legible if it could be discerned from any distance less than 24 inches without the use of aids such as magnifiers.

For consistent results, only one tester conducted this test. In all our subjective tests, each tester conducted one complete set of tests on all the monitors. This system worked to eliminate scoring variances.

In our charts, higher numbers indicate better quality. The highest overall quality score we awarded was 9.64, for the NEC 6FGp, a 21-inch display. The lowest score was 7.54 for Megatron Computer Systems' Megalmage L15MG, a 15-inch monitor. We found that the difference between a score of 9.5 and 7.5 is apparent to most monitor users. A 1-point difference is harder to discern visually unless you're looking for specific problem areas. Seeing distinctions in monitors whose scores differed by less than 0.5 point requires a sharp eye and some idea of what to look for, unless you're aided by software or hardware that gauges quality.

We did not evaluate color correctness because of the difficulty in accurately measuring this and because people who need exact color reproduction must calibrate monitor color values to other hardware devices, such as printers and scanners. If you need accurate color, we advise you to choose a monitor that allows for color adjustments and to perform your own color tests before making a purchase (see "Color-Matching Monitors" on page 220 and "Do-It-Yourself Monitor Testing" on page 222).

To arrive at our overall quality score, we weighted the image-quality and image-sharpness tests equally; together they accounted for 40 percent of the total quality score. Convergence scores represented 20 percent of the total, followed by legibility at 30 percent and contrast ratio at 10 percent.

POWER CONSUMPTION

We tested power consumption by measuring each monitor's current draw. Using a digital multimeter connected to the monitor's power system, we took readings when the monitor displayed a full Windows screen and when the screen was blanked. For monitors with power management features, we measured power consumption in the active, standby, and suspend modes. Only the full-screen Windows figures are published and scored.

The Roll Call lists wattage consumption for all the monitors. The summary charts in each of the display-size rankings list power scores based on a 10-point index. Higher numbers indicate that a monitor used less power than another product in that size class.

EASE OF USE

To evaluate how easy it was to set up and use each monitor, we considered the various adjustment controls, cabling, and tilt/swivel bases, as well as the documentation that came with the monitor. We ranked monitors on the placement, range, and ease of adjustment for image controls. Controls typically include adjustments for brightness, contrast, horizontal and vertical size and position, pin cushion (distortion), and degaussing. Some products include controls for color matching, phase adjustment, and re-setting or saving settings. A greater range of controls combined with front-panel locations earned a higher score.

For making adjustments, most of the products featured digital controls using push buttons instead of analog thumb wheels. We judged that digital controls offer a wider range of adjustments than analog controls. But sometimes the sheer number of controls and their poor design and layout made digital controls more difficult to use.

We also rated monitors for the range of tilt and swivel of their bases (all manufacturers included such bases with their products). In addition, we considered the ease of panning or tilting the monitor.

Products also received higher scores if their video cables were longer than average. We reviewed documentation for clarity and completeness. Finally, products received higher scores if they offered a wider range of technical-support options, such as toll-free phone service and on-line services.

FEATURES

We evaluated monitors for features such as a number of factory preset and user-definable resolution modes, video connectors, maximum usable screen area, weight, maximum resolution, and compliance with MPR II standards for emissions and EPA's Energy Star standards for power consumption.

Best Overall winners in each size category had the highest scores based on the weighted average of scores in the quality, image-sharpness, usability, features, power consumption, and distortion tests. Quality scores accounted for 45 percent of the total score, while features represented 20 percent, followed by ease of use (20 percent) and power usage (15 percent). We used the scores for quality, sharpness, misalignment, and distortion to select High Quality winners. Low Cost winners were those monitors priced below the average for the size class and having the highest ratio between overall scores and price.

Contributors

Andrew J. Frothing, Editor/PC Digest, on NSTL publication, spent the last three years testing monitors, systems, and computer peripherals.

Alan Joch, Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.

Chandrakrishnamurthy, Technical Analyst/NSTL, evaluates computer peripherals and systems.

Siva Kumar, Technical Analyst/NSTL, specializes in hardware and network operating-system testing.

André Whittle, Consultant/NSTL, has evaluated computer hardware for the Canadian government.

The Lab Report is an ongoing collaborative project between BYTE Magazine and National Software Testing Laboratories (NSTL). BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.
Introducing the new and improved MX series. Once again, MAG InnoVision pushes the state-of-the-art in high-performance 15-inch and 17-inch color monitors. • Low electro-magnetic and static emissions that meet the Swedish MPR II guidelines are now standard. • We've increased the programmable timings to 16 Preset and 8 User to support new high-refresh video modes. • We've added pincushion and tilt* controls for distortion-free displays. • Best of all, we've made them more affordable. • Ask your dealer for a demonstration of the new MX15F and MX17F monitors. Or call us for more information at 800-827-3998, 714-751-2008 (in CA), FAX: 714-751-5522.

© 1993, MAG InnoVision, Inc. All rights reserved. MAG InnoVision and its logo are trademarks of MAG InnoVision. All other brand and product names are trademarks or registered trademarks of their respective owners. *MX17F only.
The Keys to Image Quality

Although the monitor is the most visible part of your display system, it's only one third of the imaging puzzle. The primary piece is the video graphics adapter, which takes the data from the CPU and processes it into the signals that feed the image to the monitor.

**VIDEO ADAPTERS**

Video adapters are growing in type and number (see next month's Lab Report for a comparison of video adapters). Conventional VGA adapters convert the digital data from the CPU to analog information before sending the data to the monitor. Accelerated video adapters use special chip sets to speed up the processing of GUI operations by off-loading some of these operations from the central CPU. Many high-end adapters also offer 24-bit color rendering, which requires additional on-board RAM for storing processed data.

For highest quality, match a powerful adapter to a monitor capable of receiving the data at high vertical and horizontal frequencies. Carefully review the refresh-rate specifications for both monitors and adapters, even when vendors claim VESA compliance. An adapter may use a standard refresh rate of 70 Hz for 1024-by-768-pixel resolution but use one of a number of different horizontal frequencies. If the horizontal frequency doesn't match that preset by the monitor manufacturer, you'll have to adjust the image for size and placement. In most cases, the problem is temporary, since you can save the adjustment as a user-definable setting. But you'll need to exercise care in matching an adapter and monitor when buying a fixed-frequency monitor. If you find that you can accept the limitations of these monitors, the reward is economic: Often they are the lowest-priced displays.

**DISPLAY DRIVER**

The final piece in the puzzle is the display driver. In the standard VGA resolution mode of 640 by 480 pixels, all adapters should function without special drivers. At higher resolutions, drivers provide the programming interface between the operating system and the video adapter's hardware.

Most adapters now provide special-ized drivers for Windows 3.1. If you use OS/2 or applications that aren't Windows-based, such as CAD/CAM programs, make sure that proper drivers exist before making a purchase. If you have your adapter for a while, it may pay for you to contact the manufacturer for a driver update. Updated drivers are often available from a vendor's BBS. The time you invest in getting a new driver may pay off. We found significant differences in performance from the same adapter simply by using updated display drivers.

<table>
<thead>
<tr>
<th>Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture grill</td>
</tr>
<tr>
<td>Blooming</td>
</tr>
<tr>
<td>Degaussing</td>
</tr>
<tr>
<td>Dot pitch</td>
</tr>
<tr>
<td>Fixed-frequency</td>
</tr>
<tr>
<td>Flicker</td>
</tr>
<tr>
<td>Horizontal frequency</td>
</tr>
<tr>
<td>Interlaced displays</td>
</tr>
<tr>
<td>Misconvergence</td>
</tr>
<tr>
<td>Multiscanning</td>
</tr>
<tr>
<td>Noninterlaced displays</td>
</tr>
<tr>
<td>Resolution</td>
</tr>
<tr>
<td>Shadow mask</td>
</tr>
<tr>
<td>Vertical refresh rate</td>
</tr>
</tbody>
</table>
Leading the way in display technologies, CTX provides you with the total monitor solutions. Climb aboard.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>5A09A</th>
<th>1451</th>
<th>1461</th>
<th>1460</th>
<th>1760LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRT/Dot Pitch</td>
<td>14&quot;/0.28 mm</td>
<td>14&quot;/0.28 mm</td>
<td>17&quot;/0.26 mm</td>
<td>18&quot;/0.34 mm</td>
<td>17&quot;/0.28 mm</td>
</tr>
<tr>
<td>Scan Frequency</td>
<td>H: 30-60 kHz</td>
<td>H: 30-60 kHz</td>
<td>H: 30-60 kHz</td>
<td>H: 30-60 kHz</td>
<td>H: 30-65 kHz</td>
</tr>
<tr>
<td></td>
<td>V: 50-90 Hz</td>
<td>V: 50-90 Hz</td>
<td>V: 50-90 Hz</td>
<td>V: 50-90 Hz</td>
<td>V: 50-90 Hz</td>
</tr>
<tr>
<td>Max. Resolution</td>
<td>1024x768/60Hz</td>
<td>1024x768/60Hz</td>
<td>1024x768/72Hz</td>
<td>1024x768/72Hz</td>
<td>1024x768/72Hz</td>
</tr>
<tr>
<td>Digital Control</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Full Screen</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Low Radiation</td>
<td>5461R</td>
<td>1451R</td>
<td>1461R</td>
<td>1561R</td>
<td>1560LR</td>
</tr>
</tbody>
</table>

Certified Quality  Competitive Pricing  BBS (909) 594-8973

Considering a monitor? See your CTX dealer today.

CTX INTERNATIONAL, INC.
USA Headquarters
20530 Earlgate Street
Walnut, CA 91789
909/595-6146
Fax 909/595-6293

South Region
6950-F Northbelt Pkwy
Norcross, GA 30071
404/729-9099
Fax 404/729-8805

East Region
146 Division Place
Hackensack, NJ 07601
201/666-0707
Fax 201/666-1998

Midwest Region
500 Park Blvd., Ste. 295C
Itasca, IL 60143
708/285-0202
Fax 708/285-0212

Southwest Region
1221 E. Crosby Rd., A2
Carrollton, TX 75006
214/416-9610
Fax 214/245-7447

© Copyright 1993. CTX International, Inc. All rights reserved. All brand or product names are trade marks or registered trademarks of their respective owners.
If you need to increase your viewing real estate to see more spreadsheet cells, show an entire CAD drawing, or display multiple windows, consider a 17-inch monitor. We tested 31 products in this size category, as well as two 16-inch products from Mitsubishi and SuperMac.

Like the 15-inch monitors, all the 17-inch monitors support at least 1024-by-768-pixel resolution at 70 Hz. Only the Sony CPD-1730 and the Arche 217AX do not support 1280 by 1024 pixels. However, the newer Sony GDM-17SEI provides resolution modes of up to 1600 by 1200 pixels, as do products from IBM, Sampo, ViewSonic, and Philips. The 16-inch SuperMac E-Machines T161II supports a maximum of 1152 pixels horizontally.

Do you need the extra resolution? Remember that as the resolution increases, text and objects such as icons get smaller. We believe that a 17-inch monitor provides excellent viewing at 1024 by 768 pixels, but you need to be sharp-eyed to enjoy working at 1280 by 1024-pixel resolution on a screen area roughly 30 percent larger than a 15-inch monitor's.

We conducted our quality tests at 1024-by-768-pixel resolution. Our sharpness tests indicate that at the same resolutions, 17-inch monitors look sharper than 15-inch displays. We found this to be especially true in our Word for Windows legibility test, where the average score was 10 percent to 20 percent higher for the 17-inch products.

One drawback of a larger viewing area is a larger price: The average in this class was $1200, nearly twice that of the 15-inch monitors, although the lowest price for a 17-inch monitor ($799 for the Fora Addonics C172A/LR) is actually a few dollars below the highest 15-inch monitor cost.

Nanao reigned in our rankings for Best Overall, with three products in our top seven picks. We also rated monitors from Sigma, IBM, and NEC highly for Best Overall.

Sophisticated user interfaces also distinguish these products: Virtually all use digital controls to manage image size, shape, and color.

Acer America goes even further with its AcerView 76i by providing an on-screen display. This is an advantage over many monitors with small and hard-to-read icons that we found difficult to identify, especially in the dark.

Other items common in 17-inch displays but not on the smaller monitors are BNC video connectors (for RGB and sync inputs) and dual connectors or cables supporting both Macintosh and PC video.

Our choice for Best Overall winner is the Nanao F560iW. Although it shares virtually identical overall scores with the Nanao T560i, the F560iW had a higher quality rating than its more costly sibling. The third Nanao product, the F550iW, costs less than the other two and had similar quality scores. It uses a 0.28-mm dot-pitch mask, while the F560iW makes use of a 0.26-mm shadow mask and the T560i uses a Trinitron 0.25-mm aperture-grille mask.

Looking only at image quality, however, three products rated higher than the Nanaos. The IBM 17P uses a Sony 0.26-mm-pitch Trinitron tube, which garnered the highest rating in the image component of our quality tests. The Trinitron...
Four hours Monday, six hours Tuesday, eight hours...
The easiest monitors to face for hours and hours: ours.

If you spend a lot of time in front of a big monitor, our feeling is that it had better be a great big monitor. Our new Professional Series 17" MultiSync* 5FGp and 21" 6FGp monitors, for example. They're ideal for CAD/CAM, advanced desktop publishing, document imaging and more, because they give you the crisp, rock-steady images and vibrant colors NEC has long been known for. Plus, many other advanced features: Like our new Intelligent Power Manager system. And new OptiClear* surface, which virtually eliminates glare without sacrificing focus, brightness or color. Add to that our 3-year limited warranty and it's obvious: these are monitors that will make you very happy, not just for hours and hours. But for years and years. For more information, call 1-800-NEC/INFO. Or, for immediate response via fax, call 1-800-366-0476 and request document #174101 and 214101.

*17" and 21" CRTs yield 15.6" and 19.8" viewable screen areas.
picture tubes tend to produce strong, vibrant colors. When evaluating Trinitron-equipped products, remember that you are supposed to see two thin lines running through light-colored screens. These are tiny wires inside the tube that support the aperture grill. The IBM monitors that we evaluated are available from IBM’s new PC Company as peripherals separate from system bundles.

SuperMac’s E-Machines TP161L, a 16-inch monitor, also uses a Trinitron picture tube and is principally sold in the Macintosh market. Its high quality may warrant some consideration from DOS/Windows users as well.

Our Low Cost winners were tougher to judge, since there is a real disparity between low cost and high quality. For example, the winning Fora Addonics C172A/LR had the lowest price of the monitors ranked for low cost, but its quality score ranked third. Two products that retail for around the $1200 average cost and have excellent overall scores are the IBM 17P and the NEC 5FGe. The 5FGe rated high in quality and ease of use, but it received only moderate marks for features and power consumption. One aspect that all our evaluators noted was the high amount of glare on the polished screen surface of the 5FGe. NEC sells a screen that substantially reduces the glare, but it also decreases image brightness. Perhaps as compensation, the 5FGe had the highest contrast ratio among 17-inch monitors.

Two other monitors, the ADI Micro Scan AP and the KFC CA1718, merit consideration for low cost because of their above-average overall performance. The Acer AcerView 76i also made a respectable showing. All three sell for under $1000 and feature power management and MPR II compliance.

We measured the average power consumption of 17-inch monitors at 96 W when running a full-screen Windows image. Compare that to 81 W for 15-inch monitors and 115 W for 21-inch products.
Is Bigger Better?

If a 15-inch monitor is better than a 12-inch, and a 17-inch is more fun than a 15-inch, then a 21-inch monitor should be power-user heaven, right? Perhaps, but before you plunk down $3000 for one of the gorgeous monitors reviewed here, let’s review some facts to make sure a large monitor fits your applications.

Compared to smaller monitors at the same resolutions, larger monitors do provide more legible characters. Our sharpness and legibility tests showed this to be true: the 21-inch class of monitors had the highest quality scores among all the monitors we tested.

RESOLUTION

Logically, it makes sense that larger monitors provide higher quality. If you use the same number of pixels to make a screen image, a larger screen gives larger characters, making the characters more legible.

Under Windows at 1024- by 768-pixel resolution, a 21-inch monitor looks more readable than a 15-inch monitor because of the difference in character size. Increasing Windows resolution to 1280 by 1024 pixels increases the number of characters available but reduces their actual size. Thus, there is always a trade-off between the size of the Windows desktop and the size of the characters. Simply because a 15-inch monitor can handle 1024- or even 1280-pixel resolution does not mean that the text will be large enough to enable you to read what you type.

If you want more Windows desktop real estate, change your resolution mode. For instance, increasing resolution expands the number of rows and columns in your Windows spreadsheet. At 800 by 600 pixels, the default Excel spreadsheet gives you 27 rows and 12 columns. At 1024 by 768 pixels, you jump to 37 rows and 15 columns. Finally, at 1280 by 1024 pixels, Excel provides 49 rows and 19 columns. (Obviously, changing the default row height and column width also increases or decreases the number of visible cells.) Increasing the size of the monitor only makes those characters easier to read. The character size on a 15-inch monitor at 800- by 600-pixel resolution is almost identical to that on a 21-inch monitor at 1280 by 1024 pixels.

VIEWING DISTANCE

Remember that the larger the monitor, the greater the viewing distance it requires. Ideally, you should sit at a distance that allows you to see the entire screen without excessive head or eye movement.

For a 15-inch monitor, that distance seems to be about 18 inches; for 17-inch products, about 24 inches; and for the 21-inch displays, more than 32 inches. Of course, the farther you move back from the monitor, the smaller things appear, so again, character legibility becomes an issue.

SIZE

Another consideration in deciding on monitor size is space. Large monitors are just that—large. Think of placing your 20-inch color TV on top of your desktop computer. In addition to the weight factor (would your desk support an additional 70 or 80 pounds?), these monitors occupy a huge amount of space. They also use more energy and thus produce more heat and other emissions.

Large monitors are good for doing group presentations, detail work like CAD/CAM, or color imaging. For more typical Windows applications, 17-inch monitors let you make use of higher resolutions and more real estate at much less cost. Where money and space are considerations, a high-quality 15-inch monitor will provide excellent service at the cost of some additional spreadsheet scrolling. Our best advice is to experiment with different resolutions on several sizes of monitors, running the applications you use most, before you buy. Hands-on experience is the best way to find the monitor that’s most comfortable for you.
WHY Is Brutus*, the King of Monitors, So Impressed by the 15" SCEPTRE?

Among the finest 15-inch High Resolution Color Monitors you can get, the Microprocessor based Low Radiation (MPR II compliant) SCEPTRE CC-615L offers:

- 1024 x 768 VESA 72Hz Flicker-free
- Multi-scan 30-60 KHz
- INVAR Shadow Mask Tube, FS II Flat Screen
- 31 Memory Settings
  - (5 Factory Preset, 26 User Adjustable)
- Anti-static Screen
- Universal Power 90-260 VAC 50/60Hz Auto-sensing
- Advanced Dynamic Focusing
- Manual and Auto-Degaussing
- Front Access Push-button User Controls

PLUS: Energy Saving Option (CC-615G), SCEPTRE's Two Year Limited Warranty, and many more.

In addition, SCEPTRE's impressive full line of Micro-processor based monitors includes CE-6N, CC-6N (14-inch) and CL-617/617L (17-inch). For more information, contact SCEPTRE or its distributors today.

*Brutus: Monitor Lizard, an endangered species, recently seen in the film "The Freshman" with Marlon Brando and Matthew Broderick

DISTRIBUTED BY
SCEPTRE TECHNOLOGIES, INC. 714-993-9193 FAX 714-993-2997

© 1993 Copyright SCEPTRE Technologies, Inc. All Rights Reserved. All product and brand names are trade marks or registered trademarks of their original owners.

Circle 134 on Inquiry Card (RESELLERS: 135).
**COLOR-MATCHING MONITORS**

When it comes to color, the eye is a marvelous judge. Most of us can distinguish about 7 million colors out of the palette of 16.7 million colors that the most capable computer systems deliver. The trick to working with color on personal computers has been matching colors throughout the process, from image capture to hard-copy output.

Since the color gamut (i.e., the universe of colors) of scanners, monitors, and printers is different for each device, matching colors is difficult. A number of monitor manufacturers now include some sort of color controls for adjusting the color on the monitor to match either the input or output device.

In the 25 monitors we received that support color controls, two types prevail. Most monitors, such as the Epson T1189U, give you a simple control that switches the white balance between 9300 degrees Kelvin and 6550 K. This operation provides a uniform change across all the colors displayed and is perhaps more useful for accommodating the visual taste of users than matching colors on other devices.

More sophisticated color controls are found on monitors such as the Nanao F5501W and F7601W and the NEC FG products. On the NEC FG, you can change the gain or intensity of the three primary colors (red, green, and blue) using individual controls for each color. A color-setting memory lets you store two sets of color adjustments.

Nanao goes a step further. Besides a standard factory white-balance setting, it provides two user-definable memories for color changes. The Nanao monitors offer two sets of RGB adjustment, gain and cut-off. Gain refers to the intensity of the color—the amount of energy that illuminates the dots of red, green, and blue phosphor on the screen. Cut-off is the point at which the dots fail to illuminate. Changing the gain controls adjusts the white balance at the high end of the gray scale. Adjusting cut-off changes the white balance throughout the grayscale range.

Note that making a change in any color affects any on-screen color that has that color as a component. Monitors use the additive color process, so adding more red to make an orange more appealing means that all the apples, strawberries, and eggplants change color as well.

How valuable are color-matching systems? To please your sense of color, perhaps the simple white-balance changes offered by a number of manufacturers will satisfy you. However, making useful gain and cut-off adjustments to match the on-screen color of a monitor to a color printer/plotter’s output requires a thorough understanding of color theory and many trial-and-error adjustments. That is probably why all these systems offer an easy method to restore the factory default settings. If you are a color specialist needing a great deal of control over the color process, a large monitor with color gain and cut-off adjustments may be worth the expense.
products. The 6FGp comes with a dual-headed video cable for either Macs or DOS/Windows PCs. If you have a Mac, you attach the 15-pin D-sub connector end of the cable to your computer and the other end to a 15-pin mini-D-sub connector at the rear of the monitor. You reverse the cable to connect to a standard VGA PC. NEC also provides RGB gain controls that let the user change the content of the image by increasing or decreasing the amount of red, blue, or green in the image. With a suggested retail price of $2535, the 6FGp even falls below the average price ($2736) in this category.

At $2695, the Nissei Sangyo Super Scan Elite 21 fell near the middle in price for monitors in this size group. Nissei Sangyo is a marketing arm of Hitachi of Japan. We also received a 21-inch monitor from Hitachi of America, but the products do not resemble each other; the Nissei Sangyo display scored significantly higher in our quality scoring and cost about $300 less than theHitachi display. The two monitors compete against each other in the American market.

Interestingly, the ViewSonic 21 tied with the NEC 6FGp for the best score in the image-quality tests. But the ViewSonic displayed considerable misconvergence in that series of tests, and this lowered its otherwise-excellent sharpness test scores. In addition to the standard controls for image size, position, and pincushion adjustment, the ViewSonic offers two other useful adjustments: white balance and moiré reduction. We liked the ViewSonic's drop-down control tray because the control buttons are easy to see and identify.

The Idex VisionMaster MF-8521 has a unique power conservation feature, a sensor that registers your presence when you sit in front of the monitor. If the sensor registers nothing for an hour, the monitor automatically shuts down into a suspended power state, where it draws merely 6 W.

The price leader is the IBM 21P, which lists for $2249. The 21P features VESA-compliant power management systems, and it exhibited the lowest power consumption of all the large monitors. However, this product also suffers worse-than-average misconvergence, which brought down its overall quality score.

Also in this group was the Sony GDM-2038, which the company classifies as a 20-inch display. Its maximum viewing dimensions, however, are only about 2 cm smaller than most 21-inch products. The Sony falls in the middle of the pack in quality and overall scores.
Do-It-Yourself Monitor Testing

Users without access to sophisticated test instruments can still make informed judgments about a particular monitor's performance. The "homemade" tests that follow will help you evaluate individual products before purchase.

Before you examine a product, let it warm up for 10 or 20 minutes. Set the brightness level so that the illuminated part of the screen has the same background level as the unilluminated portion. Set the contrast level to its highest setting. Position the monitor to reduce glare as much as possible.

An easy test is for pincushioning, in which edges of the display bulge. Place a straightedge along the edges of the screen image. If the image's edge bows in or out, the monitor is exhibiting pincushioning. Excessive pincushioning causes distortion and detracts from legibility. Not all the products we tested had pincushioning controls.

To check for color registration, or convergence, examine thin white lines on a black background and check for colors showing along the edges of the line. Noticeable amounts of color or along a white line indicate poor convergence. High levels of misconvergence denote poor monitor adjustment and make viewing graphics displays difficult. You can check for geometric distortion by comparing the dimensions of same-size blocks in the corners and center of the screen. If the blocks vary considerably in size, the monitor will distort graphics and shapes; this is especially problematic for CAD and desktop publishing applications.

To test legibility, run a WYSIWYG program such as Word for Windows. Vary typefaces and font sizes, and check the monitor's ability to resolve images clearly. You should be able to read 8-point type comfortably on most monitors at resolutions of up to 1280 by 1024 pixels.

To check local regulation (i.e., how the monitor handles a block of very bright screen image), open a full-size Windows screen. In the Control Panel, select Color and set the status line to white. Select a dark color, but not black, for the background screen color. If the status bar appears to jut out to the left, the monitor is not doing a good job of regulation.

Look for screen-color consistency. Under Windows, change the background color to pure red, blue, or green. Check for even colors without splotches or shadows. If colors are mottled, try degaussing the monitor. Correcting convergence and pincushioning is possible if the monitor has the appropriate controls; splotchy color and geometric distortion are generally not user adjustable.

HONORABLE MENTIONS

The AcerView 76i displays settings on the screen, which makes adjusting images for brightness, contrast, or distortion easy. It can display the settings in five languages and gives the user a numerical setting for each control.

A tray-mounted control panel on the Idek VisionMaster MF-8521 has easy-to-see adjustment controls, making changes much easier. It also has a unique sensor that monitors for the presence of someone in front of it and induces a low power state when no one's there.

Manuals for the NEC family of products cleverly break out sections under the titles "I can’t wait," "I want to know more," and "I want to be an expert," which help you quickly find the information you need. The manuals include indexes, glossaries, and a list of addresses for organizations such as VESA and SWEDAC.
A Perfect Image Under Your Command

The irresistible features on the new KFC monitors are so innovative that capturing a true “What you want is what you get” image is no longer an imagination.

- Pin-Cushion Control: No more geometric distortion
- Rotation Control: No more tilted screen
- Trapezoid Control: No more weird picture

KFC Saves Energy, You Save Money!

KFC’s new green monitors consume less than 1.5 Watts when inactive, and less than 20 Watts when on stand-by. Compared to the average of 85–100 Watts for an ordinary monitor, each KFC monitor contributes substantially to a greener environment. And you’re not just sharing the contribution, you’re also saving money.

<table>
<thead>
<tr>
<th>Product Line</th>
<th>Product Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA1718 17&quot; Flat Screen</td>
<td>CA1507 15&quot; Flat Screen</td>
</tr>
<tr>
<td>1280 x 1024 NI</td>
<td>1280 x 1024 NI</td>
</tr>
<tr>
<td>New features</td>
<td>New features</td>
</tr>
<tr>
<td>Energy Savings</td>
<td>Energy Savings</td>
</tr>
<tr>
<td>Microprocessor controlled</td>
<td>Microprocessor controlled</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Line</th>
<th>Product Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM1428D 14&quot; MultiScan</td>
<td>CTI428A 14&quot; SVGA N1</td>
</tr>
<tr>
<td>1280 x 1024</td>
<td>1024 x 768 NI</td>
</tr>
<tr>
<td>72Hz refresh</td>
<td>Energy Savings*</td>
</tr>
<tr>
<td>Microprocessor controlled</td>
<td>Microprocessor controlled</td>
</tr>
</tbody>
</table>

*Power Saving Features Optional

KFC's new green monitors consume less than 1.5 Watts when inactive, and less than 20 Watts when on stand-by. Compared to the average of 85–100 Watts for an ordinary monitor, each KFC monitor contributes substantially to a greener environment. And you're not just sharing the contribution, you're also saving money.

Distributors and Dealers Welcome

1.800.2.KFC.USA

All products and brand names are registered trademarks of their respective companies.
## Roll Call of Color Monitors

<table>
<thead>
<tr>
<th>Model</th>
<th>Overall Score</th>
<th>Quality Index</th>
<th>Ease of Use</th>
<th>Power-Down Index</th>
<th>Price</th>
<th>Dot/Grill Pitch (Pixels)</th>
<th>Mask Type</th>
<th>Max. Horizontal Resolution (MHz)</th>
<th>Video Bandwidth (MHz)</th>
<th>Factory-Preset Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazing Technologies, Inc.</td>
<td>7.13</td>
<td>8.12</td>
<td>5.49</td>
<td>9.81</td>
<td>$650</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>85</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>ADI Systems, Inc.</td>
<td>8.02</td>
<td>8.71</td>
<td>8.36</td>
<td>7.66</td>
<td>$539</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>75</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Acer America, Inc.</td>
<td>7.55</td>
<td>8.31</td>
<td>8.25</td>
<td>7.36</td>
<td>$579</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>75</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Amstrad MicroEngineering</td>
<td>6.58</td>
<td>8.26</td>
<td>8.52</td>
<td>3.60</td>
<td>$999</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>AOI International</td>
<td>6.92</td>
<td>8.12</td>
<td>8.22</td>
<td>8.57</td>
<td>$699</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>AOC Technologies, Inc.</td>
<td>6.47</td>
<td>8.19</td>
<td>4.42</td>
<td>8.84</td>
<td>$499</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Compaq Microelectronics, Inc.</td>
<td>7.36</td>
<td>8.45</td>
<td>6.59</td>
<td>8.55</td>
<td>$459</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>CTX Technologies, Inc.</td>
<td>7.15</td>
<td>8.06</td>
<td>7.25</td>
<td>7.26</td>
<td>$699</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>CTX Technologies, Inc.</td>
<td>7.54</td>
<td>8.94</td>
<td>7.50</td>
<td>8.63</td>
<td>$639</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Delta Products Corp.</td>
<td>7.53</td>
<td>7.53</td>
<td>7.70</td>
<td>8.68</td>
<td>$370</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Delta Products Corp.</td>
<td>7.50</td>
<td>7.95</td>
<td>8.55</td>
<td>8.95</td>
<td>$395</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Epson America, Inc.</td>
<td>7.80</td>
<td>7.86</td>
<td>8.55</td>
<td>10.00</td>
<td>$299</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Festo Additions, Inc.</td>
<td>6.98</td>
<td>8.47</td>
<td>3.99</td>
<td>7.17</td>
<td>$479</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>IBM Corp.</td>
<td>7.47</td>
<td>8.04</td>
<td>8.81</td>
<td>7.38</td>
<td>$607</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>KFC International</td>
<td>8.19</td>
<td>8.33</td>
<td>7.32</td>
<td>8.30</td>
<td>$499</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>MAG 1 International, Inc.</td>
<td>7.86</td>
<td>8.74</td>
<td>7.51</td>
<td>8.94</td>
<td>$699</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Megetron Computer Systems, Inc.</td>
<td>6.81</td>
<td>7.54</td>
<td>5.74</td>
<td>8.98</td>
<td>$279</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>MGC Technologies, Inc.</td>
<td>7.46</td>
<td>8.19</td>
<td>9.19</td>
<td>7.79</td>
<td>$499</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Mitsubishi Electronics</td>
<td>8.67</td>
<td>8.97</td>
<td>8.99</td>
<td>9.99</td>
<td>$645</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Mitsubishi Electronics, Inc.</td>
<td>7.48</td>
<td>8.26</td>
<td>8.54</td>
<td>7.53</td>
<td>$1199</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>NEC Technologies, Inc.</td>
<td>7.73</td>
<td>8.73</td>
<td>7.51</td>
<td>8.94</td>
<td>$699</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Opfest, Inc.</td>
<td>2000DX</td>
<td>7.55</td>
<td>8.16</td>
<td>7.91</td>
<td>$699</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Orchestra Multimedia Systems</td>
<td>7.33</td>
<td>8.35</td>
<td>7.20</td>
<td>8.28</td>
<td>$546</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Proton Corp.</td>
<td>7.27</td>
<td>8.15</td>
<td>7.19</td>
<td>8.58</td>
<td>$799</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Quark Peripherals, Inc.</td>
<td>7.24</td>
<td>8.28</td>
<td>5.98</td>
<td>9.14</td>
<td>$579</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Sony Electronics, Inc.</td>
<td>7.46</td>
<td>8.71</td>
<td>7.16</td>
<td>8.41</td>
<td>$665</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>SuperMac Technology, Inc.</td>
<td>7.81</td>
<td>8.97</td>
<td>7.94</td>
<td>6.64</td>
<td>$399</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>ViewSonic</td>
<td>7.55</td>
<td>7.92</td>
<td>9.36</td>
<td>6.63</td>
<td>$549</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Zenith Data Systems Corp.</td>
<td>8.26</td>
<td>8.90</td>
<td>7.67</td>
<td>8.94</td>
<td>$599</td>
<td>0.28</td>
<td>Dot 1280</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

### Notes
- **Best** = BYTE Best
- **INP** = Information not provided
- **Higher numbers = better performance**
- **Below 6.59 = Poor**
- **6.60-7.49 = Fair**
- **7.50-8.49 = Good**
- **8.50 and above = Excellent**
USER­
SETTABLE
MODES

MAC II"
SUPPORT?

INP

No
No
No
Yes
No
Yes
No
No
Yes
Oplioo
Option
No
Yes
No
No
Yes
Yes
Option
Yes
Yes
Yes
Yes
Yes
Yes
No
Yes
No
Yes
Yes
No

72
72
72
72
70
70
72
72
72
70
70
70
72
75
72
70
72
70
76
76
76
72
70
72
70
72
76
75
76
70
72
72
72
72
70
72
70
75
70

15
16
24
14
8
4
19
19
19
24
INP
15
25

No
No
No
No
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
No
Yes
Yes
Ye s
Yes
Yes
Yes
Yes
Yes
Yes
Yes

15
10
18
8

ENERGY STAR
RECIPIENT?

POWER
MANAGEMEN T?

WATTAGE
USED

FCC
CLASS

MPH 11

TOLL-FREE
PHONE

PHONE
NUMBER

INQUIRY
NUMBER

No
Yes
No
No
No
INP
Yes

64.8
86.4
88.8
76.8
75.6
66.0
74.4
87.6
96.0
74.4
74.4
64.8
88.8
86.4
68.4
66.4
70.8
81 .6
160.8
70.8
80.4
80.4
76.8

B
B

66NI
SO NI
871
87 1
70NI
70 NI
U•supported
U•supported
75NI
SONI
SONI
SONI
60NI
U:isupported
60NI
Unsupported
Unsupported
60NI
60NI
60NI
76 NI
60 tll
Unsupported
60NI
Unsupported

No
Yes
No
No
No
INP
No
No
No
Opliona!
Optional
No
No
Yes
Yes
No
No
No
No
No
No
Yes
No
No
No
No
No
No
Yes
Yes

No
Yes
Yes
No
No
Yes
Optional
Yes
Yes
Optional
Yes
Yes
Yes
Yes
Yes
Yes
No
Yes
Yes
Yes
Yes
Yes
Yes
Yes
No
Yes
Yes
No
Yes
Yes

None
(800) 228-0530
1800) 228-0530
1800) 800-6328
(800) 343-5m
(800) 437-1688
1800) 888·6482
(800) 888-2012
(800) 888·2012
None
None
(800) 289-3n6
(800) 336-3962
(800) 772-2227
1800) 253-2872
(800) 827·3998
None
None
1800) 843·2515
(800) 843-2515
18001632·4636
1800) 843·6784
(800) 257-9988
None
(800) 457-4447
INP
(800) 488­2878
(800) 541-4787
(800) 888·8583
1800) 553·0331

17 14)255-1688
(408) 944-0100
(408) 944-0100
(510) 651·8886
(408) 956-1070
(510) 623-8100
(510) 656-3333
(909) 595-6146
1909) 595·6146
(510) 770-0660
(510)770-0660
(310) 782·0770
(408) 944-0393
(919) 543-7049
(714) 546-0336
(714) 751·2008
(714) 777-6166
(818) 300-8406
(714) 236-6352
(714) 236-6352
1508) 264-8759
(909) 468-3750
(714) 708-3400
(310) 404-2222
(408) 942-4242
(404) 449-6220
(714) 993-9193
(408) 541-6150
(909) 869-7976
(708) 808-5000

1105
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1106
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1346
1347
1348
1349

No
Yes
Yes
No
No
No
No
No
No
No
No
Yes
Yes
Yes
No
No
No
Yes
Yes
Yes
Yes
No
No
No

No
Yes
Yes
No
No
No
No
No
No
No
No
Yes
Yes
Yes
No
No
No
Yes
Yes
Yes
Yes
No
No
No

86.4
117.6
88.8
84.0
97.2
88.8
102.0
59.6
91.2
109.2
82.8
102.0
99.6
81.6
114.0
93.6
96.0
84.0
111 .6
126.0
84.0
111.6
88.8

(800) 800-6328
1800) 343-5777
1800)437-1688
None
(800) 888-2012
(800) 876-4382
(800) 336-3962
(800) 772-2227
(800) 253-2872
1800) 745-7011
(800) 827-3998
(800) 843-2515
(800) 800-5202
(800) 800­5202
1800) 800-5202
(800) 632-4636
(800) 843-6784
1800) 257.9988
(800) 726-2797

(714)255-1688
(408) 432-6200
(408) 944-0100
(408) 944-0100
1510) 356-5600
(510) 651-8886
(408) 956-1070
(510) 623-8100
(510) 438-9946
(909) 595-6146
(510) 226-6250
(408) 944-0393
(9 19}543­7049
(714) 546-0336
(510) 623-6000
(714) 751 -2008
(714) 236-6352
(310)325-5202
(31 0) 325-5202
(310) 325-5202
(508) 264-8759
(909) 468-3750
(714) 708­3400
None

1350
1351
1353
1354
1355
1356
1357
1358
1359
1360
1361
1352
1362
1363
1364

9'2.4 .

B
Pending
B
A
B
B
B
B
B
B
B
B
B
B
B
B
B
B
B

Yes
Yes
Yes
Yes
Yes
No
Yes
No
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes
Yes

None
(800) 368-2237
1800) 228-0530
(800) 228-0530
1800) 356·9990

72
76
75
72
75
76
76
70
70
70
76
76
70
76

60 NI
60 NI
60 NI
60NI
60 NI
60 NI
INP
75NI
74 NI
60 NI
60 NI
60 NI
77 NI
60 NI
70 NI
60 NI
60 NI
60 NI
71 NI
72 NI
N~I supported
60NI
60 NI
7!NI

Yes

70

76 NI

No

No

82.8

B

Yes

1800) 835-3506

(310)217-1300

1374

72
76
80
70
75
70

76NI
60 NI

11
21

Yes
Yes
Yes
Yes
Yes
Yes

No
No
No
No
Yes
No

No
Yes
No
No
Yes
No

94.8
87 .6
104.4
93.6
105.6
105.6

B
B
B
B
B

Yes
Yes
Yes
Yes
Yes
Yes

None
(800) 488­2878
(800) 845-8086
1800) 352-7669
1800) 352-7669
(800) 888-8583

(404) 449-6220
(714) 993­9193
(510) 770-0100
1408) 955·4136
(408) 955-4136
(909) 859·7976

1375
1376
1377
1378
1379
1380

13
10
33
4
19
24
33
15
21

Yes
Yes
Yes
Yes
Yes
Yes
No
Yes
Yes

70
75

60NI
77NI

103

79NI
74NJ
72NI
74NI
80 NI
76NI
71NI

No
Yes
Yes
No
Yes
No
Yes
No
No

No
Yes
Yes
No
Yes
Yes
Yes
No
No

111.6
108.0
134.4
82.8
118.8
124.8
114.0
124.8
120.0

Yes
Yes
Yes
Yes
Yes

(800)225· 1370
(800) 772-2227
(800)394-4335
(800) 843-2515
(800) 800-5202
(BOO) 632­4636
(800)441-4832
(800) 352·7669
(800) 888-8583

(201) 573-0774
(919) 543.7049
1215) 957-6543
(714) 236-6352
(310) 325-5202
(508) 264­8759
(617) 461·8300
(408) 955·4136
(909) 869·7976

1381
1382
1383
1384
1385
1386
1387
1388
1389

1

8
INP
10
0
15
9

16
11
24
8

0
19

16
8

9
None
10
22

8
26
23
15
16
9

13
14
16
16
15
4

J

MA X. RE FRESH
RATE (HZ) AT
1024x768 (N I)'

72

95
70
76
70
72
72

I =interfaced: NI= noninterlaced

MAX. REFRESH
Rm (HZ) AT

1280 xl024'
60 NI
SONI
SO NI
SO NI; 871
l~P

64 NI
Unsupported
74NI
71 NI

• 16-inch display

No
No

Optional
Optional
No
No
Yes
Yes
No
Yes
No
No
No
No
No
No
No
No
No
Yes
No
No
Yes

,9'2.4
69.6
75:6
63.6

94.0
96.0
66.0

B
B

B

B
B
B
B
8
8
B
B

B
B
8

B

8
B

B
B
B
B
B
B
A
B
B
B

B
B
B

A
B
A
A

A
B

y~

Yes
Yes
Yes

1365
1366
1367
1368
1359
1370
1371
1372
1373

' 20-inch display
J ANUARY 19'.14

BYTE/NSTL LA B

RE P ORT

225


Looking for something?

From people and places to finger prints and genes, the MS-160SE™ finds it FAST... at 160 megabytes/sec!

Whether you are looking for a needle in a haystack or just the number of times that Abraham, Isaac and Jacob appear in the Bible, you need an MS-160 Search Engine (SE). The MS-160SE combines a free text search engine with a RAM DISK capable of reading 160 megabytes per second. Searches are performed using exact or fuzzy templates. If you are interested in taking statistics, the board will report the number of times your template was matched. If you want to see each reference, our software will stop the processor and let you see it.

MS-160SE search templates are specified using "regular expressions." Each byte in the expression can specify a single value or a range defined by an upper and lower bound. Up to eight 32-byte wide templates can be used together to form complex search patterns. Alternatively, all eight templates can be used to define a large template that can be up to 256 bytes in length. The Microway MS-160 processor features 512 comparators and 64-bit wide memory to search your data at 160 megabytes per second. The MS-160 also contains a data router and event detector which are controlled by our software. The throughput of its 512 specialized integer units is 10 billion compares per second, which is the equivalent free text searching speed of five hundred 486s or a 10,000 MIPS processor!

The MS-160SE is just as at home in the laboratory as it is in a law office or library. Examples of its use include genetic engineering, meteorological science, image processing and the analysis of spectra of any kind. Numerous applications exist in law enforcement, from finding missing persons and vehicles to analyzing finger prints. The board can also be used as a part of a data logger or data feed parser, triggering on pre-defined events. When used as a 2D filter, the template becomes a 256 by 256 1-bit grid or a combination of eight 256 by 32 1-bit grids.

The heart of the board, the MS-160 processor, can also be used to build instruments, such as logic analyzers, or intelligent hard disk controllers which include a text filter. Microway's engineering staff can help you to implement such designs.

The MS-160SE can be interfaced from PC languages, such as Microsoft C, or you can use canned applications. A Microway Text Retrieval package comes with the card. This package is ideal for law offices or libraries which must be able to instantly make complex searches on data bases downloaded from CDs or hard disks. A complete document management package is available which can handle text and images together, as well as a TCP/IP network interface that makes it possible to build a "Search Server."

The MS-160SE can be fitted with up to 320 megabytes of memory. Software and hardware developers are encouraged to contact Microway at 508-746-7341. We'll show you how to find whatever you're looking for... fast.
Wide-Area Windows Networking

Are NT and Windows for Workgroups truly WAN-savvy?

JON UDELL

The networking that's built into Windows NT and Windows for Workgroups enables machines to share each other's files, printers, and clipboards on a LAN. This set of features, which Microsoft refers to as Windows networking, comes in very handy. (Cynics might prefer the term Windows and OS/2 networking, since Microsoft has to date shipped more OS/2-based networks than Windows-based ones.)

A WFW or NT user on BYTE's Ethernet LAN can, for example, browse for and then connect to a shared directory on my Silicon Graphics Mips R4400-based Magnum running NT; a shared printer that's attached to my Everex 486DX2/50, also running NT; or a shared clipboard item on my WFW machine. Windows networks also interoperate with LAN Manager and LAN Server networks.

What Windows networks don't do by default, however, is talk to other Windows networks. Can Windows networks be WANs (wide-area networks)? That's a fascinating question that Microsoft is now trying to answer in several different ways.

Windows networking belongs to a larger family of networking products that use two protocols—NetBIOS and SMB—to enable workstations to communicate with each other and with servers. NetBIOS provides both connection-oriented services (i.e., sessions) and connectionless services (i.e., datagrams or messages); SMB provides a higher level of service that workstations use to, for example, connect to servers, open and read files, lock records, and queue print jobs.

Endless confusion surrounds NetBIOS. You often hear people say that Windows networking, or other SMB/NetBIOS-based network products, can't run on WANs because NetBIOS "isn't a routable protocol." That's a red herring. NetBIOS is not a transport protocol, so it makes no sense to say that it can or cannot be routed through an internetwork. The NetBIOS protocol instead serves as an interface to a transport protocol, and it's that transport that might or might not be routable.

The default transport for LAN Manager, LAN Server, and Windows networking is NetBEUI, a purely LAN-oriented protocol that is, in fact, unroutable. You can build campus-size NetBEUI networks (like Microsoft's) using bridges, but you can't build global NetBEUI networks using routers.

So how does your Windows client in Canada talk to your Windows server in Sweden? Microsoft took the first step with LAN Manager 2.1. That product provided TCP/IP as an alternate NetBIOS substrate. TCP/IP, which is the foundation of the worldwide Internet, is eminently routable and well supported by vendors of WAN communications gear. It has also been annotated as Microsoft's "strategic" networking protocol. But there's more to NetBIOS-over-TCP than meets the eye.

B-Nodes, P-Nodes, and M-Nodes

A pair of Internet RFCs (requests for comment) numbered 1001 and 1002 propose standards for NetBIOS-over-TCP networking. In the LAN Manager implementation, which carries forward to NT, workstations are b-nodes (broadcast nodes). A NetBIOS-over-NetBEUI station calls a session partner by broadcasting to all nodes on the local network. A NetBIOS-over-TCP b-node works the same way, using UDP (User Datagram Protocol) to effect the broadcast.

But TCP/IP broadcasts don't cross routers; if they did, all that extra traffic would bring the Internet to a screeching halt. The RFC 1001/1002 documents therefore define a completely different scheme for wide-area NetBIOS-over-TCP. P-nodes (point-to-point nodes) use directed UDP datagrams and TCP sessions to emulate NetBIOS-level multicast and broadcast services. M-nodes (mixed nodes), a further refinement, combine the convenience of broadcasting on the local network with the efficiency of point-to-point communication across the WAN.

How do p-nodes and m-nodes establish off-LAN connections? They rely on a pair of services called the NetBIOS Name Server, or NBNS, and the NetBIOS Datagram Distribution Server, or NBDD. These agents learn and cache mappings between NetBIOS names and IP addresses, and they intelligently manage naming (i.e., registration, discovery, and defense) and messaging (i.e., multicast and broadcast). A commercial implementation...
Beyond DOS

Do the LAN Manager and NT implementations of NetBIOS-over-TCP use p-node and m-node technology coupled with NBNS/NBDD services? No. They rely instead on a table of NetBIOS-name/IP-address mappings (the LMHOSTS file) stored on each participating workstation. Microsoft calls this technique a modified b-node approach.

To make things more concrete, see the figure “Alternative Windows Networking Scenarios” below. In the first part, “Local TCP/IP,” my two NT machines act as b-nodes, sharing files, printers, and clipboards using TCP/IP alone (there is no NetBEUI present); they can also telnet to Bytepb, BYTE’s UUCP host. In the second part of the figure, “Routed TCP/IP,” I’ve split the network in two. The router is Everex, which uses the basic IP routing capability of NT to join the 192.1.2 and 192.1.1 class-C networks.

Because Everex’s Windows networking is configured on the 192.1.1.84 adapter but not the 192.1.2.1 adapter (NT supports Windows networking over just one TCP/IP interface at a time), Magnum and Everex cannot by default share each other’s files, printers, and clipboards. NT’s internal IP router stands between them. To enable Windows networking across the router, I had to add the line EVEREX 192.1.1.84 to Magnum’s LMHOSTS file and also add the line MAGNUM 192.1.2.2 to Everex’s LMHOSTS file. (I also had to configure Magnum’s default IP gateway to be 192.1.2.1.) Then everything worked—except browsing. In the local TCP/IP case, Magnum and Everex could browse each other’s shared resources, but in the routed TCP/IP case they couldn’t. With an LMHOSTS reference to Everex, Magnum could NET USE a known shared drive on Everex but couldn’t browse (or NET VIEW) Everex to discover what resources it was sharing.

Why not? Workgroup browsing requires broadcasting, which is, as we’ve seen, strictly local in TCP/IP. According to J. Allard, Microsoft’s program manager for TCP/IP technology and the author of a document on NT’s TCP/IP (available by ftp from rhino.microsoft.com), browsing does work within NT Advanced Server domains that span TCP/IP subnetworks. It works because browse masters on each subnetwork communicate with a domain’s primary controller using directed, point-to-point links (which, however, must be described in LMHOSTS files). Workstations, in turn, query local browse masters for share information.

What about TCP/IP support in the new WFW 3.11? Although the product will probably have shipped by the time you read this, its much-anticipated 32-bit NDIS 3.0 TCP/IP stack isn’t yet ready. Microsoft says you’ll be able to use a (separately available) real-mode NDIS 2.0 TCP/IP stack as the sole substrate for Windows networking on WFW 3.11, but I haven’t had a chance to try that yet.

The IPX/SPX Option for NT and WFW

I repeated these experiments using NT’s NetBIOS-over-IPX. In the third part of the figure, “Local IPX,” Magnum and Everex conduct mutual Windows networking on IPX network 1, which also reaches Ourtown, a NetWare server, and the rest of BYTE’s editorial LAN. In the fourth part of the figure, “Routed IPX,” Magnum shares IPX network 666 with a stand-alone NetWare router that’s also joined to IPX network 1.

Windows networking between Magnum and Everex was instantly and fully functional, requiring no administrative intervention as in the routed TCP/IP scenario. Further, because IPX propagates broadcasts through routers, Magnum and Everex could browse off-LAN to locate each other’s shares. The same situation prevailed when I rebooted Everex to DOS and launched the beta version of WFW 3.11. Its IPX transport can substitute for NetBEUI as the sole substrate for Windows networking. Both IPX and NetBEUI can now run as 32-bit VxDs (virtual device drivers) in WFW 3.11, incidentally.

Other new VxD components include a selection of NDIS 3.0 network adapter drivers and a VxD-based FAT (file allocation table) file-system driver. This accumulation of VxD components makes WFW 3.11 an intriguing preview of the forthcoming lightweight 32-bit version of Windows known as Chicago. Of particular note is the fact that the NDIS 3.0 drivers for both WFW 3.11 and NT are built from common sources, according to Microsoft. This sharing of driver code will be a key synergy between Chicago and NT.

Which Strategic Protocol?

Let’s recap. TCP/IP, Microsoft’s strategic networking protocol, enables wide-area Windows networking, but the current implementation leaves a lot to be desired. Due to the lack of a dynamic NetBIOS Name Server, the mapping of NetBIOS names to IP addresses requires cumbersome manual maintenance of LMHOSTS files. That’s the sort of labor-intensive, error-prone activity that network administrators desperately want to avoid. (LAN Manager 2.2 introduced a stopgap measure—TCP/IP extensions that enable broadcast domains to span selected subnetworks—but it doesn’t carry forward to NT.)

Even with correct LMHOSTS mappings, workgroup browsing can’t cross subnetworks. And while TCP/IP comes with NT, it won’t be bundled with the most advanced version of DOS-based Windows, WFW 3.11.

IPX/SPX looks pretty attractive in comparison. It works seamlessly on routed IPX networks, and it is bundled with both NT and WFW 3.11. Moreover, IPX/SPX can simultaneously handle both Windows-to-Windows and Windows-to-NetWare connectivity.

When IPX/SPX appeared late in the development of NT under the name NWLink, the absence of a NetWare redirector for NT (which is now, by the way, available in beta) made NWLink’s role unclear to many people. Microsoft’s own marketing pitch tended to
focus on NWLink’s ability to integrate SQL Server into NetWare environments. In reality, it’s a fully functional Windows networking protocol. If you operate a routed IPX internetwork, you can do local- and wide-area Windows networking using NWLink.

Given these options, you might wonder which routable protocol complements NetBEUI on Microsoft’s own worldwide Windows network. Amazingly, it’s a protocol that Microsoft doesn’t offer to its customers. The folks in Redmond connect to Microsoft’s satellite offices using XNS (Xerox Network Services), an older protocol from which IPX/SPX inherited its routable properties. The annotated wide-area Windows protocol, TCP/IP, can’t yet support Microsoft’s own mission-critical wide-area networking. If Microsoft doesn’t use it, should you?

**What’s in a Name?**

While this all looks mighty suspicious, Microsoft’s Allard is candid about the situation. “XNS solved a problem for us years ago and became entrenched here,” he says, “but that doesn’t mean it’s the right solution for us or our customers.” Microsoft is now developing an NBNS-like service called WINS (Windows Internet Name Service) that is, as Allard points out, a requirement for efficient use of any routable protocol on WANs.

NetBIOS is a dynamic, distributed name service that works well when bandwidth is essentially free. But LANs and WANs are polar opposites in this regard. Propagating broadcasts through routers can work, but Microsoft pays dearly in tariffs for its extravagant worldwide use of XNS. Users of IPX/SPX WANs can control those tariffs only to the extent that administrators can configure routers to filter the broadcast traffic.

Ultimately, no matter what the protocol, you need efficient management of a distributed namespace that encompasses users, devices, and network services. That’s the real problem WINS will tackle. If it works, you’ll see Microsoft (and its customers) doing wide-area networking over a choice of protocols.

Will WINS be a full-blown RFC 1001/1002 NBNS/NBDD service? No, says Allard, precisely because it shouldn’t be tied to TCP/IP or any other protocol. (WINS will use p-node technology, for example, but it won’t depend on it.) TCP/IP—because it’s more scalable and robust than IPX/SPX—will often be the preferred choice, but it shouldn’t be required. If you have an IPX/SPX infrastructure, you ought be able to leverage it.

Should WINS, or Windows networking in general, be tied to the kind of flat distributed namespace that NetBIOS uses? Again, the answer is no. A structured namespace will likely serve the needs of the distributed enterprise much better.

There’s an interesting opportunity for convergence here. Windows wide-area networking requires advanced name support. So do Windows distributed objects in the forthcoming Cairo. Killing these two birds with one stone would make a lot of sense, and that’s what I predict will happen. Meanwhile, I’ll be watching network developments in Redmond with interest. When Microsoft’s wide-area Windows networking over TCP/IP is good enough for those folks to use, it ought to be good enough for us.

Jon Udell is a BYTE senior technical editor at large. He can be reached on the Internet or BIX at judell@bix.com.

---

**DATA COMPRESSION LIBRARIES™**

PKWARE’s® Data Compression Libraries™ allow software developers to add data compression technology to software applications. The application program controls all the input and output of data allowing data to be compressed or extracted to or from any device or area of memory.

- All Purpose Data Compression Algorithm Compresses Ascii or Binary Data Quickly with similar compression achieved by the popular PKZIP software, however the format used by the compression routine is completely generic and not specific to the PKZIP file format.
- Application Controlled I/O and memory allocation for extreme flexibility.
- Adjustable Dictionary Size allows software to be fine tuned for Maximum Size or Speed.
- Approximately 35K memory needed for Compression, 12K memory needed for Extraction.
- Compatible with most popular Languages: C, C++, Pascal, Assembly, Basic, Clipper, Etc.
- Works with any 80x86 family CPU in real or protected mode. $295.00
- No runtime royalties.

**RUNNING OUT OF EXPENSIVE DISK SPACE?**

PKZIP can help! PKZIP compresses your files to free up disk space and reduce modem transfer time. You can compress a single file or entire directory structures with a single command. Compressed files can be quickly returned to their normal size with PKUNZIP.

Software developers can reduce the number of diskettes needed to distribute their product by using PKZIP. Call for Distribution License information.

The included PKZIP utility lets you store compressed files as a single self-extracting .EXE files that automatically uncompressed when run. Only $47.00

---

Circle 106 on Inquiry Card.
When it comes to computing... we wrote the book.

Rely on Osborne to deliver computer books with the information and insights you need... on virtually every hot topic. With our books, you'll find the answers fast, so you can become more productive, knowledgeable, and confident.

Check out our two-color text that highlights important information: chapter titles, page numbers, special tips and illustrations.

Special icons call attention to unique shortcuts, great tips and professional advice.

Abundant screen displays are clear and crisp, and marked for easy identification.

Osborne
Get Answers—Get Osborne
For Accuracy, Quality and Value

AVAILABLE NOW AT YOUR LOCAL BOOK AND COMPUTER STORES

Barnes & Noble
Super Crown
Borders

For Accuracy, Quality and Value

Circle 97 on Inquiry Card.
A Standard for Writing Recordable CDs

The new DIS 13490 standard allows updates to recordable CDs while maintaining cross-platform data exchange

JASON HYON

CD-ROM has fulfilled its promise of becoming a significant data storage and distribution medium of the 1990s. You don’t have to look any further than today’s desktop computers to confirm this: Most Macintoshes ship with CD-ROM drives, every MPC includes one, and nearly every Unix workstation comes with a CD reader for system software installation.

A key to the success of the CD industry is ISO 9660:88 (hereafter referred to as ISO 9660), the international standard for the CD-ROM logical format. This standard allows the same CD-ROM to be read and interpreted on Mac, MS-DOS, Unix, VAX/VMS, and many other computer platforms.

However, some design problems surface when ISO 9660 drivers are implemented on various operating systems. For example, the information needed to do a Unix directory-listing command is stored not in the directory records, but in the extended attribute records located with the data file. Thus, to do a simple directory command, seeks to the individual data-file locations must be done. Furthermore, a DOS or Mac driver that’s not savvy to this type of directory structure can’t access the material.

An important feature that’s not supported by ISO 9660 is the ability to incrementally add information to recordable media, a feature known as multisession capability in CD terminology. This ISO 9660 limitation has become a major problem since the advent of Kodak Photo CDs, which allow you to add a new set of images to an existing platter. Also, low-cost (i.e., under $6000) CD-R (compact disc recordable) mechanisms allow companies to produce limited-run CDs of specialized information. It would be desirable to be able to simply update existing CDs with new information, rather than having to scrap the lot and start over.

CD-WO (compact disc write-once) technology has advanced since the ISO 9660 standard was adopted in 1988. CD-WO is an evolution of CD-ROM to a sequential, write-once medium. It is defined by the Orange Book (developed by N. V. Philips and Sony), which specifies the medium and the basic CD-WO system and supports writability and updatability. Consequently, while the Orange Book standardizes the physical media, a new standard—similar to ISO 9660—is needed to define the logical organization of data on the disc.

The goals in drafting this new standard were as follows: add support for existing CD-WO functions, overcome the deficiencies of ISO 9660, provide support for future extensions (e.g., Windows NT), and maintain compatibility with ISO 9660 within the new framework. Moreover, it had to support additional volume and file-structure standards that are optimized for different media, such as WORM and rewritable CDs.

One difference between the new standard and ISO 9660 is that the former provides logical “visibility” to the tracks and sessions on a CD. This is accomplished through the use of track records in the existing CD-WO standard.

This new standard has followed the same path of acceptance as ISO 9660: When the High Sierra Group drafted a proposal for a CD-ROM volume and file-structure standard, the European Computer Manufacturers Association modified it and accepted it as ECMA 119. It was then accepted as ISO 9660 from DIS 9660. Similarly, the Frankfurt Group (so called because of the location of its first meeting in Frankfurt, Germany) drafted a proposal for a CD-ROM and CD-WO volume and file-structure standard, which ECMA modified and accepted as ECMA 168.

Currently, the logical standard, called DIS 13490, is in
Under the Hood

CD-WO Extended Area

Volume space table
Path tables information
Path table

End-Transaction Descriptor

End-transaction descriptor sequence

Volume descriptors

The structure of an ETD and how ETDs are linked when material on the disc is updated.

international review. It is very likely to be accepted as ISO 13490 after the review period. To eliminate confusion, it’s important to note that in this article CD-WO refers to the physical standard (per the Orange Book), while DIS 13490 refers to the logical structure of data on a CD-WO disc.

CD-ROM Basics

Before I illustrate the CD-WO volume and file-structure standard, it’s beneficial to briefly describe ISO 9660, the existing volume and file-structure standard for CD-ROM. ISO 9660 divides a disc into four main areas, called descriptors, that describe its data organization. These four areas are called volume descriptors, path tables, directory records, and extended attribute records, or XARs.

In the volume descriptor area, a primary volume descriptor contains the locations of the path tables, the root directory, and other important information on the disc. Unlike CD-WO, since the contents and location of the files are predetermined and do not change, the locations of the path tables and root directory are recorded in the primary volume descriptor.

The path table describes the relationship between directories and subdirectories. The directory records point to subdirectories or files in a directory.

This mechanism provides two ways of traversing the directory tree of a CD-ROM file system: by chaining through directory records or through the path table. If this same method were used for a CD-WO file system, once a file or directory was updated, every directory record would have to be rewritten to reflect the change. For this reason, the relationship among directories and files for the CD-WO file structure are indicated only in the path table. Thus, directory records for the CD-WO file structure do not contain a pointer to their subdirectory or file.

Finally, ISO 9660’s XARS provide the owner ID, group ID, and record structure of a directory or file. However, XARS are recorded on a file or directory basis, and this causes a big performance hit on a CD-ROM drive. This problem has been resolved in the CD-WO file structure, as I will describe later.

The fields used in the internal structure of DIS 13490’s descriptors are similar in format and value to the fields used in the internal format of ISO 9660. However, certain fields have been altered so that DIS 13490’s structures facilitate the support of Posix. This allows the standard to encompass the dominant operating systems in the market, such as DOS, Mac OS, Unix, and VMS. Included among the participants in the Frankfurt Group were representatives of these operating-system developers.

When you mount a physical volume, the operating system must know what types of data, and in what formats, are recorded on that medium. To do that, DIS 13346 (a volume and file-structure standard for nonsequential write-once media and rewritable media), DIS 13490, and possibly a new tape standard have created a common volume-recognition scheme. These commonly defined volume-recognition sequences enable systems to mount media for the proper volume standard and to boot from the media.

Further, the defined character sets have been expanded from the ISO 9660 standard, and the need for special separator characters has been reduced. The XARS as defined in ISO 9660 have been eliminated, and the functions of XAs (extended attributes) have been expanded through the use of the XA area in the directory and path-table records.
The DIS 13490 standard is organized into four parts, as described below:

• **Part 1:** General. States the notations and definitions used in this standard.

• **Part 2:** Volume and boot-block recognition. Describes volume and boot recognition structures for interchange with other standards.

• **Part 3:** Volume and file structure. Describes volume and file descriptors along with a new, more efficient XA capability.

• **Part 4:** Record structure. Defines the various record types, such as fixed records, variable records, stream records, and so on.

All parts of the standard are independent. The market will determine what parts will be supported. Thus, a vendor can choose to implement only parts 1 and 2 for volume recognition and boot purposes, letting a system recognize what driver to use in mounting the disc’s native volume and file system. If a vendor were to implement parts 1, 2, and 3—the volume and file structure without the record-structure support—a transportable volume for data interchange with other operating systems could be created. Part 4 could be implemented for systems that support record structures, such as DEC’s VMS. Lots of implementations will probably support only parts 1, 2, and 3, since many microcomputer operating systems (e.g., Mac OS, DOS, and Unix) don’t use record structures.

There is currently another CD-ROM standard, called Rock Ridge. Its intent is to use CD-ROM as a complete implementation of X/Open and Posix file systems and directories. The purpose of the Rock Ridge initiative is to create an agreeable common format by utilizing the system area in the directory record of ISO 9660 while maintaining compatibility with the installed base of ISO 9660 hardware and software.

The SUA (system use area) in the directory record includes necessary information such as UID (user ID), GID (group ID), the UID and GID numbers used by receiving X/Open systems, the mode bits, and the major and minor device. Most Unix CD-ROMs already use this standard for file interchange among Unix systems.

While the Rock Ridge standard provides data interchange with Unix systems, DIS 13490 will have to support future operating systems such as Windows NT. Fortunately, DIS 13490 provides many ways to implement future operating-system-specific needs by allowing vendors to embed information in the descriptors and the SUA.

Conforming DIS 13490—receiving systems (i.e., systems that read data on CD-WO) will support a subset of ISO 9660. However, the XAR in ISO 9660 won’t be supported by these receiving systems. Thus, it is possible to have a disc that supports both ISO 9660 and DIS 13490 on the same medium.

**The Structure of DIS 13490**

DIS 13490 starts by using descriptors similar to those used in ISO 9660. These descriptors can be categorized into three main parts: the CD-WO EA (extended area), the ETD (end-transaction descriptor), and path tables.

Volume descriptor sets, or VDSes, are located in the CD-WO EA. The EA is a container for volume and file descriptors (see the figure “CD-WO Extended Area”). The VDS contains at least one PVD (primary volume descriptor) and TD (terminating descriptor), and zero or more SVDs (substitute volume descriptors), ETDs, and VPDs (volume-partition descriptors).

In a CD-WO EA, different BDs (boot descriptors) can be written. This allows a “generic” boot CD-ROM. At start-up, such a boot ROM would be scanned for BDs for matching system identifications. The system identification encodes the system type and system-dependent options, such as combinations of processor type and memory management. After examining the boot identifier, the boot ROM can present the operator with a

---

**A CD-WO structure, illustrating the arrangement of a set of directories, subdirectories, and files, with a new file (File008) added.**
choice of operating systems that can be booted.

A PVD identifies the volume, the volume set to which the volume belongs, the volume’s attributes, the character sets used in recording the contents of certain fields within the PVD, and the rule for recording and locating the ETD. An SVD provides an alternate identification of the volume and the volume set to which it belongs. A VPD specifies a volume partition, attributes of the partition, and its identification. The TD identifies the end of a VDS.

Because CD-WO is an updatable medium, the volume information can be revised by writing new VDSes. The standard also specifies how to recognize the most recent valid VDS. In addition, in a CD-WO EA, or at a location pointed to by the ETD, an FSDS (file-system descriptor set) identifies the file set; the set of characters allowed in certain fields of the descriptors associated with the file set; attributes of the file set; optional application and publisher information; and optional copyright, abstract, and bibliographic information.

An FSDS contains an FSD (file-set descriptor)—a concept of a logical volume—and an IUD (implementation use descriptor). The FSD is directly associated with a path table that identifies every directory in the directory hierarchy describing the set of files in the file set. Thus, at least one FSDS should be written over a volume to describe the disc’s contents. Also, zero or more IUDs identify an implementation and contain information for that implementation’s use. The IUD is one of the descriptors that allow extensions for current and future operating systems’ needs that are not yet defined by this standard.

By using descriptors, the new DIS 13490 standard allows the updating of files on CD-WO media.

All VDSes, FSDSes, and BDs are enclosed in a BEAD (beginning extended-area descriptor) and a TEAD (terminating extended-area descriptor). Thus, the CD-WO EA identifies that the CD-WO volume and file-structure standard was used to write that disc. The figure “CD-WO Extended Area” illustrates the minimum required descriptors for a volume or a volume set. The BD is optional. The ETD is one of the most important descriptors in DIS 13490. As the information on a disc changes, VDSes, FSDSes, and ETDS are used to update the volume and file structure. The more a disc is updated, the more complicated these sequences of descriptors are. Thus, this standard suggests several rules for recording ETDSs so that they can be searched effectively.

An ETD contains a pointer to the current and previous VDS and FSDS and the previous ETD sequence. ETDSs contain information for locating important descriptors. The first is the PTI (path table information); the second is the volume-space table, which contains the TSR (track specification record). The PTI records that point to the location of the path table (which is discussed below). The TSR contains a set of records that describe a track, noting such things as its size and recording format. The figure “End-Transaction Descriptor” on page 232 illustrates the ETD and the relationship between a PVD and previous and current ETDSs.

Multiple PVDs and PTIs allow multiple directory hierarchies. A path table specifies the root of a directory hierarchy, each directory in this hierarchy, and its relationship (if any) with other directories in the hierarchy. The path tables also supply the location and size of the directory file for each directory in the directory hierarchy.

Volume-structure descriptors, path-table records, and directory records have an XAA (extended attribute area). This area provides extension capabilities to the standard by providing the incorporation of tag-identified attributes. These attributes are associated with an ordinary file when the XAA contains tags in the directory record, and they are associated with a directory when the XAA contains tags in the path-table record. The XAA can contain several attributes, the number of which can exceed the desired directory (or path-table) record size. Or, such a record might contain attributes deemed by the implementation to be located in another extent. In this case, a continuation extent’s XAF (extended attribute field) provides this capability. The XAF is used to partition a designated continuation extent into a system-use area and an application-use area.

By using the descriptors described above, the new DIS 13490 standard allows the updating of files on CD-WO media as described in the Orange Book. Consequently, the files can be modified, the directory hierarchy can change, and directories can be added within the constraint that write-once media will retain all previous revisions of recorded information. The figure “DIS 13490 Structure” on page 233 shows a simple set
Introducing
Audio/VideoBlender...

twice the blast, half the slots.

Now, for the first time, you can get single-frame and full-motion video capture with 16-bit audio on a single board!

AITech’s new Audio/VideoBlender provides this double blast in one. Receive the same high-quality sound of the leading audio board. Plus full-motion video capture. All on one board!

Audio/VideoBlender eliminates the need for a separate audio card for capturing, digitizing and playing back video and sound. Saving an expansion slot. And, the additional cost of purchasing individual video and audio boards.

With one integrated audio/video board, compatibility issues also decrease. Spend time on producing videos rather than configuring audio and video boards.

So, with Audio/VideoBlender, create and edit videos for business and home presentations with not only full-motion video, but 16-bit PC audio. Display color resolutions of 16-bit (64K) colors, 15-bit (32K) colors or 256 colors are available. Plus, connectors for NTSC or PAL signals. Conversion from the AITech format to various video capture formats including Microsoft AVI and Intel Indeo is also provided.

For increased sound impact, Audio/VideoBlender offers 16-bit digital recording with stereo line-in and microphone input. Up to two simultaneous audio source inputs with software selection control for microphone input or audio line-in are also available.

If audio functions aren't a requirement, AITech offers the VideoBlender. All the features of the Audio/VideoBlender are offered except built-in audio.

AITech can assist you with other desktop video needs too. We offer a complete line of fully compatible DTV products, including integrated audio/video output, compression and genlock/overlay products, and audio/video encoders.

For a double blast in one, or information on our other products, contact your local dealer or call us at 1-800-882-8184 or 1-510-226-8960, or fax 1-510-226-8996.

AITech International, 47971 Fremont Blvd., Fremont, CA 94538

Vision for Multimedia

© AITech International, 1993. Audio/VideoBlender, VideoBlender, VedioSurge, WaveWatcherTV, audioSHOW, gamePlayerTV and ProPC/TV Plus are trademarks of AITech International. All other trademarks are the property of their respective holders. Specifications are subject to change without notice.

Circle 64 on Inquiry Card.
This unique Time-limited software protection system is based on a plug containing a real-time clock. It allows users limited execution times for leasing and demonstration applications. A password system allows you to rewind the clock by telephone based on a plug containing a real-time clock. It allows applications.

The premiere network protection plug for UNIX systems that connects the standard serial port of computers and workstations.

Comprehensive network protection starts with a single plug. The LANPlug lets you operate protected software from any workstation on the network, while supervising a number of authorized simultaneous operation applications.

This unique Time-limited software protection system is based on a plug containing a real-time clock. It allows users limited execution times for leasing and demonstration applications. A password system allows you to rewind the clock by telephone based on a plug containing a real-time clock. It allows applications.

The amazing Software protection system based on a hardware plug. Contains read-write programmable memory. This system is practical and easy to use for both programmer and end-user. Supports various programming languages, operating systems and types of computers.

MEMOPLUG™

Ever seen a grown pirate cry? Just plug this in ... and watch

U-PLUG™

LANPLUG™

CLOCKPLUG™

Circle 142 on Inquiry Card.

Hands On Under the Hood

of directory hierarchies that can be built with this standard, as well as the updated structure when a file is added to a subdirectory.

Recording Methods

The Standard of Recording (i.e., “Orange Book Part II: CD-WO,” N. V. Philips and Sony, November 1990) identifies two methods that specify which tracks on a disc can be recorded. These methods are track-at-once and incremental, with either fixed- or variable-length packets. Each recording method has a different addressing scheme that has advantages specific to certain applications.

Track-at-once, the only method currently used in the current market, refers to recording one or multiple tracks in one uninterrupted stream. A simpler version of track-at-once is volume-at-once, which refers to the recording of a complete CD-WO volume in one uninterrupted stream; this is how CD-ROM is mastered. By using the track-at-once method, you can do stepwise creation of a CD-WO disc, with up to 99 tracks possible (see the figure “Volume-at-Once vs. Track-at-Once” on page 234).

Incremental recording refers to writing within a track with multiple data streams, where they are separated by gaps. The recording of these streams need not be done at once. Streams within a track can be either fixed-length (i.e., they are all the same length) or variable-length. However, this scheme requires that existing players recognize new information that resides among data streams. This embedded information cannot be recognized by existing CD-audio and CD-ROM players.

A multisession disc is a special version of a CD-WO disc. A session is a sequence of one or more tracks where the track numbers form a continuous, ascending sequence. Each session could be an ISO 9660 volume.

Note that both CD-ROM (Yellow Book) drives and CD-WO/CD-R (Orange Book) drives do not support all types of recording schemes. For example, most CD-ROM drives can read only those discs that are recorded in a single-session, track-at-once format. Also, one brand of CD-WO recorder can record discs only with the track-at-once method. Users need to be aware of these limitations when deciding what type of CD drive to purchase. Although the logical format of a disc conforms to the standard, the disc might not be readable by some drives.

Within a year, most CD-WO drives should be able to record and read all three types of recording schemes. Also, new CD-ROM drives should be able to read all types of CD-WO discs.

Editor’s note: DIS 13490, also known as ECMA 168, is available from the European Computer Manufacturers Association, 114 Rue du Rhône, CH-1204, Geneva, Switzerland; phone: +41 22 735 36 34; fax: +41 22 786 52 31. The research described in this article was carried out by the Jet Propulsion Laboratory at the California Institute of Technology, under a contract with NASA. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not constitute or imply its endorsement by the U. S. government or the Jet Propulsion Laboratory.

ACKNOWLEDGMENTS

I would like to thank Thomas Wong at Sun Microsystems and Mike Martin at JPL for their input.

Jason Hyon is a project leader at the Jet Propulsion Laboratory in Pasadena, California. He can be contacted on BIX clo "editors" or on the Internet at jhyon@jpl.nasa.gov.
Subclassing in OLE 2.0

It's not just an API anymore: The Component Object Model of OLE 2.0 is the beginning of object-oriented system services

GEN KIYOOKA

Much has been written about OLE 2.0, and a great deal of it smacks of resistance and harsh criticism. Much of the furor over OLE 2.0 seems to arise from its purported complexity and from the apprehension and resistance that accompany a paradigm shift. It seems that software developers, faced with another challenging advance in software interoperability, are not amused.

The problem is one of perception. Many perceive OLE 2.0 as a newfangled cosmetic add-in for Windows 3.1, along with a needlessly complex set of specifications and implementation requirements. In fact, OLE 2.0 marks the delivery of new operating-system software and provides new tools for managing complexity and solving problems. From a marketing perspective, Microsoft has done a great job of packaging this new issue to be resolved by time itself, and its realization a testament to the foresight of the OLE architects.

OLE and C++: A Match Made in Purgatory

The first issue might be restated as a proposition: "For Windows to be a true object-oriented system, it should be based on an object-oriented language (e.g., C++) featuring encapsulation, inheritance, and polymorphism. The role of the programmer is to refine the functionality of the base system." OLE does not fully subscribe to or endorse this model as the proper solution for system-level (large granularity) software interconnection.

Thus, under OLE 2.0, the use of C++ or inheritance is strictly relegated to an internal component implementation detail. Other languages and software techniques can be used to implement objects. Publishing an object to be employed by people requires that the object expose a standard and rigorous interface.

OLE's lack of support for a standardized inheritance mechanism merely indicates that inheritance is inappropriate for rigorous, standardized software interconnection between components due to be aggregated into appropriate solutions by the end user. Of the other criteria for object orientation, encapsulation holds the place of honor, with polymorphism—or rather, reuse of interface—playing a secondary role.
The second issue seems to arise when the neophyte OLE programmer is faced with the complex administrative burden of implementing drag-and-drop under OLE 2.0, the source and dropped onto the target window implements the functions in the IDropTarget interface. In this case, the protocol involves two separate parties and two separate interfaces. The rigor of this contract ensures that drag-and-drop functionality is implemented uniformly throughout the system.

Unlike an informal grouping of function calls, an OLE interface binds a set of function calls together into a unit as an opaque means for accessing an object. Contrast this with a more informal set of functions in a conventional API. The Component Object Model defines a binary specification of what an interface looks like. More concretely, it specifies a binary description of what an interface is.

This binary specification has these four goals:

1. To provide a function-invocation mechanism that provides a compile-time-type-safe and opaque means for manipulating a software component object
2. To provide polymorphic interfaces for different classes of objects with similar behaviors
3. To provide a limited inheritance from a common shared interface, called Unknown (analogous to a base superclass called Object in a standard, singly rooted inheritance hierarchy)
4. To allow objects in the local process space and those in remote process spaces to be manipulated in a uniform manner

To achieve these goals, the Component Object Model uses a binary specification of an interface object as a pointer to an opaque chunk of memory whose first 32-bit element is a pointer to an array of function pointers representing the methods that encapsulate the object. This array of function pointers is a VTBL.

**Do-It-Yourself Polymorphism**

Consider the problems a VTBL interface sets out to solve. Imagine being exposed to Smalltalk in an educational setting and, in your first C programming assignment, being asked to implement an object-oriented, polymorphic class hierarchy with inheritance. The first practical C++ compiler for your operating environment would not be available for several years.

One solution would be a message-passing architecture similar to the one used in the window manager of Microsoft Windows. In this model, polymorphism is achieved through generic parameters whose contents are interpreted according to the message context. Inheritance is achieved by chaining uniformly defined message-handling functions. The message-handling function that first receives the message represents the most specialized subclass in the inheritance hierarchy. It can choose to discard, implement behavior for, or pass a message on to the handler of its immediate superclass. Unfortunately, this method is ill-equipped to handle data definitions at each successive subclass in a hierarchy.

Another solution strikes closer to the heart of the binary interface standard of the OLE Component Object Model: You envision the accretion of both data and functions as proceeding in an orderly fashion down from a general superclass to a specific subclass. Since you’re a C programmer fond of malloc() and free(), you have decided that an object be instantiated by malloc() and destroyed by free(). To separate the behav-
ior from the private data of these objects, you decide to make the first data element of every object a pointer to an array of function pointers. Each successive specialization in the class hierarchy can add its own new functions to the array of function pointers and its own new data to the private data definition. Only one array of function pointers need be maintained for each class.

This is exactly the binary model used in a single-inheritance C++ class hierarchy. C++ multiple inheritance introduces vulnerabilities to this otherwise comprehensible and clean model.

Proxy Interfaces for a Uniform Representation

The Component Object Model lets consumers manipulate objects only through the object’s interface pointer. Given this opaque definition of an interface, the Component Object Model’s final goal can be realized: accessing remote and local objects in a uniform way.

Consider a rectangular chart object that has been inserted into a spreadsheet application. The spreadsheet manipulates the chart object’s contents by invoking functions on the object’s OLE interfaces. But if another application program implements the chart object, the actual implementation is performed in another process space. Therefore, the interface pointer used by the spreadsheet application points not to the chart object itself, but to a proxy representation of the chart object’s interface in the local process space. The proxy object forwards the methods invoked on this local interface (through a lightweight RPC, or remote procedure call) to the actual implementation in another process space.

This is the fundamental magic of OLE 2.0. By performing a major behind-the-scenes effort, OLE exposes a uniform and familiar (i.e., function through-pointer invocation) means for manipulating all objects in the system.

A Minimal OLE Program

Rather than jump into a fully capable OLE application with thousands of lines of code, look at the INSTANCE.CPP listing—the OLE equivalent of “Hello World.” As you can see, the most basic requirements for an OLE application do not extend much beyond the basic requirements for a standard Windows application. Execution begins at WinMain, and two additional calls, OleInitialize() and OleUninitialize(), are required for a bona fide OLE application startup and shutdown. The rest of the code involves instantiation, our next topic.

Remember (from OLE 1.0) that the OLE system maintains a system registry—essentially a hierarchical database containing information about each OLE-capable object server on your computer. Each OLE application is required, as part of its setup program, to merge its information with the registration database. Instantiating an OLE object is similar in principle to late binding or dynamic linking. Applications that know nothing of each other can communicate by invoking functions on objects owned by one another. The registration database is a key part of the process, providing a central repository (i.e., catalog) of system parts.

Creating an Instance of an OLE Object

Look at INSTANSE.CPP again. This code shows how to create an instance of an object. To instantiate an object, you need to know its globally unique class identifier. These class identifiers are stored in the registration database (where you’d normally be obtaining it). But for the sake of clarity, I’ve taken a copy of the definition of the class identifier for CPoly from the code to DISPDEMO, included in the OLE developer’s kit, and placed it directly in INSTANCE.CPP.

The interface pointer returned by the CoCreateInstance() function represents the instantiated object. Having a pointer to the IUnknown interface is like having a pointer to CoObject, the root class, in MFC (Microsoft Foundation Classes). You know nothing specific about the object except how to release your reference to it (IUnknown::Release()) and how to ask it for other interfaces it may support (IUnknown::QueryInterface()).

To run INSTANCE.EXE on your system, your computer has to have the OLE 2.0 developer’s library installed. If the Dispatch polygon sample programs function correctly, INSTANCE.EXE should, too. This is a large-model program created with Microsoft Visual C++; it links implicitly to the OLE2.LIB (OLE2.DLL) and COMPOBJ.LIB (COMPOBJ.DLL) import libraries.

The Subtleties of Using Interfaces

Now that you have had a chance to examine the instance application, you should be familiar with the basics of OLE objects:

```c
void CBrowseDlg::QueryInterfacesOf(IUnknown FAR* pIUnknown)
{
    POSITION Position = m_RegInterfaces.GetHeadPosition();
    COLEInterface *pInterface,
    while (Position && (pInterface =
                        (COLEInterface *)m_RegInterfaces.GetAt(Position)))
    {
        const char *Name = (const char *)(*pInterface->GetName());
        IID InterfaceId;
        if (NOERROR = IIDFromString( (char*)Name ) )
        {
            const InterfaceId IUnknown FAR* pQueryInterface =
            if (pIUnknown->QueryInterface(InterfaceId,
                    void **&pQueryInterface) = NOERROR) {
                m_InterfaceLB.AddString( Name );
                pQueryInterface->Release();
            }
            pInterface =
            (COLEInterface *)m_RegInterfaces.GetNext( Position );
        }
    }
    m_InterfaceLB.AddString( "IUnknown" );
}
```

JANUARY 1994 BYTE 239
Hands On Some Assembly Required

constructing an instance of a class, invoking functions on the interface pointer (instance), and destructing the instance (Release). It's time to expand the scope of this discussion.

Obviously, the interface IUnknown, with just three members (i.e., QueryInterface, AddRef, and Release), has limited applicability for creating a compound document implementation with in-place editing, OLE automation, and the like. Under OLE 2.0, you generally do object instantiation by requesting a new instance represented by a pointer to the IUnknown interface (as in INSTANCED.CPP). The consumer using this object then queries the object about its capabilities by requesting further, more specific, interfaces through the QueryInterface() function.

If the object is capable of supporting the functionality implied by the interface, QueryInterface() gives the consumer additional and more capable means of manipulating the object. An application developer can begin by implementing a few interfaces and successively add functionality until the complete OLE feature set is realized.

IBROWSE.EXE is a small program that demonstrates the generalized model of locating and instantiating objects by way of the system registry. It also demonstrates the use of QueryInterface() as a means of interrogating an object to determine that object's capabilities. The program enumerates all the object classes in the registry. You simply choose a class from the first listbox, and you see a second listbox populated with the names of the interfaces that an object of the selected class is capable of supporting.

IBROWSE.CPP simply instantiates the object requesting the IUnknown interface. Once this interface has been obtained, IBROWSE.CPP enumerates all the interfaces listed in the system registry, calling QueryInterface() on the IUnknown pointer for each interface type. By simultaneously examining this program and exploring the structure of the system registration database, it's easy to understand the role of the registry in OLE 2.0. QUERYINTERFACES.CPP is from the IBROWSE source code. (You can explore the structure of the system by using the REGEDIT.EXE utility with /v on the command line. This utility is distributed with the source code associated with this article.)

Because of the opaque nature of interfaces, and because the implementation and interface of an object can span process and even machine boundaries, managing memory in this object model has some inherent complexity. Unfortunately, the Component Object Model places the burden of managing this complexity squarely on the shoulders of the implementor. Ironically, just as C++ introduced a convenient automatic constructor/destructor model for reducing memory management complexity common in C programs, the Component Object Model introduces a reference-counting system. But unlike in Smalltalk, which provides automatic language (i.e., transparent) support for object reference counting, the C++ or C programmer has to be mindful of a bevy of reference-counting rules. Two steps forward, one step back.

For simple programming examples like the ones accompanying this article, the use of reference counting is trivial. As the implementor creates an instance of an interface pointer for the consumer, the reference count on that interface is bumped by one. This is not evident in the accompanying listings because it takes place in the private code of the application (or DLL). The use of Release() invoked on IUnknown) is visible in IBROWSE.CPP: Each interface pointer obtained from QueryInterface() is released, as is the initial interface pointer obtained by CoCreateInstance().

continued
Everyone makes claims. We make sure.

When the industry wants product testing taken to the nth degree, they take it to NSTL.

In every field, one name sets the standard. In microcomputer testing, the name is NSTL, the leading independent testing lab.

The NSTL compatibility certification seal on a product says that it withstood the toughest lab in the industry — and it's ready for your business.

The seal saves you a lot of comparison and guesswork. It says you'll find the product compatible with a wide range of business applications and hardware. It helps you make the right choice.

Real-world testing for real-world use.

Beyond compatibility testing, we access nearly every conceivable problem — from engineering-level hardware bugs to the everyday usability of business software.

And we test with the end-user in mind, in a real-world environment, just the way your staff uses equipment. Except our trials are more punishing.

Our publications, and others that publish our work.

In a separate facility we also do comparison testing for our own Ratings Reports: Software Digest®, PC Digest® and LAN Reporter®. They're read by people who purchase an average of more than $500,000 in microcomputer hardware and software annually.

And because of the respect we've earned, some of the industry's leading publications, like Data Communications, LAN Times, Unix World and Datapro Research Group publish our test results.

Look for the NSTL seal and be sure.

Experts rely on the NSTL name: now you can, too. The final test of a product is its compatibility in a business environment. The NSTL mark tells you it's already met that test. Look for it when you compare products.
Supports Adaptec/ASPI-compatible adapters, Mac SyQuest cartridges.
Transfer of scan files, colour separations.
Reads/writes 44/88 MB low-cost adapters and parallel port solutions (Puma, D2-Para). Under Windows with ASPI, under DOS for other configurations.

MacSQ*
Reads/writes 44/88 MB Mac SyQuest cartridges.
Transfer of scan files, colour separations.
Reads, writes and formats Mac 1,44 MB floppies. Under Windows, file exchanges between Word, Excel, PageMaker, XPress, and other sibling applications, without any hardware modification.

MacScuzzy*
A superset of MacSQ, formerly announced and advertised as MacDisk Pro, also drives 128 MB MO cartridges and 90 MB Bernoullis and soon even bigger Mac SCSI volumes (600 MB MO).

Logicieis & Services DUHEM
21, rue La Bruyère - F-75009 PARIS (France)
Tel. (33.1) 49 70 04 55/Fax (33.1) 49 70 04 56
Free leaflet and demo disk. Offer good until supply lasts.
MacDisk 125 $, MacSQ 208 $, MacScuzzy 245 $ (without Schl & fees).
EEC residents, add French VAT (19.6 %). We accept most credit cards.
Dealers welcome. Software in French/English/German. Manual in French/English.
* Registered trademarks of LSD in France and trademarks of LSD elsewhere.

A MESSAGE TO OUR SUBSCRIBERS
From time to time we make the BYTE subscriber list available to other companies who wish to send our subscribers material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

Many BYTE subscribers appreciate this controlled use of our mailing list, and look forward to finding information of interest to them in the mail. Used are our subscribers’ names and addresses only (no other information we may have is ever given).

While we believe the distribution of this information is of benefit to our subscribers, we firmly respect the wishes of any subscriber who does not want to receive such promotional literature. Should you wish to restrict the use of your name, simply send your request to the following address.

BYTE Magazine
Attn: Subscriber Service
P.O. Box 555
Hightstown, NJ 08520

Hands On
Some Assembly Required

Subclassing and OLE interfaces
I mentioned earlier that the Component Object Model does not allow subclassing—that is, taking an existing interface and refining the behavior of methods in that interface. However, just as every great musician eventually learns the appropriate time to break rules concerning embouchure, harmony, and form, making maximum use of the OLE architecture smacks of misbehavior.

Subclassing under OLE 2.0 is as simple as providing an intermediary any time a request is made for an interface pointer, through either QueryInterface () or standard function calls to the OLE libraries, like CoCreateInstance(). The intermediary forwards the call to obtain the interface pointer. However, it also creates a mock interface, stores the actual interface pointer in this mock interface’s private data, and passes the mock interface back to the caller. Since the details of the interface methods are well known, any function invoked on the mock interface can be forwarded to the actual interface with any desired pre- or post-processing.

Not surprisingly, this is also an accurate description of the proxy-interface stubs and marshalling used by the OLE system to forward method invocations over process boundaries. Using these techniques completely violates the pure theoretical underpinnings of interfaces under the Component Object Model, so if anyone asks how you happened on the notion, I’d appreciate it if you recall how it came to you in a dream.

Hooking into standard function calls like CoCreateInstance () can be messy. However, there’s a much easier, flexible, and general method, illustrated by the HANDLER sample in the OLE 2.0 developer’s kit. The sample illustrates the use of subclassing in creating a nifty debugging tool.

HANDLER is an example of exposing OLE interfaces from a DLL instead of by a separate EXE. It stands as an intermediary directly between the consumer and the provider of interfaces by rewriting the registration database entries to trick the OLE system into requesting interfaces from the handler instead of from the actual objects (tucking the original entries away for safekeeping).

The Component Object Model affords other conveniences for large-granularity reuse through aggregation. But the number of practical circumstances in which granular objects can be aggregated into new entities is yet to be adequately demonstrated. For some, genetically mutating Excel with PageMaker through aggregation may be the fulfillment of a lifelong dream; for others, decidedly not.

Dispelling any initial impressions of OLE 2.0 that you may have gathered may not always be easy. However, aside from the thorns surrounding reference-counting semantics, the model underlying OLE 2.0 is well thought out, clean, and simple. In fact, the uniformity and simplicity of the model make it possible to attempt such wondrous feats of software as in-place editing.

No software designer committed to object-oriented methods, usability, or the benefits of software systems that can be successfully managed will think twice about employing OLE. Those who do hesitate will one day complain that Microsoft unfairly dominates component software solutions, even though today we all stand as equals on the threshold of this new order. ■

Editor’s note: Both source code and executable files are available electronically; see page 5 for details.

Gen Kiyooka (San Diego, CA) likes OLE and its implications and, as a tool developer, welcomes any suggestions that will make the construction of OLE software components pleasurable and productive. You can reach him on the Internet or BIX at gen@bix.com.
The good news is that we have the Novell NetWare server running. Alex installed NetWare 3.11 on a Gateway 2000 4DX2-50, and all went well. I haven't had a chance to work with it much yet, but at least it's installed. Windows for Workgroups is no bad start on LANs for small businesses, but it does have limits; in particular, it hasn't been reliable with large-capacity optical drives (see below), doesn't have security, and has very limited support for DOS machines. We're looking forward to working with NetWare to link up Windows, OS/2, and Macs.

We're using NetWare 3.11 rather than version 4.x because I'm told that getting 4.x up and running can be more difficult, and since I don't have multiple servers or a complex system, version 3.11 is good enough. I expect I'll know a lot more about that in a month or so; stay tuned.

One reason I didn't get to the network earlier was that the trips haven't stopped. Three this month—I'm writing this crammed into steerage class on a cross-country flight. I was asked to lecture on space operations to the Air War College at Maxwell AFB in Alabama, and the U.S. government not only wants my time for what amounts to no fee, but they will pay only for a tourist-class seat. With all my travel, I have upgrade certificates, but I didn't manage to book an upgraded seat; which gives me a opportunity to test laptops under ghastly conditions.

One trip I did thoroughly enjoy was to White Sands Missile Test Range to watch them launch my spaceship. Actually, DC/X isn't quite a spaceship, and it isn't really mine; it's a one-third scale model of the spaceship that General Graham, Max Hunter, and I sold to the National Space Council in 1989. McDonnell Douglas managed to build it on time and in budget, and it flew precisely as expected, going up, hovering, and landing on a tail of fire.

My present trip combines my lecture at the Air War College with a trip to Washington to talk with members of Congress about how we can revive the X programs, which enabled the U.S. to dominate world aerospace for three decades after World War II. Alas, the only people who remember how the X programs worked are dinosaurs like me.

The X programs were not big operational projects, nor were they prototypes. They were small, tightly managed projects using the best available technology to build the best test vehicles we could make. The output was a practical application of new technologies that could then be used by industry to build operational aircraft. The effect was to reduce technical uncertainties. Firms could concentrate on using that technology to build marketable products. Entrepreneurs will take market risks or technical risks, but faced with both, they'd rather put their money in something less uncertain.

The X programs gave us a long period in which it would have been thought absurd for a major airline to buy airplanes from anyone but U.S. companies. Then McNamara canceled the X programs in the name of arms control. Now, you're as likely to fly on an Airbus as a U.S. plane, and the Brazilians are selling us commuter airplanes. How are the mighty fallen....
Pournelle

I'm writing this on the ancient Zenith Mastersport 386SL, which turns out to be endurable even in steerage. The Mastersport has a smaller screen than some of the newer laptops, but that's counterbalanced by that splendid Zenith keyboard and a general feel that just plain works; and perhaps the small screen is an advantage given the cramped working space. I've carried a lot of laptops, and I've liked several of them; but every time, I find myself coming back to this old Mastersport.

I remember when 9600-bps modems were a big deal; now they all come with 14.4 Kbps, and many are even faster. Whether you can use that new speed is another matter. The latest arrival at Chaos Manor is the AT&T 14400 ETC. AT&T Technologies is no newcomer to the modem game. Many of my friends are very fond of their communications equipment.

The AT&T 14400 ETC modem comes with a communications program called Comit and SofNet's FaxWorks 3.0 for Windows. I can't recommend Comit at all, but the modem works well right with Datastorm's Procomm Plus and HyperAccess, which some columnists swear by. FaxWorks isn't my favorite laptop fax program for Windows—I'm more familiar with BitFax, which comes with the AT&T/NCR machines—but it seems to work all right.

Washington, D.C., has lousy telephones, as I discover every time I go there. Whatever modem I carry, I have trouble getting on-line at all, and I almost never manage to connect at 9600 bps. On this last trip, I traveled light: no checked luggage, just a briefcase and my wheeled carryons. After I got my clothes and toothbrush in, there was precious little room for electronics, so I carried Macronix's MaxLite 144 fax modem, which is only slightly larger than a pack of cigarettes. When it came time to connect to Tymnet in Washington, I found that a 9600-bps connection was impossible. It took three tries to get on at 2400 bps with error correction. That worked, but there was so much error correcting, it felt like 300 bps.

When I got home, I decided to experiment. Was my problem with the Mastersport? To be sure, I tried the USRobotics modem on the Mastersport and got a 9600-bps connection first thing. Then I tried the SupraFaxModem 14400. That locked on at 9600 bps, but it needed two tries. At 9600 bps, the ATI modem locked on first try. No difference between the ATI and the USRobotics modems in several trials; both worked perfectly. Several tries with the SupraFaxModem showed that it

Your Choice of Keyboard Monitor Switches

Access multiple computers with a single keyboard and monitor to cut equipment costs, save valuable space, and end clutter

- Simple pushbutton operation for quick selection
- Four, eight, or twelve ports per unit
- Daisy-chaining connects unlimited number of CPUs
- Compatible with EGA, VGA, Macintosh, Sun, and others
- Optional keyboard booting for 286, 386, and 486
- Optional RS232 or PS/2 mouse interface
- PCB construction for high reliability and low crosstalk
- Rack mount, matrix, and customized units available

Manually controlled unit

Switch by keystroke, from front panel, or RS232 port
Two or four ports per unit
Cascade units to support up to 255 CPUs
Supports monochrome, EGA, and VGA
Includes keyboard booting for 286, 386, and 486
Includes RS232 and PS/2 mouse interface
LEDs display selected CPU and CPU power-on
Scan function switches among CPUs automatically

Keyboard controlled unit

Keyboard controlled unit

Call toll-free now for your copy of our Switching and Sharing Solutions catalog.

Make the Rose Connection

10850 Wilcrest Drive • Houston, Texas 77099 • Phone (713) 933-7673 • Fax (713) 933-0044

1-800-333-9343

Circle 109 on Inquiry Card.
STATISTICA/W™ (for Windows) Complete Statistical System with thousands of on-screen customizable, presentation-quality graphs fully integrated with all procedures • Complete Windows 3.1 support, DDE, OLE, TT-fonts, multiple toolbars, right mouse button support • Unlimited numbers of data-, results-, and graph-windows • Inter-window integration: data, results, and graphs can be treated as objects and converted into one another in a number of ways • The largest selection of statistics and graphs in a single system; comprehensive implementations of Exploratory techniques; multi-way tables with banners (presentation-quality reports); nonparametrics; distribution fitting; multiple regression; general nonlinear estimation; stepwise logit/probit; general ANCOVA/MANCOVA; stepwise discriminant analysis; log-linear analysis; factor analysis; cluster analysis; multidimensional scaling; canonical correlation; item analysis/reliability; survival analysis; time series modeling; forecasting; lag analysis; quality control; process analysis; experimental design (with Taguchi); and much more • Manuals with comprehensive introductions to each procedure and examples • Hypertext-based Stats Advisor expert system • Extensive data management facilities (spreadsheet with long formulas, block operations, advanced clipboard support, DDE hot links, relational merge, data verification, powerful programming language) • Batch command language and macros also supported, "turn-key system" options • All output displayed in Scrollsheets™ (dynamic, customizable, presentation-quality tables with toolbars, pop-up windows, and instant 2D, 3D and multiple graphs) • Extremely large analysis designs (e.g., correlation matrices up to 32,000x32,000, unlimited ANOVA designs) • Megafiler Manager with up to 32,000 variables (8 Mb) per record • Unlimited size of files; extended ("quadruple") precision; unmatched speed • Exchanges data and graphs with other applications via DDE or an extensive selection of file import/export facilities • Hundreds of types of graphs, including categorized multiple 2D and 3D graphs, matrix plots, icons, and unique multivariate (e.g., 4D) graphs • Facilities to customize design new graphs and add them permanently to menu • On-screen graph customization with advanced drawing tools, interactive stretching and resizing of complex objects, interactive embedding of graphs and artwork, special effects, icons, maps, multi-graphics management, page layout control for slides and printouts; unmatched speed of graph redraw • Interactive rotation, perspective and cross-sections of all 3D and 4D graphs • Extensive selection of tools for graphical exploration of data: fitting, smoothing, overlaying, spectral planes, projections, layered compressions, marked subsets • Price $995.

Quick STATISTICA/W™ (for Windows) A comprehensive selection of basic statistics and the full graphics capabilities of STATISTICA/W™ • Price $495.

STATISTICA/dos™ (for DOS) A STATISTICA/W-compatible data analysis system • Price $795.

Quick STATISTICA/dos™ (for DOS) A subset of STATISTICA/dos statistics and graphics • Price $295.

Domestic sh/h $10 per product; 14-day money back guarantee.

Circle 113 on Inquiry Card.

StatSoft™

2325 E. 12th St. • Tulsa, OK 74104 • (918) 563-4149
Fax (918) 563-4376

Overseas Offices: Statsoft of Europe (Hamburg, FRG), ph: 040/4200347, fax: 040/42013110; Statsoft UK (London, UK), ph: 0462/629222, fax 0462/482655; Statsoft Pacific (Melbourne, Australia), ph: (03) 663 6506, fax: (03) 663 6117; Statsoft Canada-CGC (Ottawa), ph: 416/914-6277, fax: 416/849-0717.

STATISTICA/Mac™ (for Macintosh) A comprehensive selection of basic statistics and the full graphics capabilities of STATISTICA/Mac™ • Price $395.

Quick STATISTICA/Mac™ (for Macintosh) A subset of STATISTICA/Mac; a comprehensive selection of basic statistics and the full graphics capabilities of STATISTICA/Mac™ • Price $295.

STATISTICA/DOS™ (for DOS) A STATISTICA/W-compatible data analysis system • Price $795.

Quick STATISTICA/DOS™ (for DOS) A subset of STATISTICA/dos statistics and graphics • Price $295.

Domestic sh/h $10 per product; 14-day money back guarantee.

Circle 113 on Inquiry Card.

StatSoft, STATISTICA, Quick STATISTICA, Quick STATISTICA/Mac, Quick STATISTICA/dos, and StatSoft are trademarks of StatSoft, Inc.
Attention U.S. BYTE Subscribers

Watch for the next BYTE DECK mailing that will be arriving in your mailbox soon!

Use this as a fast, convenient tool to purchase computer products and services. It's loaded with essential hardware and software products that you should be aware of when making your buying decisions...and it's absolutely FREE!

If you have a computer product or service, and would like to reach 275,000 influential BYTE magazine subscribers, please give Brad Dixon a call today at (603) 924-2596.

Here's what a BYTE Deck advertiser has to say:

"The BYTE Deck does very well for us - we've been in for over two years - and will continue advertising in '93."

Karen Tacy
Rainbow Technologies, Inc.

would always work, but sometimes it did need two tries. I never got a 9600-bps lock with the MaxLite 144.

After that, I tried a particularly noisy path line to an Internet node down toward San Diego. It's a good test; of all my modems, including the ATI, the only one that would work at 9600 bps was the USRobotics, and it took two tries before it got an error-correcting lock. All the others failed no matter how often I tried, despite experiments with initializations.

The ATI modem comes with good manuals, and it's generally easy to set up, but you may have to try different setup strings. The USRobotics modem generally works with its default settings. I have similar reports from Mike Banks, the coauthor of my communications book. If you deal with lousy communications nodes, you're better off using a USRobotics modem. The ATI 14400 ETC is nearly as reliable.

Of course, both those modems are big. If you're traveling, the SupraFaxModem costs less, is much smaller and lighter, and will generally do the job, but it's still bulky compared to the MaxLite 144. The Max-Lite 144 can be battery-powered, but, alas, it won't always connect at 9600 bps. However, it usually will get 9600 bps, and it always seems to work at 2400 bps.

I have found a real glitch in the networking capability of Windows for Workgroups, but I learned to love Maximum Storage's Duette optical drive. My Windows for Workgroups network usually consists of four machines: three 486s of various speeds and one 386. Windows for Workgroups is a peer-to-peer network and doesn't really have servers, but the 386 sort of functions that way. It sits back in the cable room and is loaded down with assets to be used by the other machines.

In particular, it has a Pioneer DRM-604X Minichanger CD-ROM drive and a Pioneer read/write optical drive, which I use for archiving programs and book files when I am done with them.

Sometimes, when I use File Manager to move a big chunk of stuff across the network to the Pioneer optical drive, the system will trundle along for a while and then lock up. When it does that, it locks up cold, and I can't access either the sending system or the 386 'server' where the optical drive resides. When that happens, I can generally use Ctrl-Alt-Del on the sending system; to close File Manager, and after a while, something times out over on the 386. I'll then find that some files have been moved and some haven't.

I confess this annoyed me, but it didn't happen often enough that I really worried about it. No data was lost, and nothing was irretrievably locked up. While my general philosophy is that if an error rate is high enough to measure, it's too high, there were so many possibilities—the Pioneer optical drive, the Pioneer 816, of one of the network cards, Windows for Workgroups itself—that I just learned to live with it.

Then I got the Duette drive. This thing is the fastest optical drive I've ever seen. I used a Future Domain SCSI card to install it on a Gateway 2000 4DXZ-66, and it just screamed. Meanwhile, I did have the problem of storing a whole bunch of installed applications files while I reformatted the PS/2's hard disk. The simplest way was to use LapLink Pro and a parallel port to move the files to the Duette. That's much slower than the slowest network, but it does work. My first attempt wasn't very successful. Since the Duette seemed to work just fine under Windows—it appeared as drive D on the Gateway 2000—I did the file transfer with the Gateway 2000 running Windows for Workgroups and the PS/2 running OS/2. This had the advantage that I could move files between the PS/2 and any computer on the Windows for Workgroups network. However, when I started moving huge blocks of files from the PS/2 to the Duette, odd things happened, and eventually the system locked up.

The remedy to that was to exit Windows and run LapLink Pro under DOS on the Gateway 2000. That worked fine, and pretty soon I had 400 MB of files transferred from the OS/2 system. When I put the Gateway 2000 back into Windows for Workgroups, I had no problems moving files from the Duette to other machines.

So far, so good; but then I tried to move some files across the network to the Duette. Pretty soon the system locked up, exactly as it had with the Pioneer optical drive, so I had the same problem with two different computers running two different optical drives. Clearly, Windows for Workgroups isn't happy about networking to optical drives.

OK, thought I. I'll move the files to the Gateway 2000's hard drive and then move them again onto the Duette. That way, I won't be writing to the optical drive across the network.

The transfer to the Gateway's hard drive worked fine, but when I moved this big block of stuff onto the Duette—a local move—once again it locked the system. I exited Windows and used Norton Commander to move the files under DOS. That was no problem. I'm told that people running straight Windows don't have problems with file moves, so I concluded that
Windows for Workgroups doesn't really understand large optical drives. There's a new version (3.11) of Windows for Workgroups coming out soon. It's supposed to fix a lot of problems and provide many new features. I'll try that when I get it.

We have Windows NT, both in shrink-wrapped copy and in the Win32 SDK (Software Development Kit). The SDK comes with a CD-ROM chock full of development tools, including NT 3.1, lots of code, Visual C++ for NT, a system guide, and a partridge in a pear tree. Microsoft makes a real effort to get this stuff into the hands of software developers just as soon as they can, and they set their prices as low as possible. Meanwhile, IBM had a low-cost special on their OS/2 development and device driver kits, but that's over: the price is back up to $600 or so.

I recall way back when Texas Instruments' research people produced some really interesting software development tools. They decided to license and sell them at what they thought were fair prices, which were still high for developers who weren't sure they wanted to work with the TI systems anyway. Lo, they sold only a few copies, and not many developers wrote applications for TI systems. Moral: making money by selling SDKs is eating your seed corn.

I haven't installed Windows NT, and I probably won't for a while. Friends assure me that it works, and some people I respect think it's wonderful, particularly as a development environment. I believe this. What I don't believe is that Windows NT is particularly relevant to small systems just now. With regards to PCs, NT is a stalking horse that will be relegated to much larger systems when the new Microsoft "dream" operating systems—code-named Chicago and, more important, Cairo—come out. (At one time at least, there was also a Newark. The slogan at Microsoft is "on to Cairo"; Newark is further than Chicago but not yet to Cairo. Incidentally, I understand that MS-DOS 6 was code-named Yakima, which is closer to Seattle than Chicago.)

NT's real role is to combat IBM's higher-end RISC stuff like AS/400. I'm told that IBM's AS/400-related revenue in 1992 was $14 billion, with a $2 billion profit; no small sums, even for Microsoft.

Thus, working with Windows NT is no waste of time. In addition, Chicago and Cairo will have much in common with NT, and it's much in Microsoft's interest to provide an easy migration from NT to the new RISC-based operating systems we're about to see. As desktop machines become more powerful, there will be more and more integration of software, and NT is likely to serve as a bridge between mainframes, big workstations, and high-end desktop systems.

I also understand that Chicago will incorporate peer-to-peer networking within the operating system. I think Microsoft had hoped to bring Chicago out soon, making any improvements to Windows for Workgroups a waste of time; but they just released a Windows for Workgroups upgrade, which may put a handle on when they expect to ship Chicago.

There's too much software that won't work and won't tell you why. Last night, I found I couldn't print. Chasing that particular problem down took most of the day and was instructive.

The first thing to check is cables. I looked at the printer cable. Just to be sure, I got out an Inmac Blue. Inmac cables are

**“DynaComm® is Microsoft’s® choice for terminal emulation.”**

It should be yours.

Evaluating terminal emulation software? Consider the one Microsoft chose for communicating across their world-wide network. FutureSoft's DynaComm for Windows™ offers a single solution for PCs communicating across multi-platform networks to host computers.

DynaComm features:
- 16 Terminal emulation types for UNIX, DEC, Hewlett-Packard, IBM, and Data General systems
- 19 Network interfaces including TCP/IP and IPX
- Powerful development tools for creating GUI front ends to host applications

800-989-8908

FutureSoft.
12012 Wickchester Lane, Suite 600 • Houston, Texas 77079-1222 USA
713.496.9400 • 713.496.1090 FAX • 800.989.8908 Sales (USA)

Windows is a trademark of Microsoft Corporation. Microsoft is a registered trademark of Microsoft Corporation. DynaComm and FutureSoft are registered trademarks of Future Soft Engineering, Inc.
pricey, but they’re extremely reliable. It wasn’t the cable. Keyboard next: a faulty keyboard can overload the A20 handler and cause odd addressing errors. Changing keyboards did no good, so the next thing was to define the problem. I found that Windows for Workgroups would print to my Hewlett-Packard LaserJet III using Q&A Write. That uses a font cartridge. However, when I tried printing with Word for Windows (which uses TrueType fonts), I’d get a line of garbage across the top of the first page and dozens of pages of blank paper thereafter. This is not what a novelist on deadline needs.

Next question: Could it be Word? Make a test message in Windows Write and try printing that. Same result.

First things first. I solved the deadline problem by using LapLink to send the entire Word for Windows directory, program and files, over to the PS/2 Model 77. I then let OS/2 “migrate” Word for Windows. That created a Word icon letting me run Word without opening the Windows Program Manager. Printing required that I string a cable from the OS/2 machine to the LaserJet III, open the file in Word for Windows, and tell it to print. Nothing to it, and in truth, OS/2 prints so much faster than Windows, I actually saved time doing it that way.

That got my story draft printed and showed clearly that the problem wasn’t with my files, my copy of Word, or the printer. What was left? Corrupted printer drivers in the Cheetah’s copy of Windows? A corrupted copy of Windows? I used Palindrome to restore the entire Windows directory from DAT (digital audiotape), which took about 20 minutes. For good measure, I erased the HP driver and reinstalled it from the original floppy disks. No joy: I still got a line of garbage followed by many pages of blank paper.

The next step was to use the Windows for Workgroups network to send the Word directory over to the Gateway 2000 4DX2-66 and connect the printer cable to that machine. It printed fine, meaning that my problem was specific to the Cheetah. Sigh.

Eventually I figured it out, but first a diversion, which I assure you is relevant. Meanwhile, I confess to being a bit annoyed: Microsoft sells us these highly complex systems, and then when they don’t work, they want us to pay for technical support. There has to be a better way.

I have a new Nanao FlexScan T560i 17-inch monitor. Mind you, there was nothing wrong with the old one, which has been in constant use for well over a year; but Nanao is proud of the energy-saving features in the newer models. The Nanao offices are near Los Angeles, so Brian Mast offered to bring out a new model to swap for my old one.

I confessed to some misgivings: I still hadn’t figured out why I couldn’t print, and this would be yet another change to the system. Still, the computer shouldn’t be able to tell the new monitor from the old, so I agreed, and promptly forgot about it until Brian showed up outside Chaos Manor. We lugged the FlexScan upstairs—it’s a heavy sucker—and connected it up. As promised, it worked perfectly.

If, like me, you sit staring at a computer screen most of your day, you owe it to yourself to get a Nanao monitor. They make really big ones, but the 17-inch FlexScan seems about the right size for me: I put it about 30 inches from my nose, and my text lines are just the right length so
that I see the whole line without moving my eyes. Meanwhile, the colors are sharp and crisp, and everything on the screen is as steady as if it were painted. Best of all, I'm in a brightly lit south-facing room, but I don't have a problem with glare. People often ask me how I turn out so many words: the secret is good equipment, and the FlexScan is a big part of that.

Brian had also brought a copy of the newest edition of Berkeley Systems' After Dark screen saver. Of course, screen savers don't do anything you can't accomplish by turning off your monitor, but I confess an attraction for Captain Kirk, Mr. Spock's antics, and even the notorious Flying Toasters. The new edition has another feature: after an interval you can set, Mr. Spock goes away, and the screen is totally blanked out. When the FlexScan detects that condition, it shuts itself down so that it draws only 7 W, as opposed to a couple of hundred when it's active.

The bottom line is I love this Nanao monitor.

When I started to install After Dark, I got a Protection Violation error, and when I reset and tried once more, it happened again. This caused me to wonder if my computer was doing something flaky, so I went into the BIOS Setup program and turned off shadow RAM and caching. When I booted up and tried the After Dark installation again, I got the same error. Brian assured me that most of the people at Nanao use After Dark with Windows for Workgroups, so clearly the problem was something about my own installation.

One nonstandard feature is a shareware program called Plug-In for Program Manager. I've written about this before: it enhances the Windows Program Manager without replacing it. It does such a good job that although I rather like Symantec's Norton Desktop for Windows, I find with Plug-In I don't use Norton. Time to remove that—which did the trick. After Dark installed just fine. Since removing Plug-In solved one problem, maybe it took care of another? I knew darned well I'd been able to print with Plug-In installed—in well over a year, this was the first glitch I could trace to it—but it would do no harm to try printing.

Word printed just fine. I installed Plug-In again. Tried printing. Worked just fine. So did After Dark; it was only the installation program that fought with Plug-In.

I could print again, but, of course, I had the cache and shadow RAM turned off. I turned them back on, tested again—and couldn't print.

Jeff Sloman finally solved the problem for me. Turn on BIOS cache and shadow RAM, get into Windows for Workgroups, open the Printer icon in the control panel, and deselected the box that says "Fast print direct to port." Ignore the dialog box about ports, and Bob's your uncle.

I've been offered an explanation of why this works, and I suppose by next month I'll care; meanwhile, here's another instance of software that can't tell you what's wrong with itself.

Every time I threaten to abandon Windows, I find another valuable program that needs it. VisSim is a simulation program that turns your PC into an analog computer; that is, you can build various analog blocks and connect them up on-

Imagine storing up to 100 high-quality full screen images on a single floppy disk with enough room left over for the program to display them. Fractal compression files average between 10KB and 32KB and display at barracuda speeds. These incredibly small files provide unmatched space savings in whatever storage media you may use. Using fractal compression, Microsoft Encarta was reduced from four CD-ROM disks to one.

Whether it's stills or full motion video, DOS or Windows, Iterated Systems' OBJ and .DLL family of toolkits will help you conserve your resources.

Iterated Systems, Inc.

FOR ADDITIONAL INFORMATION:
TEL: 800 437-2285 FAX: 404 840-0806
5550A PEACHTREE PARKWAY NORCROSS, GEORGIA 30092.
screen the way you would connect the physical operational amplifiers and other analog components with wires.

I wrote about a previous edition a year or so ago. There's now a greatly improved version. Alas, the manual isn't much improved. You'll need to know something about model building or have a separate book on analog modeling systems; but assuming you know what you're doing, VisSim is very powerful. There are also new add-on modules, including Analyze, and a real-time interface to many analog/digital boards. You can use VisSim to model a complicated control system and then connect it to the real thing in real time.

VisSim works with matrix operations programs, including MatrixX. There's a C-code generator module you can use to write compilable code that will run models about 10 times faster than the on-screen visual-block models do.

VisSim is a good general-purpose tool for modeling systems, from something simple like an artillery shell to the Jay Forrester World Dynamics models. Until Windows, you had to go to a Mac to find a program as good as this. Recommended.

This year, Microsoft has improved both their desktop and laptop mice. I said last issue that their new large-size "tear drop" desktop mouse is an improvement over the "Dove soap bar" model. Now they have a new Ballpoint mouse, and that, too, is a genuine improvement. Like the previous Ballpoint, this is a thumb trackball mouse that attaches to your laptop keyboard.

You can also attach it to your desktop. If you prefer trackballs to mice, you definitely should look at this. If you're only indifferent, it's still worth a look. The action is smooth, and the mounting is improved over the old Ballpoint mount; while the button placement is nearly ideal, with extremely natural button action.

I got a call from a consultant friend: a client had a system infected with a new virus. I didn't recognize the symptoms, so I gave him the phone number of Alan Solomon's S&S International in England, on the theory that if Dr. Solomon can't fix the problem, no one can. My friend bought a copy of Dr. Solomon's Anti-Virus Toolkit, and that did the trick.

It's not time to panic, but there are a lot of wild viruses out there. I routinely check my system every week now. I boot up from a floppy disk that has always been write-protected and run Dr. Solomon's; if you have valuable databases or important work on your computer, I advise you to do the same.

Software developers who convert DOS applications to Windows should pay a lot of attention to installation details. This was brought home to me when I installed the upgrade of WinMortization Pro from Etter Industries. This useful little program calculates loan and mortgage amortizations and prints reports on them. Easy to use, too.

Then last week I got a Windows version. I decided to update, and trouble started. First, it said I had an obsolete \WIN DOWS\SYSTEM\GRID.VBX and offered to replace it. Since I use Windows for Workgroups and don't know what GRID.VBX does, it seemed prudent to tell it not to replace that; I figured I could do that later if necessary. The rest of the installation seemed to go all right, but when I tried to run the program, it said "C:\WIN DOWS\THREE D.VBX is out of date," and died. Thinking I may have done the installation wrong, I tried again. The result was two programs and two readme icons in the W INM OR T PRO program group; the installation program doesn't check to see if those are already present.

I deleted the whole mess and talked to Etter Industries. They had meanwhile talked to Microsoft, because this had happened before. Apparently, some unknown third-party application is inserting an ancient copy of THREED.VBX in the Wind ows subdirectory. The remedy is to delete it, because there's a current copy of THREED.VBX in the WINDOWS\SYSTEM subdirectory (where it belongs).

I deleted the superfluous \WIN DOWS\THREE D.VBX, deleted all traces of WinMortization Pro, and started over. Again, it offered to replace \WIN DOWS\SYSTEM\GRID.VBX. I again declined, and the installation went flawlessly; but attempts to launch the program terminated with the message that I had an obsolete GRID.VBX. I decided to install again, this time letting it replace GRID.VBX, which it appeared to do; but trying to launch the program got the same result as before, and once again I had two copies of the program and readme icons in the WINMORTPRO group box.

Next, try to delete GRID.VBX. You
can't. GRID.VBX was, according to Windows, in use. OK, exit Windows. Reset the machine. Copy GRID.VBX to GRID.FOO and make the original. Scrub all traces of WINMORTPRO, including the Windows program group. Enter Windows with some trepidation. Since I have no idea what GRID.VBX does, I wouldn't have been surprised if Windows couldn't open Windows without that file, but it did. Install WinMortization Pro yet again. This time, unprompted, it decompressed GRID.VBX and copied it into \WINDO\SYSTEM; I presume the previous attempt failed but the installation program didn't notice that. Anyway, all went well.

**Microlytics has a Windows version** of their pioneering Word Finder thesaurus, and it works quite well with Word for Windows and other Windows word processors. To use it, you select (highlight) a word in your text and then leave your word processor for the desktop, invoke Word Finder, wait for its dialog box to pop up (as a small window superimposed over your text), and click on the "import" button. After you have done that the first time, you can return to your word processor by clicking anywhere on your text, and the next time you need to use Word Finder, just highlight a word and do Alt-Escape. Word Finder will appear.

All this works, but no better than doing Shift-F7 within Microsoft Word. The synonyms given are about the same, and, as a bonus, with the thesaurus included in Word, you don't have to highlight the text, just get the cursor into or next to it.

I have long been a fan of Word Finder, and I use the DOS version (along with Definitions/Plus) in Q&A Write when I'm doing first drafts of text. If you're using a word processor with an inadequate thesaurus, Word Finder is the one to get; it integrates nicely with nearly all of them. The Mac version works just fine, too.

**There are a lot of Bible programs now.** The latest arrival is Holy Bible from Software Marketing. It's for DOS/VGA and takes 11 MB. It comes on seven 3½-inch floppy disks and features the King James Version, with red highlighting, maps, chronology, art files of sacred masterpieces, a concordance with search capability, and a bunch of other stuff. Useful for Bible scholars, and for that matter, pretty good browsing for anyone interested in the subject.

**I have a whole bunch of books this month.** The computer book of the month is from the Hayden Development Group Staff, with contributions from a dozen experts. It's called *Everything You Wanted to Know about the Mac* (Hayden, 1992), and it's really complete.

*Distributed Systems Management* by Alwyn Langsford (Addison-Wesley, 1993) is a specialized book for people who find they have to manage computer systems in many locations. Distributed computing is the wave of the future, but it can create unexpected headaches for management. This is a good place to learn about them.

The book of the month is Joel N. Shurkin's *Termate's Kids: The Groundbreaking Study of How the Gifted Grow Up* (Little, Brown, 1992). Lewis Terman...
HEADS, IT'S REAL.
TAILS, IT'S FAKE.

It's your choice. A little more than 50 percent of all business software in use today is pirated.

You might save a few bucks on it—but when phony software doesn't work, forget calling for product support. When it infects your computer with a deadly virus, it'll be your work that gets lost. The documentation is nonexistent or inadequate, so that won't help. And, of course, there will never be any product upgrades.

Selling or copying software without authorization is against the law, with severe criminal and civil penalties including imprisonment of up to five years, fines of up to $250,000, or both. If you suspect the sale or use of pirated software, call the BSA Anti-Piracy hotline:

(800) 688-BSA1 (2721)

© 1993 Business Software Alliance. All rights reserved.
No Doubt

YOU're the
Expert!

BYTE READERS are considered experts in today's complex computer environment. When you need to make decisions, BYTE editorial is there to give information on current products and emerging technologies.

► And when you order products, BYTE advertisers are ready to answer your every need. Use the convenient toll-free numbers in this issue, and remember to say:

► You Saw it in BYTE

Pournelle
did a great deal of pioneer work in intelligence testing and did studies of gifted children. One of his groups, more than 1500 California children with genius- and near-geniusevel IQs, became known as "the Termites" and were featured in a number of studies. Shurkin is the chief science writer at Stanford University and has a deservedly good reputation for accuracy as well as readability. This book follows the Termites up to the present. If you're interested in gifted children, you'll find this book fascinating.

The game of the month is MicroProse's Master of Orion, which is Reach for the Stars on steroids. It's addicting.

Next month, presentation programs and more on networking, including a test of the new Windows for Workgroups 3.11. As usual, there aren't enough hours in the day.

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

For More Information

After Dark ($49.95) features Captain Kirk and Mr. Spock. Contact Berkeley Systems, Inc., 2095 Rose St., Berkeley, CA 94709, (800) 877-5535 or (510) 540-5535; fax (510) 540-5115. Circle 1146 on Inquiry Card.

The ATI 14400 ETC modem (ETC I, $249; ETC E, $299) comes with good manuals. It's generally easy to set up. Contact ATI Technologies, Inc., 33 Commerce Valley Dr. E, Thornhill, Ontario, Canada L3T 7N6, (905) 882-2600; fax (905) 882-2620. Circle 1147.

If you do a lot of mousing around, think seriously about the new Microsoft Ballpoint mouse ($125). It really is that good. Microsoft's Win32 SDK (call for price) comes with a CD-ROM chock full of development tools. There's a new version (3.11) of Microsoft's Windows for Workgroups ($249.95) coming out soon. Contact Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052, (600) 426-9400 or (206) 882-8600; fax (206) 883-8101. Circle 1148.

If you deal with lousy communications, you should use a USRobotics Courier HST Dual Standard modem ($1295). Contact USRobotics, Inc., 8100 North McCormick Blvd., Skokie, IL 60076, (800) 342-8877 or (708) 982-5010; fax (708) 982-5225. Circle 1149.

If Dr. Solomon's Anti-Virus Toolkit can't solve your virus problem, nothing can. DOS version, $99; Windows version, $125; OS/2 version, $149. Contact S&S International, Ltd., Berkeley Court, Mill St., Berkhamsted, Hertfordshire HP4 2HB, U.K., +44 442 877877; fax +44 442 877882. Circle 1150.

Maximum Storage's Droste drive ($2790) is the fastest optical drive I've ever seen. Contact Maximum Storage, Inc., 518 North Nevada Ave., Suite 203, Colorado Springs, CO 80903, (800) 843-6299 or (719) 442-6674; fax (719) 442-6671. Circle 1151.

If, like me, you sit staring at a computer screen most of your day, you owe it to yourself to get Nanao's FlexScan T6600 monitor ($2199). Contact Nanao USA Corp., 23535 Tello Ave., Torrance, CA 90505, (800) 800-5202 or (310) 325-5202; fax (910) 530-1679. Circle 1152.

Useful for Bible scholars, Holy Bible ($49.95) is also pretty good browsing for anyone interested in the subject. Contact Software Marketing Corp., 9830 South 51st St., Building A.131, Phoenix, AZ 85044, (602) 893-3377; fax (602) 893-2042. Circle 1153.

Master of Orion ($59.95), or Reach for the Stars on steroids. Contact MicroProse, 180 Lakefront Dr., Hunt Valley, MD 21030, (410) 771-1151; fax (410) 771-1174. Circle 1154.

The MaxLite 144 fax modem ($299) is slightly larger than a pack of cigarettes and can be battery-powered. Contact Macromimix, Inc., 1348 Ridder Park Dr., San Jose, CA 95131, (800) 858-5311 or (408) 453-8088; fax (408) 453-8488. Circle 1155.

Plug-In for Program Manager ($20) enhances the Windows Program Manager without replacing it. Contact Pinmnet Crafter&, Inc., 2580 Runic Way, Alpharetta, GA 30021, (404) 740-9821; fax (404) 740-1914. Circle 1156.

If you're traveling, the SupraFaxModem 14400 costs less (for IBM PCs, $229.95; for Macs, $249.95). Contact Supra Corp., 7101 Supra Dr. NW, Albany, OR 97321, (503) 967-2401; fax (503) 967-2401. Circle 1157.

VisiSim (Personal VisSim, $495; VisSim, $1495) is a good general-purpose tool for modeling systems. Recommended. Contact Visual Solutions, Inc., 487 Graton Rd., Westford, MA 01886, (508) 392-0100; fax (508) 392-0101. Circle 1158.

WinMortization Pro for Windows ($99.95) is about the best program around for doing complex loan amortizations. Contact Eetter Industries, Inc., 82 Shoreview Dr., Bedford, Nova Scotia, Canada B4A 1V5, (800) 565-2662 or (902) 835-6060; fax (902) 835-5431. Circle 1159.

Word Finder Plus ($39.95) is the thesaurus to get. The Mac version works fine, too. Contact Microlytics, Inc., 2 Toby Village Office Park, Pittsford, NY 14534, (800) 828-6293 or (716) 248-9150; fax (716) 248-3866. Circle 1160.
What's New Hardware

UPGRADE YOUR PC TO MULTIMEDIA ▲
Media Vision's (Fremont, CA) Memphis multimedia upgrade system ($999) gives you the power to create voice or video-annotated presentations on your PC. The MPC- and MPC2-compliant system incorporates Media Vision's Pro Audio 16 sound technology to produce 16-bit stereo sound; built-in MIDI support lets you control other MIDI musical instruments using the on-board MIDI connectors or an external music keyboard. Other features include a 20-voice synthesizer, a software-controllable mixer, and a SCSI CD-ROM controller interface. A double-speed CD-ROM drive can transfer data at 300 Kbps with a 350-ms access time. Memphis supports DOS, Windows 3.1, and NT, OS/2 2.1, and NextStep. The system is also backward compatible with Sound Blaster and AdLib.
Phone: (800) 845-5870 or (310) 770-8600.
Circle 1315 on Inquiry Card.

THREE-IN-ONE ETHERNET CARD ▼
A technique called workgroup filtering integrates Ethernet port connectivity, filtering, and on-board SNMP management on the 10BT-FTR card (from $3095). Designed for use with the INX 5000 intelligent wiring hub, the 10BT-FTR filters and forwards all or some of the local and remote network traffic that passes through the filter. Two custom ASICs on the Racal-Datacom (Boxborough, MA) card give the Ethernet interface and filter control for all information that passes through the card, providing packet-forwarding at the full Ethernet speed of 10 Mbps.
Phone: (800) 722-2555 or (508) 263-9929.
Circle 1319 on Inquiry Card.

BUBBLES OF COLOR
The BJc-600 ($719) from Canon Computer Systems (Costa Mesa, CA) uses an ink formula that, according to Canon, dries 100 times faster than conventional inks, giving you nonbleeding color on plain paper. The 360-dpi BJc-600 uses four separate ink cartridges to hold the primary output colors of cyan, magenta, yellow, and true black. You can change each color cartridge separately as it runs out, eliminating waste. A 256-nozzle print head has 64 nozzles for each of the four colors. The printer also accepts recycled paper, labels, Bubble Jet transparencies, and back print film.
Phone: (800) 848-4123 or (714) 438-3000.
Circle 1327 on Inquiry Card.

PEN INPUT FOR YOUR PC
A combination software and hardware pen-input system, Handwriter for Windows ($399) is compatible with standard, off-the-shelf Windows applications. From Communication Intelligence (Redwood Shores, CA), Handwriter for Windows comprises handwriting recognition, Pen Extensions for Windows, signature-verification software, pen utilities, a cordless pen, and a tablet with a 10-foot cable that plugs into your computer's serial port. You can write, edit, point, select, drag, create customized gesture macros, draw, and navigate through menus.
Phone: (800) 888-9242 or (415) 802-7888.
Circle 1318 on Inquiry Card.

MULTIMEDIA UPGRADE
The Mega 535M Multimedia Upgrade Kit ($649) from Megamedia Computer (San Jose, CA) provides you with the necessary equipment to add multimedia capability to your 386- or 486-based computer. The kit is compatible with the MPC Level 2 specifications and includes a Chinon CDS535 internal SCSI-2 CD-ROM drive, a Pro Audio Spectrum 16 sound card with a SCSI connection, amplified magnetically shielded speakers, and SCSI and audio cables.
Phone: (800) 634-2633 or (408) 428-9920.
Circle 1326 on Inquiry Card.

BITWISE COLOR PORTABLE
The BitWise ACP (from $6295) 10-inch active-matrix TFT color or flat-screen portable is packed with power for working in multimedia, CAD, and engineering applications. From BitWise Designs (Schenectady, NY), the 486-based computer has 4 MB of RAM (expandable to 32 MB), 128 KB of cache RAM (expandable to 256 KB), and up to 2 GB of internal hard disk capacity. A 5¼-inch drive bay accommodates a CD-ROM, WORM, or read/write optical drive. One half-size and three full-size expansion slots are available. You can run an external Super VGA monitor at up to 1024- by 768-pixel resolution.
Phone: (800) 367-5906 or (518) 356-9740.
Circle 1325 on Inquiry Card.

A FIVE-IN-ONE DESKTOP UNIT
The multifunction Omnifax G5 ($1995) provides the functionality of a 14.4-Kbps plain-paper fax, a PC fax board, a laser-quality printer, a copier, and a scanner with optional OCR capability. The Omnifax can simultaneously scan one document, print another, and send or receive a third. The unit's fax capabilities include a 99-number auto-dialing feature, quick scanning into memory, auto-batching to group documents going to the same destination, broadcasting, and page retransmission. The 300-dpi print function works from any DOS or Windows application. You can use the PC fax board function to send a file from your attached PC or from a PC on a LAN. The unit lets you edit scanned documents and incoming fax messages on your PC. Depending on your application, you can rotate, scale, and clip documents on the PC, export image documents to Windows Paintbrush, or copy files to the Windows Clipboard.
Contact: Omnifax, Los Angeles, CA. (800) 221-8330 or (310) 641-3690.
Circle 1312 on Inquiry Card.
MAC ETHERNET CONNECTORS
The AAU-I-2 and AAU-I-T transceivers ($89 each) provide Ethernet connection for the Mac Centris 610 and 650 and Quadra 800, 900, and 950 systems. The AAU-I-to-10Base-2 AAU-I-2 has an auto-terminating BNC connector and supports up to 50 nodes per segment. The AAU-I-T provides a single-port AAUI-to-10Base-T connection. From MacNet (San Jose, CA), each transceiver has an LED that provides power-on status.
Phone: (800) 486-2638 or (408) 954-8888.
Circle 1316 on Inquiry Card.

KEYBOARD CALCULATOR
A solar-powered calculator that adheres to your PC keyboard, the MediaMate Keyboard Calculator ($99.99) allows you to do separate calculations while working on your computer. The device, which fits above the keypad, has a battery backup and displays eight figures with a floating decimal. The unit is from Hunt Manufacturing (Philadelphia, PA).
Phone: (800) 765-5669 or (215) 732-7700.
Circle 1321 on Inquiry Card.

PORTABLE SPARC
Based on the MicroSparc processor, the 50-MHz PowerLite portable workstation (from $9995) is configurable with up to 80 MB of memory and more than 1 GB of internal disk space. The RDI Computer (San Diego, CA) system comes with a 640x480x16 palette, 1 MB of DRAM video memory, and a 1024x768x256 palette. The system also has an on-board hard disk and two open SBus slots that you connect directly to the bottom of the unit. You can configure the PXU to include extra hard drives, SBus slots, and SCSI peripherals.
Phone: (619) 558-6985.
Circle 1317 on Inquiry Card.

VIDEO CARDS FOR TV DISPLAY
VideoOut ($99), from International Computers (Wauwatosa, WI), consists of a plug-in card and software. The card, which gets its power from the PC bus, functions as a pass-through for VGA video signals. The TSR software stays resident until you press the hot key; it then quickly reprograms the registers on your VGA card to convert the video signal to the timing for NTSC, letting your TV receive the signal. VideoOut, which, according to the manufacturer, is compatible with all VGA boards, automatically detects a board’s manufacturer and configures itself to fit the particular configuration.
Phone: (414) 764-9000.
Circle 1323 on Inquiry Card.

The Channel One multimedia video card ($459) enables you to display or output computer-generated data and graphical images to any device that supports VGA, S-VHS, and composite NTSC/PAL. From STB Systems (Richardson, TX), the Channel One comes with 1 MB of 60-nS DRAM video memory and a Sony CXA1145 RGB encoder that enables the card to convert VGA signals to NTSC/PAL video formats. The card is based on Cirrus Logic’s 5426 video-controller chip.
Phone: (214) 234-8750.
Circle 1324 on Inquiry Card.

SPEEDY MULTIPORT CONNECTIVITY FOR UNIX
Control’s (St. Paul, MN) RocketPort family of controller boards (from $259) replaces major hardware components, such as the processor, serial ports, and bus-interface logic, with two specially designed ASICs. One ASIC includes a 36-MHz processor in place of the conventional multiport board processor. The board is designed to maintain consistent speeds of 230.4 Kbps or 115.2 Kbps at each port. RocketPort supports operating systems such as DOS, Windows, Unix, SCO Unixix, and QNX and is available with eight, 16, or 32 ports.
Phone: (800) 926-6876 or (671) 551-1000.
Circle 1330 on Inquiry Card.

PCMCIA SCSI ADAPTER
The FastSCSI PCMCIA host adapter card ($229.95) from Logic (Costa Mesa, CA) is based on the company’s ESP406, a single-chip SCSI processor that automates SCSI operations at hardware speed without host intervention, according to QLogic. The adapter supports DOS, Windows 3.1 and NT, NetWare, SCO Unix, and OS/2. The card connects directly to the internal PCMCIA Type II bus and includes a 50-pin connector for use with external devices.
Phone: (714) 438-2200.
Circle 1331 on Inquiry Card.

A MODEM WITH PARALLEL-PORT CONNECTIONS
A 28,800-bps portable modem with fax, the TravelPorte Fast ($499) has data throughput of up to 115.2 Kbps using V.42bis and MNP 5 data compression. The Windows-compatible modem uses the parallel port interface and drivers to achieve this high throughput rate. From Microcom (Norwood, MA), the TravelPorte Fast supports MNP 10 and communications with non-V.42bis modems such as V.42, V.32bis, and V.32, as well as synchronous and asynchronous operation. The FastPorte supports operating systems such as DOS, Windows, Unix, SCO Unixix, and QNX and is available with eight, 16, or 32 ports.
Phone: (800) 926-6876 or (671) 551-1000.
Circle 1330 on Inquiry Card.

IMP COEXISTS WITH YOUR MOUSE
A wireless remote-control input device, Imp ($199) lets you position the cursor, execute common mouse functions, and replicate keyboard functions from as far as 15 feet away from your computer. Windows- and Microsoft Mouse-compatible, Imp consists of a hand-held wireless transmitter and a compact receiver that connects to your PC’s serial port. The transmitter has a control disc for cursor control and four auxiliary buttons that act as keyboard keys. Powered by your PC, the receiver has indicator lamps that reflect communication activity and the status of the batteries in the transmitter.
Contact: Arcana Tech, Pittsburgh, PA. (800) 364-6777 or (412) 441-6611.
Circle 1313 on Inquiry Card.
**What's New Hardware**

**GRAB A CARD AND SCAN IT**

The CardGrabber ($399) is a plug-and-play scanner of business cards that uses the parallel port of notebooks and desktop computers. From Pacific Crest Technologies (Newport Beach, CA), the DOS- and Windows-compatible CardGrabber scans a card and then stores the information in a Windows-based address book. You can use the address book to search, customize, sort, and print your information. You can import and export data to any Windows or DOS database and PIM, as well as ASCII text, word processors, Lotus-compatible spreadsheets, and PDAs. The 15-ounce device has built-in AI and OCR software.

**Phone**: (800) 870-3391 or (714) 261-6444.
**Circle 1339 on Inquiry Card.**

**SPEAK TO YOUR DOCUMENTS**

A fully integrated business audio system, SoundXchange Model BX ($169) lets you record and play your voice in OLE-compatible Windows 3.1 documents. From InterActive (Humboldt, SD), the Model BX includes a built-in sound board that records at 2750 to 11,025 Hz. It plays back sound files recorded at frequencies of up to 44,100 Hz. The system attaches to the side of your monitor and plugs directly into your computer's parallel port.

**Phone**: (605) 363-5117.
**Circle 1344 on Inquiry Card.**

**RAID FOR MACS AND PCS**

A series of disk array subsystems for the Mac, the Personal Array (from $1595) supports striping, mirroring, and spanning, with seek times as low as 5 ms and data transfer rates of up to 10 MBps. The subsystem software lets you select and switch among the configurations. From Procom Technology (Irvine, CA), the Personal Array consists of two SCSI drives in a compact, modular case; you snap new modules directly onto the system when you want to expand it.

**Phone**: (800) 800-8600 or (714) 852-1000.
**Circle 1337 on Inquiry Card.**

The MicroDFT-1 (from $4495), a hot-swappable RAID storage device from ECCS (Tinton Falls, NJ), provides up to 2 GB of fault-tolerant storage. The subsystem, which slides into 5¼-inch drive bays, can replace your computer's primary hard drive to provide a fault-tolerant boot drive. The hardware-only product is based on RAID-1 technology, which eliminates the need for software mirroring. The MicroDFT-1 reaches a data transfer rate of up to 7 MBps by reading from the drive that is closest to the data. Seek time is as low as 8 ms.

**Phone**: (800) 322-7462 or (908) 747-6995.
**Circle 1336 on Inquiry Card.**

**CONNECT REMOTE USERS**

The OutPost remote messaging system ($299) provides near-real-time E-mail responsiveness for remote locations and eliminates the need to regularly run an MHS session. The combined hardware and software from Calculus (Deerfield Beach, FL) permits you to have nondedicated MHS servers by letting the remote PC power-off without losing connectivity. At the remote location, the OutPost Remote Service Unit receives inbound MHS transactions, stores messages in nonvolatile memory, and provides audio and visual indications of the saved message.

**Phone**: (305) 481-2334.
**Circle 1338 on Inquiry Card.**

**CARD WITH A MULTIPLE VIEW**

The FastMax/MV dual-channel display controller ($399) from VidTech Microsystems (Minneapolis, MN) supports two VGA channels that are totally independent of each other. Each channel can display different resolutions at the same time and can be configured with a 512-KB or 1-MB DRAM frame buffer. Resolution on the DOS- and Windows-compatible controller can go up to 1280 by 1024 pixels with 16 colors; 1 MB of DRAM per channel is required. You can install as many as four cards per system.

**Phone**: (612) 780-8033.
**Circle 1332 on Inquiry Card.**

**DIGITALLY CONTROLLED MONITOR**

The Brilliance 2130 21-inch color auto-scanning monitor ($3499) from Philips Consumer Electronics (Knoxville, TN) gives you digital control of internal signals to fine-tune picture quality. The monitor supports refresh rates of up to 76 Hz at 1280- by 1024-pixel resolution, as well as an extended horizontal scanning frequency range of up to 82 Hz and a 150-MHz video-amplifier bandwidth. The flat-square display has a 0.29-mm dot pitch and an antireflective, antistatic, multilayer coating.

**Phone**: (212) 532-6300.
**Circle 1336 on Inquiry Card.**

**PC-PERIPHERAL PORTABLE POWER PROJECTOR**

The ergonomic Desktop Projector 2800 ($8995) stands less than 6 inches high and pulls in its lenses and mirrors for transport and storage. The active-matrix projector incorporates a fully integrated digital video processor and accepts all three international video formats and power sources as well as S-VHS.

The optical system in the Desktop Projector focuses the available light through the aperture of the LCD panel to provide an image up to four times brighter than one on a standard LCD panel, according to the manufacturer, Proxima. A "folded" optical design and angled panel placement enable the lens to be stored inside the device. You simply move the mirror to adjust the position of the image on the screen. The Active Color Enhancement technology uses processing techniques that provide enhanced color matching from a palette of 16.7 million colors, Proxima says. The 410-W quartz halogen redundant lamp system lets you operate the projector in a lighted room.

**Contact**: Proxima, San Diego, CA, (619) 457-5500.
**Circle 1334 on Inquiry Card.**
Still trying to stay ahead of new information technologies without Datapro on CD-ROM?

Let's face it: When it comes to making critical business decisions about information technology, there are no easy answers. But now there's an easy way to get virtually instant access to the information you need to plan effectively—Datapro on CD-ROM.

Locate and retrieve information without wasting precious time

Provided to you in both Windows and DOS versions, Datapro on CD-ROM makes it a snap to search Datapro's comprehensive information services—by keyword, title, subject, or table of contents entry. Cut and paste between reports to custom-tailor information that can be printed or stored to disk. And with up to eight comparison columns displayed on screen at once, it's easy to appraise technologies and products.

Keep up with rapidly changing technologies and markets—and stay ahead of the competition

If you need quick, convenient access to the latest information about products, vendors, and technologies in the computer and communications markets, Datapro on CD-ROM can guide you every step of the way. And with new disks sent automatically each month, professionals involved in planning, purchasing, implementing, and managing information technology stay on top of all the issues.

With Datapro on CD-ROM vendors maintain their competitive edge by keeping up with the newest products offered by the competition. System integrators, consultants, and value-added resellers stay ahead of rapidly changing technologies and evolving markets. Corporate, technical, and public librarians provide their patrons with easy-to-use information resources that detail every aspect of computer and communication systems.

In-depth expert analyses and user experience are the surest ways to understand markets, technologies, and products

Datapro on CD-ROM transforms your PC into an information server loaded with a comprehensive library of computer and communications resources. First Looks furnish a quick preview of new products enhancements. User Ratings discuss how real users evaluate products and services. Technology Concepts establish the fundamentals and explore all the essential aspects of a technology. Market Overviews feature a comprehensive summary of specific technologies, markets, vendors, and products. Comparison Columns detail product features and functions. Competitive Outlooks deliver an even-handed evaluation of advantages and drawbacks to products and technologies.

Product Reports offer expert analysis and user opinions about vendors and their offerings. Management Reports provide experienced assistance with system maintenance.

A single source for all your information needs

When it comes to computer systems, Datapro on CD-ROM gives you everything you need on one disk. Topics include managing information technology, application development, security, Unix systems, workstations and servers, document imaging, and workgroup computing.

Datapro on CD-ROM's comprehensive look at communications systems includes data, voice systems and inter-networking, net management, and broadband services.

Datapro—an essential resource

For over two decades Datapro's unmatched information services have helped users, buyers, and managers of information technology make timely, intelligent decisions to ensure continued growth. Today, with its staff of over 400 specialists and more than 100 expert analysts, Datapro has the resources to address virtually every critical issue in computing and communications. Isn't it time to learn more about Datapro on CD-ROM?
BUILD APPLICATIONS FROM PICTURES
A visual application builder that relies on moving icons and creating diagrams to develop client/server applications, HarborView (Manchester, MA) program enables you to work with pictures rather than traditional programming mechanics. You develop the business logic, and HarborView then automatically builds the forms from the logic. To modify an application, you change the picture, and HarborView automatically rebuilds the application.
Phone: (508) 526-1376.
Circle 1281 on Inquiry Card.

NUMBERS AND SYMBOLS
The Symbolic Math Toolbox ($495), from The Mathworks (Natick, MA), provides an extension to Matlab that integrates symbolic computing with numeric computation. Based on an embedded version of Waterloo Maple Software's Maple V, the toolbox provides commands for variable precision arithmetic, direct access to the Maple kernel, and Maple's core math library and linear algebra module, which are included.
Phone: (508) 653-1415.
Circle 1275 on Inquiry Card.

DETECT NT FILE CORRUPTION
File Alert for Windows NT ($99 for each hard disk to be scanned) is file-corruption-detection software that automatically notifies you at the first sign of corruption. From Executive Software (Glendale, CA), File Alert continually checks and verifies data integrity in all types of files. It detects corruption from sources such as hardware or power failures, user error, and software defects and creates and maintains a journal of any corrupted files it finds.
Phone: (800) 829-4357 or (818) 547-2050.
Circle 1276 on Inquiry Card.

TAME ALL THAT TAX-TIME TENSION
The 1993 updates of AM-Tax Personal ($39) and AM-Tax Professional ($150) include what-if worksheets that enable you to quickly compare different tax scenarios, such as single, married filing jointly, and married filing separately. An audit-alert feature automatically reviews a completed return for more than 100 omissions and inconsistencies. The program from AM Software (Kansas City, MO) issues a warning when various itemized deductions exceed national averages, provides on-line help for operation and forms calculation, and has the ability to print blank copies of any federal or state form that it supports.
Phone: (800) 859-8537 or (816) 426-8361.
Circle 1286 on Inquiry Card.

CROSS-PLATFORM DATA ACCESS AND MANIPULATION
Multiuser client/server-based software, Kenan Technologies' Acumate Enterprise Solution 1.0 lets you access all the data on your company's enterprise-wide system regardless of its format or location. With the software's analysis tools, such as forecasting, business modeling, and exception highlighting, you can extract previously defined information as you need it.
Built around Multiway, the company's multidimensional database and 4GL engine, Acumate ES seamlessly integrates data from sources such as relational databases, spreadsheets, flat files, text reports, and proprietary packages. It then stores the data in a format that permits browsing.
Features include object-oriented programming, a focal-point integrator, data-loading/data-analysis Copilots, and an open API that provides flexible links to front ends such as Excel, Visual Basic, and Improv. Acumate ES is compatible with Windows 3.1 and NT, OS/2 2.0, Unix, and Alpha. Licenses range from $500 to $3000 per seat.
Contact: Kenan Technologies, Cambridge, MA, (617) 225-2224.
Circle 1271 on Inquiry Card.

DATA COMPRESSION AND ARCHIVING
A Windows product that also runs under DOS, Greenleaf ArchiveLib ($279) from Greenleaf Software (Dallas, TX) is an object-oriented data-compression run-time library that lets you compress ASCII or binary data into an archive for storage. C and C++ programmers can compress and archive buffers of data within an application without having to store them as a file. Compressed data can be retrieved into a disk file or a memory buffer. You can code without specifying the type of data to be compressed or the type of location in which the data will be archived.
Phone: (214) 248-2561.
Circle 1277 on Inquiry Card.

AN ATLAS FOR THE MAC
Now available for the Macintosh, Street Atlas USA ($169) provides a complete road map of the U.S. on a single CD-ROM. From DeLorme Mapping (Freeport, ME), Street Atlas USA includes 646 MB of mapping data, delineating urban areas, population centers, block address ranges for large metropolitan areas, and elevation lines. You can print maps from within the program or export them to the Mac Clipboard to use them in other applications.
Phone: (207) 865-1234.
Circle 1279 on Inquiry Card.

DOCUMENTS BY DESIGN
By Design for Microsoft Word for Windows ($99) enables you to create professional-looking documents even if you have no design training. The Streetwise Software (Santa Monica, CA) package supports version 6.0 of Word for Windows and integrates directly into the Icon Bar and Tool Menu. It includes page designs of formats for newsletters, business forms, faxes, memos, and letterheads and has features such as Quick Doc templates, an integrated address book, and a set of design tools.
Phone: (310) 829-7827.
Circle 1280 on Inquiry Card.
MULTIMEDIA IN A PIM
Available in three editions, the Personal Daily PlanIt PIM ($59.95 on CD-ROM or $49.95 on floppy disk) can run under Windows or on the Macintosh. Each edition revolves around a theme: PlanIt Earth has an environmental theme, PlanIt Paradise is a swimsuit edition, and PlanIt Adrenaline features high-intensity pursuits. With each of the titles, you can import and mix and match your own Kodak Photo CD images. Integrated voice annotation and voice recognition let you annotate your to-do lists and appointments with verbal comments. The Media Vision (Fremont, CA) PIM includes an appointment scheduler and alarms that interrupt other programs. You can link contacts and locations with scheduled events and track contact activity with a notes log for everyone in the directory.

Phone: (510) 770-8600.
Circle 1284 on Inquiry Card.

Cognitive Software Learns From Experience

Based on cognitive processing, the Top of Mind Help Desk for Windows incorporates principles of fuzzy logic, neural networks, case-based reasoning, expert systems, and text association. Top of Mind's ongoing learned experience forms the basis for its smart pick lists—case information and diagnostics listed by strength. The software forms its own links and associations and processes information the way people do. Faced with a problem, the software provides an answer based on this learned experience, while it gathers and stores precise data about the user's needs in continual expansion of the database for use in solving future problems. From $4500.

Contact: The Mollay Group, Parsippany, NJ, (201) 884-2040.
Circle 1272 on Inquiry Card.

Design Applications in ADA
A GUI application designer and Ada GUI source code generator for Windows, Visual Ada for Windows ($595) lets you choose from push buttons, bit maps, text-entry fields, combo boxes, static text fields, radio buttons, and scroll bars to create and modify GUI applications. The Aetech (Carlsbad, CA) code uses the company's Standard Ada Human Computer Interface Library, which consists of an Ada library of data structures and subprograms that work independently on systems that use a standard GUI, such as Motif, Open Look, and Windows.

Phone: (619) 431-7714.
Circle 1283 on Inquiry Card.

Software Update

4PC-Doctor 1.2, WaterGate Software (Emeryville, CA), adds external cache testing, tape drive information, SIMM stress testing, modem setup information, PostScript printer testing, disk-usage information by file type and directory, BIOS data area information, and more. $129.95.

Phone: (510) 596-1770.
Circle 1296 on Inquiry Card.

Sentinel 2.0, AIL Software (Dulles, VA), is fully integrated with Hewlett-Packard's SoftBench development environment and adds a new GUI. From $595.

Phone: (703) 430-9247.
Circle 1301 on Inquiry Card.

MapExpert 2.0, Delorme Mapping (Freeport, ME), is a completely revised and expanded database of every city, town, and rural area in the U.S., including urban areas, population centers, and elevation lines. $495.

Phone: (207) 865-1234.
Circle 1297 on Inquiry Card.

GX Graphics 3.0, Genus Micro-programming (Houston, TX), features direct support of Super VGA chip sets, high-color and true-color video modes, increased VESA support, mode X resolution support, multiple Super VGA pages, faster drawing primitives, 16-bit protected-mode support, and more. $249.

Phone: (713) 870-0737.
Circle 1298 on Inquiry Card.

Novalink Professional 3.1, ResNova Software (Huntington Beach, CA), provides support for Apple Open Collaborative Environment, Novell, UUCP, and FidoNet; multiple file attachments; enhanced graphics and sound. From $300.

Phone: (714) 379-9000.
Circle 1299 on Inquiry Card.

IMPROVE PICTURE QUALITY
By presenting a slide show of screen images similar to test patterns used by TV stations, DisplayMate for Windows ($79) gives you the means to improve monitor-picture quality. From Sonera Technologies (Rumson, NJ), the slide show presents ways to improve sharpness and contrast, reduce some forms of geometric distortion, minimize or eliminate moiré patterns, and improve color and gray-scale accuracy. Test patterns let you explore color quality, balance, range, accuracy, and color matching.

Phone: (800) 932-6323 or (908) 747-6886.
Circle 1282 on Inquiry Card.

PUT A CLOAK ON YOUR TSR
Developed for Netroom 3.0, Helix Software's (Long Island City, NY) Cloaking technology is now available as the Cloaking Developer's Toolkit ($299) for designing "Cloaked" utilities for memory managers such as DOS, DR DOS, QEMM, and 386Max. Cloaking allows device drivers and TSRs to run in protected mode without using conventional memory.

Phone: (718) 392-3100.
Circle 1278 on Inquiry Card.

COGNITIVE SOFTWARE LEARNS FROM EXPERIENCE

Based on cognitive processing, the Top of Mind Help Desk for Windows incorporates principles of fuzzy logic, neural networks, case-based reasoning, expert systems, and text association. Top of Mind's ongoing learned experience forms the basis for its smart pick lists—case information and diagnostics listed by strength. The software forms its own links and associations and processes information the way people do. Faced with a problem, the software provides an answer based on this learned experience, while it gathers and stores precise data about the user's needs in continual expansion of the database for use in solving future problems. From $4500.

Contact: The Mollay Group, Parsippany, NJ, (201) 884-2040.
Circle 1272 on Inquiry Card.
Diagnostic Utility Has Answers

Designed specifically for Microsoft Windows, CheckIt Pro: Analyst ($149.95), from TouchStone (Huntington Beach, CA), is a diagnostic utility that provides a comprehensive system analysis. The CKData applet collects all system information needed to troubleshoot your system; you can save the CKData-created data file across the network for interpretation by the utility. The Upgrade Analyst module lets you rate your computer's performance against that of others, compare systems to find configuration differences, analyze system setup, and access a software-compatibility library.

Phone: (714) 969-7746. Circle 1289 on Inquiry Card.

Virus Detective

A 3-D proactive antivirus program, Virus Detection System Pro 3.0 (from $49) from Z-RAM (Annapolis, MD) combines scanning, integrity verification, and file analysis to protect your computer from viruses. The network-compatible program has a detailed set of instructions for system administrators to customize features to fit a particular situation. VDS Pro includes generic cleaning and positive overwrite.

Phone: (410) 266-5221. Circle 1293 on Inquiry Card.

Add Your Voice to Visual Basic

The Visual Voice ($495) custom control and toolkit for Visual Basic and C++ developers lets you build PC-based voice-processing applications such as voice mail, interactive voice response, and fax on demand. From Syntax Innovation (Cambridge, MA), Visual Voice makes the PC the server and the phone the client. Set up to support the Microsoft/Intel Telephone Application Programming Interface, Visual Voice includes a set of visual tools that help you create and revise all voice-processing objects such as voice prompts, menus, and files.

Phone: (617) 621-9545. Circle 1287 on Inquiry Card.

Document Imaging for the PC

Westbrook Technologies' (Westbrook, CT) PC-based document-imaging File Magic Vision ($199) software supports 200 file formats, including color photos, video, and slides. The OCR software directly integrates documents from scanners and fax cards. Imported images can be from photographs, video-capture boards, film scanners, slides, and transparencies. An advanced viewing feature lets you display, index, retrieve, and store computer-generated, scanned, or fixed text-and-image documents in a single File Magic database.

Phone: (203) 399-7111. Circle 1280 on Inquiry Card.

Integration and Linking for UNIX

Applixware applications and tools provide UNIX LAN and WAN information-sharing as well as personal office functions. Based on an information object architecture, Applixware can integrate with external applications to build applications that you define.

Office applications include Applix Words and Applix Graphics ($695) and Applix Spreadsheets ($495). Applix Data ($995 per seat) lets you access information on Informix, Oracle, Ingres, and Sybase relational databases without any SQL knowledge. Applix Mail ($195) and Applix Open Mail ($295) let you exchange and edit multimedia compound documents, messages, and data files directly from source applications or the Applix Mail facility. You can communicate across disparate hardware platforms, operating systems, and networks.

Contact: Applix, Westborough, MA, (508) 870-0300. Circle 1273 on Inquiry Card.

Software Update

FA Server 1.1, Network Appliance (Santa Clara, CA), supports FDDI, has increased disk storage (to 27.3 GB), rebuilds replaced RAID disks on-line, and adds a Unix-compatible dump command for network backup. $16,995.

Phone: (408) 562-1900. Circle 1300 on Inquiry Card.

Global Lab Image 3.0, Data Translation (Marlborough, MA), supports Add-In Modules, adds image-analysis features, and provides additional particle measurements, enhanced particle counting, new filters, and new frame-grabber support.

Phone: (508) 481-3700. Circle 1311 on Inquiry Card.

The Norton AntiVirus 3.0, Symantec (Cupertino, CA), can identify and resist known and unknown viruses, incorporates Virus Sensor technology, detects 100 percent of the NCSA libraries, and optimizes the virus scanner and user interface. $129.

Phone: (408) 252-3570. Circle 1303 on Inquiry Card.

TapeWare/LAN-NLM 4.2, Emeritus Technologies (Fresno, CA), adds full NetWare 4.x Directory Service backup support and Cruise Control for automated backup tape rotation. From $299.

Phone: (209) 292-8888. Circle 1304 on Inquiry Card.

OS-9 3.0, Microware (Des Moines, IA), adds a preemptible kernel and enhancements such as faster interrupt response and context switching, more efficient interprocess communications mechanisms, improved deterministic, enhanced memory management facilities, and greater system-call throughput. From $4000.

Phone: (515) 224-1929. Circle 1307 on Inquiry Card.
SOLUTIONS
Access Technologies for People Who Are Blind

Olga Espinola and Diane Croft

"... first-class and strongly recommended. ... This is the book to keep on the desk always within reach for study and reference...."  
—Jeffrey Moyer, access consultant  
Journal of Visual Impairment & Blindness

Solutions takes a hard look at adaptive technology through the actual experiences of blind people who use it on the job every day. There is something for everyone—the solo computer novice, the mid-level user, or the "expert" wanting an overview or refresher course.

There are interviews, resources galore, training programs, financial-aid assistance, and much more, including a complete product price list, and current information on every type of adaptive device. No more searching for bits and pieces of information; now it's all in one book.

"... a whale of a good book... edifying, clear, inspiring, and lots of fun to read. My students are in for a great adventure."
—Ted Lennox, access instructor  
Eastern Michigan University

"... you don't need to know much about technology or computers to use this book; it explains everything."
—BOOKLIST, American Library Association

"... excels in its ability to couple the technical and the practical sides of adaptive issues...."
—National Association of Private Rehabilitation Professionals

"Solutions is vitally important and empowering... with this knowledge, a blind person can present him- or herself as prepared, informed, and qualified...."
—Jeri Williams, blind computer user

Available in
print
braille
cassette
IBM disk

National Braille Press
88 St. Stephen Street
Boston, MA 02115
(617) 266-6160
$21.95 USA
$25.95 CAN

Solutions takes a hard look at adaptive technology through the actual experiences of blind people who use it on the job every day. There is something for everyone—the solo computer novice, the mid-level user, or the "expert" wanting an overview or refresher course.

There are interviews, resources galore, training programs, financial-aid assistance, and much more, including a complete product price list, and current information on every type of adaptive device. No more searching for bits and pieces of information; now it's all in one book.

"... a whale of a good book... edifying, clear, inspiring, and lots of fun to read. My students are in for a great adventure."
—Ted Lennox, access instructor  
Eastern Michigan University

"... you don't need to know much about technology or computers to use this book; it explains everything."
—BOOKLIST, American Library Association

"... excels in its ability to couple the technical and the practical sides of adaptive issues...."
—National Association of Private Rehabilitation Professionals

"Solutions is vitally important and empowering... with this knowledge, a blind person can present him- or herself as prepared, informed, and qualified...."
—Jeri Williams, blind computer user
Quatech's Solid State Drives for PCMCIA

- 100% Reliability  •  No Moving Parts

Quatech's line of Solid State Drives for PCMCIA (Type I and Type II) fit into any personal computer and conform to the PCMCIA/JEIDA standards thus allowing your PC to access the newest technology used in notebooks, hand-held computers and PDA's. These drives are available in three options: 3.5" front drive, rear card slot drive, or 3.5" front drive and rear card slot drive.

Quatech's line of PCMCIA FLASH Memory, SRAM and I/O Cards offer add on memory in one, two and four meg options. SRAM available in one and two meg options only. FAX/modem, Serial RS-232, RS-422, EPP Parallel Port, and Digital I/O give you maximum flexibility for your application.

For more information on PCMCIA products or our complete line of communication, data acquisition and industrial I/O products call: 800-553-1170

FAX: 216-434-1409
BBS: 216-434-2481

Mail Order

The latest offerings from vendors supplying products of all leading manufacturers at extremely competitive prices.

Hardware/Software Showcase

This categorized four-color display section makes it easy to find Hardware and Software products from a wide variety of manufacturers and suppliers.

Buyer's Mart

From Accessories to Laptops to Word Processors, you can easily find the dealers you are looking for in this directory of products and services.
### COMPUTERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gateway 2000</td>
<td>$699.99</td>
</tr>
<tr>
<td>Gateway 2000</td>
<td>$799.99</td>
</tr>
<tr>
<td>Gateway 2000</td>
<td>$899.99</td>
</tr>
<tr>
<td>Gateway 2000</td>
<td>$999.99</td>
</tr>
</tbody>
</table>

### DOT MATRIX & LASER PRINTERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epson LQ-1070</td>
<td>$389.99</td>
</tr>
<tr>
<td>Epson LQ-1070</td>
<td>$489.99</td>
</tr>
<tr>
<td>Epson LQ-1070</td>
<td>$589.99</td>
</tr>
</tbody>
</table>

### MODERN & COMMUNICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xerox 4000</td>
<td>$299.99</td>
</tr>
<tr>
<td>Xerox 4000</td>
<td>$399.99</td>
</tr>
<tr>
<td>Xerox 4000</td>
<td>$499.99</td>
</tr>
</tbody>
</table>

### PENS

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canon BJC-600</td>
<td>$389.99</td>
</tr>
<tr>
<td>Canon BJC-600</td>
<td>$489.99</td>
</tr>
<tr>
<td>Canon BJC-600</td>
<td>$589.99</td>
</tr>
</tbody>
</table>

### MEMORY UPGRADES

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingston 8MB</td>
<td>$99.99</td>
</tr>
<tr>
<td>Kingston 8MB</td>
<td>$149.99</td>
</tr>
<tr>
<td>Kingston 8MB</td>
<td>$199.99</td>
</tr>
</tbody>
</table>

### NEW!

- Lease Option
- Call for Details

---

**CDW Sells for Less and Services You Better!**

(800) 959-4CDW

CALL FOR FREE CDW® CATALOG

FAX (708) 291-1737

©1994 CDW® Computer Centers, Inc. BT819

Circle 152 on Inquiry Card.
## Memory

### Cache Memory

<table>
<thead>
<tr>
<th>Size</th>
<th>6MB</th>
<th>1MB</th>
<th>2MB</th>
<th>4MB</th>
<th>8MB</th>
<th>16MB</th>
<th>32MB</th>
<th>64MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>5.50</td>
<td>8.50</td>
<td>11.50</td>
<td>15.00</td>
<td>21.00</td>
<td>29.00</td>
<td>43.00</td>
<td>95.00</td>
</tr>
</tbody>
</table>

### Individual D-RAM Chips

<table>
<thead>
<tr>
<th>Model</th>
<th>1Mb</th>
<th>2Mb</th>
<th>4Mb</th>
<th>8Mb</th>
<th>16Mb</th>
<th>32Mb</th>
<th>64Mb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>2.00</td>
<td>4.00</td>
<td>6.00</td>
<td>8.00</td>
<td>10.00</td>
<td>12.00</td>
<td>14.00</td>
</tr>
</tbody>
</table>

### Intel Math Chips

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>486</td>
<td>4.00</td>
</tr>
</tbody>
</table>

### Change Your 386 to 486DC

- Upgrade to 486DX clock doubling
- Clock doubling mode configuration
- Performance and system stability
- New speed configuration

### SIMM Modules (Add $5.00 for SIPP)

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1MB</td>
<td>65.00</td>
</tr>
<tr>
<td>2MB</td>
<td>155.00</td>
</tr>
<tr>
<td>4MB</td>
<td>305.00</td>
</tr>
<tr>
<td>8MB</td>
<td>525.00</td>
</tr>
</tbody>
</table>

### 72 Pin SIMM (EISA)

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1MB</td>
<td>65.00</td>
</tr>
<tr>
<td>2MB</td>
<td>155.00</td>
</tr>
<tr>
<td>4MB</td>
<td>305.00</td>
</tr>
<tr>
<td>8MB</td>
<td>525.00</td>
</tr>
</tbody>
</table>

### CYRIX FasMATH PROCESSOR

- Programs executed up to 120 times faster
- Plug & play support
- Intel 80486-compatible

### AST MEMORY MODULES

- Advantage 128K
- Premium 256K
- Memory 256K
- Memory 512K

### Zenith MEMORY MODULES

- Advantage 128K
- Premium 256K
- Memory 256K
- Memory 512K

### IBM PS/2 SIMM MODULES

### Toshiba Laptop Memory

### COMPAG MEMORY Modules

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>386DX-166</td>
<td>399.00</td>
</tr>
<tr>
<td>386DX-100</td>
<td>299.00</td>
</tr>
</tbody>
</table>

### COMPAG Laptops & Notebooks

- 386DX-166
- 386DX-100

### PCMCIA Version 2.0

- All products brand new & guaranteed
- We buy excess inventory
- Trademarks registered with their respective companies.
EPP Aware
New double speed drive available

Printer Port Connections Are The New Tools Of The Trade.

Once you discover just how easy it is to install a backpack CD-ROM drive to your computer, you'll never be inconvenienced by conventional installation methods again. Just plug backpack into your computer and you're ready to go. No interface cards, hardware conflicts or expansion slots required. Because of its unique printer port interface, backpack fits all IBM PC compatibles and portables regardless of CPU speed. In addition, a built-in audio circuit with both headphone and line output jacks allows for connection of sound cards or Hi-Fi. You can run thousands of your favorite multimedia programs and view Kodak™ Photo CDs too, with CD-ROM backpack. Compact and versatile, you can expect backpack to go wherever you go, bringing with you the wealth of information CD-ROM storage makes possible. Printer pass-through is included. Tape drive, hard drive and diskette backpack drives are also available. Call today for ordering information and a dealer nearest you.

MicroSolutions
132 W. Lincoln Hwy.  DeKalb, Illinois 60115  Telephone 815.756.3411  Fax 815.756.2928
Call Toll Free 800.295.1214

Circle 161 on Inquiry Card (RESELLERS: 162).
Appro International, Inc. is dedicated in providing our customers with top quality products, unsurpassed service and support at an extremely attractive price. With extensive experience in the rackmount industry, our representatives can offer a wide range of products to fit a variety of customers' needs. We provide a wide range of rackmount enclosures, monitors, keyboards, Single Board Computer (SBC), and backplanes. Whether your need is to ruggedize a current system or acquire a completed rackmount system, APPRO has the solution. Call our representatives for more information on our rackmount products.
The Simple Connection Behind Computers and Backpack Tape Drives.

It's fast. It's small. It's reliable. It's incredibly compatible.

Backpack is the best selling parallel port tape drive on the market. We'd like to tell you why. With Backpack, tape backup is quick and simple. Just plug it into your printer port and it's ready to use. No hardware conflicts, no slots required. One model fits all IBM PCs, compatibles and portables, regardless of CPU speed. Backpack can store up to 250MB on a tape using data compression, is completely QIC80 compatible, and reads QIC40 tapes. With its compact size and 1Mbps transfer rate, Backpack is the smallest and fastest parallel port tape drive you can buy. Micro Solutions is dedicated to the perfection of backup technology. CD-ROM, hard drive, and diskette Backpack drives are also available. Call today for ordering information and a dealer nearest you.

Call toll free: 800-295-1214

Circle 163 on Inquiry Card (RESELLERS: 164).
**SIMM MODULES**

**PERSONAL COMPUTER MEMORY**

<table>
<thead>
<tr>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 9</td>
<td>$45</td>
</tr>
<tr>
<td>4 x 9</td>
<td>$158</td>
</tr>
<tr>
<td>1 x 36</td>
<td>$195</td>
</tr>
<tr>
<td>2 x 36</td>
<td>$410</td>
</tr>
</tbody>
</table>

**LASER PRINTER MEMORY**

Brother HL-8

- 1 MB - $40
- 2 MB - $72
- 4 MB - $106

Brother HL-10

- 1 MB - $40
- 2 MB - $80
- 4 MB - $120

Canon LBP-800

- 1 MB - $40
- 2 MB - $80
- 4 MB - $130

Canon LBP-900

- 1 MB - $40
- 2 MB - $80
- 4 MB - $120

Canon LBP-900DL

- 1 MB - $40
- 2 MB - $80
- 4 MB - $120

HP LaserJet 4

- 1 MB - $42
- 2 MB - $85
- 4 MB - $127

**Printer Accessories**

- Parallel Port cable
- USB cable
- PS/2 cable
- SCSI cable
- Cables for various printers

**Call the Upgrade Experts**

Circle 16 on Inquiry Card (RESELLERS: 157).
Recognized as the two best PC-diagnostic tools on the market.

NOW AVAILABLE IN ONE GREAT PACKAGE...

ALL NEW VER. 5.0

**Micro-Scope**

*Universal Diagnostics Software*

Fully operating system independent diagnostic software.

Recently named as PC Upgrade Magazine’s Utility of the Month.

FULLY OPERATING SYSTEM INDEPENDENT,
BIOS INDEPENDENT, AND CMOS INDEPENDENT.

MICRO-SCOPE Universal Computer Diagnostics was developed to satisfy the expanding need for accurate system diagnosis in the rapidly growing desktop computer market.

- **CACHE MEMORY** – "Micro-Scope" Ver. 5.0 now fully tests cache memory and the cache controller subsystem.
- **LOW LEVEL FORMAT** – Ability to do factory style initialization of all IDE drives, together with the ability to do factory style low level formatting on all drives, including MFM, RLL, ESDI, SCSI, and all IDE drives.
- **O/S, BIOS, and CMOS INDEPENDENT** – Does not rely on O/S for diagnostics. Talks to PC on a hardware level regardless of the O/S, BIOS or CMOS setting.
- **TRUE HARDWARE DIAGNOSTICS** – Accurate testing of CPU, IRQs, DMA, memory, hard drive, floppy drive, video cards, etc.
- **DISPLAY DRIVE TYPE** – Reads and displays the actual drive parameters for any drive type automatically.
- **CPU DETERMINATION** – This capability is necessary for accurate system diagnosis on 386SX, 386DX, 486DX and 387 and 487 chip implementations. Because each of these specific chips has its own unique instruction set, and therefore cannot be accurately diagnosed with any program which cannot recognize these differences!
- **MEMORY TEST** – “Micro-Scope” 5.0 has no limitations as to the size of memory it can accurately test. Micro-Scope now also tests up to 2 meg of video memory!
- **MEMORY EXAMINE** – Displays any physical bit of memory. Very useful for determining memory conflicts. Very useful for determining available memory space.
- **BATCH CONTROL** – All tests, even destructive, may be selected for testing.
- **ERROR LOGGING** – Automatically inputs errors during testing to an error log.
- **AUTOMAPPING** – Automatically finds bootable sectors, and runs POST on them automatically.
- **IRQ DISPLAY** – Shows whether hardware or software is using an IRQ.
- **SECTOR EDITOR** – Allows the editing of any sector of floppy or hard disk media (even track 0).
- **AND MUCH MORE...** We don’t have enough space here for everything this software can do!

The only Power-On Self-Test card you need to debug any “dead” PC!

**POST-PROBE**

The only Power-On Self-Test card you need to debug any “dead” PC!

**SERVICE NEWS**

Named as Product of the Month in the July issue of Service News.

"This is the only card that will function in every system on the market. The documentation is extensive, and not only covers the expected POST Codes for different BIOS versions, but also includes a detailed reference to the bus signals monitored by the card.”

— Scott Mueller from his globally recognized book, ‘Upgrading & Repairing PCs, Second Edition’

**Call MICRO 2000, Inc. for volume discounts and after sales service!**

800-864-8008

1100 E. Broadway, Suite 301

Glendale, California 91205

818-547-0125 • Fax 818-547-0397

Circle 168 on Inquiry Card.
WE DARE YOU TO COMPARE!

THE SOURCE FOR STORAGE SOLUTIONS!

STORAGE SOLUTIONS FOR ANY COMPUTER SYSTEM ON ANY OPERATING SYSTEM.

S*A*G expert technicians and knowledgeable sales personnel have been providing hard drives and storage systems to the international computer service industry since 1987.

We have been satisfying the technical demands and needs of people who replace and upgrade computer systems for major corporations worldwide.

PRODUCT: We carry a full line of all storage products. Call for any product.

PRICE: Volume discounts available. Call for current prices.

TECH SUPPORT: Toll-free Mon - Fri 9AM - 6 PM EST

DELIVERY: We offer immediate delivery and have a 92% rate of shipping the same day.

PAYMENT: VISA, Master Card, Corporate, Government and Educational purchase orders are welcome. No surcharge for VISA, MC, or CODs.

STORAGE SUBSYSTEMS

We can custom configure any subsystem from 100MB to 100GB - Call for prices

3.5" DISK SUBSYSTEMS

MICROPOLIS RAIDION
UP TO 93 GB
RAID solutions for OS/2, NOVELL, UNIX, and Macintosh

REMOVABLE DISK SUBSYSTEMS

TOWER SUBSYSTEMS—B FULL HEIGHT OR 16 3.5" DRIVE SOLUTION

CD-ROM CHINON

CDS-525 850MB 200MS $347

MACINTOSH SPECIALS

Call immediately for cost savings on all MAC drives

WEIGHT DIGITAL 2YR WARRANTY

<table>
<thead>
<tr>
<th>TYPE</th>
<th>MB SIZE</th>
<th>SEEK</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDE</td>
<td>W0210</td>
<td>200 1&quot;</td>
<td>14 $S799</td>
</tr>
<tr>
<td>IDE</td>
<td>W021040</td>
<td>1050 1&quot;</td>
<td>14 $S383</td>
</tr>
<tr>
<td>IDE</td>
<td>W02340</td>
<td>340 1&quot;</td>
<td>13 $S370</td>
</tr>
<tr>
<td>IDE</td>
<td>W02420</td>
<td>420 1&quot;</td>
<td>13 $S345</td>
</tr>
</tbody>
</table>

30 DAY MONEY BACK GUARANTEE!
CUSTOMIZED SOLUTIONS!
WIDEST SELECTIONS!
TOLL-FREE TECH SUPPORT!

DRIVE PRICES GO DOWN - CALL FOR CURRENT PRICES

Circle 181 on Inquiry Card.
Viper Vision is the fastest and easiest way to import any picture directly into your computer! Viper Vision’s sharp input/output is ideal for Architects, Engineers, Real Estate, Sales, Police, Medical, Government and Business. Simply capture a photo image using your VCR, LASER DISK, TV or CamCorder. Viper Vision supports NTSC or PAL formats and easily plugs into the printer port of your computer in just seconds! Take pictures of work progress, terrain or other features. Manufacturers can add pictures of inventory items to their databases quickly and easily. Marketing personnel can make sales brochures in just seconds. Graphic Arts & Publishing personnel can experience resolution 720 x 480 true color. You can even output directly to a Linotronic or similar Image setter or just send to your favorite service bureaus. For home use the Viper Vision is the ideal product to store your favorite pictures in digital format, permanently. Viper Vision is fast! Images are processed in about a half of a second. Why pay to have snapshots developed and then run through your scanner? With Viper Vision you simply bypass the whole process. Viper Vision is easy to use, simply put, any image that you see through the viewfinder of your CamCorder can be imported into your Windows application. Call and order yours today!
As a BYTE reader, you have a reputation for being an informed decision maker. You're one of the experts, directing the buying decisions of the most current products and emerging technologies.

You're the Early Product Adopter, with a window to today's complex computer environment.

By using the toll-free numbers in this issue, you're just a phone call away from reaching the leading suppliers and manufacturers of the products you're looking for.

Let Them Know Who They're Dealing With
Tell them you saw it in

BYTE
### Memory Solutions

#### New Products

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>64MB 72-PIN</td>
<td>$2995.00</td>
</tr>
<tr>
<td>16MB x 36 FOR:</td>
<td>$2995.00</td>
</tr>
<tr>
<td>ALR EVOLUTION VQ</td>
<td>$2995.00</td>
</tr>
<tr>
<td>ACER POWER 486E</td>
<td>$2995.00</td>
</tr>
<tr>
<td>AIR 486 EISA-VL BUS</td>
<td>$2995.00</td>
</tr>
<tr>
<td>AMI ENTERPRISE IV</td>
<td>$2995.00</td>
</tr>
</tbody>
</table>

#### Industry Standard 72-PIN

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>256K x 36 - 1MB</td>
<td>$CALL</td>
</tr>
<tr>
<td>512K x 36 - 2MB</td>
<td>$CALL</td>
</tr>
<tr>
<td>1MB x 36 - 4MB</td>
<td>$CALL</td>
</tr>
<tr>
<td>2MB x 36 - 8MB</td>
<td>$CALL</td>
</tr>
<tr>
<td>4MB x 36 - 16MB</td>
<td>$CALL</td>
</tr>
<tr>
<td>8MB x 36 - 32MB</td>
<td>$CALL</td>
</tr>
<tr>
<td>16MB x 36 - 64MB</td>
<td>$CALL</td>
</tr>
</tbody>
</table>

#### Best Bargain

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCMCIA SRAM 2MB</td>
<td>$179.00</td>
</tr>
</tbody>
</table>

### The Ultimate Combo:

- Voice Mail
- Fax Mail Box
- Data Modem
- Digital Answering Machine

... and more

Feature to feature, this is the Home-office machine of the 90's. Only $199.00

(please call for your free brochure)

#### Other Memories Available For:

- 64MB 72-PIN
- 1MB x 3
- 4MB x 9
- 16MB x 9
- 16MB x 8

**Prices Subject to Change Without Notice**

---

**CitiTronics Inc.**

**CALL FOR UPDATED LOW PRICES AND NEW PRODUCTS**

Office Hours: Mon.-Fri. 9am to 5:30pm pst

Terms: C.O.D., Cash, Visa or MasterCard. Company and University P.O.'s accepted upon credit approval.

**TEL. (818)855-5688 FAX (818)855-5687**

414 CLOVERLEAF DR., UNIT B, BALDWIN PARK, CA 91706

---

All product names, trademarks and registered trademarks are the property of their respective companies.

Circle 167 on Inquiry Card.
Need the fastest Windows performer?

High Performance Micro-International HCP Model 65681M

“If you need a notebook with processing power for massive spreadsheets and databases, to perform gray-scale imaging, or for other demanding tasks, the HCP 65681M is for you. It ran our Windows performance test twice as fast as the Compaq LTE lite 4/25E... In fact, this was the fastest monochrome notebook in our entire test sample. The HCP 65681M's monochrome screen quality is the best we saw from passive-matrix monochrome displays... and an excellent keyboard.”

October 1993 BYTE/NSTL LAB REPORT

MICRO-INTERNATIONAL, INC. 10850 Seaboard Loop, Houston, Texas 77099
National Sales:(800) 967-5667•Local Sales:(713) 495-9096•FAX:(713) 495-7791
$2740 for a monochrome 486/266M system with MS-DOS 6.0, Windows 3.1, 8MB RAM, and 250MB hard disk. Prices for other configurations are available upon request.
Office hours Monday–Friday 8:00–6:00 • Saturday 10:00–1:00 • Sunday–Closed

Circle 169 on Inquiry Card.
Everyone makes claims. We make sure.

When the industry wants product testing taken to the nth degree, they take it to NSTL.

In every field, one name sets the standard. In microcomputer testing, the name is NSTL, the leading independent testing lab.

The NSTL compatibility certification seal on a product says that it withstood the toughest lab in the industry — and it's ready for your business.

The seal saves you a lot of comparison and guesswork. It says you'll find the product compatible with a wide range of business applications and hardware. It helps you make the right choice.

Real-world testing for real-world use.

Beyond compatibility testing, we access nearly every conceivable problem — from engineering-level hardware bugs to the everyday usability of business software.

And we test with the end-user in mind, in a real-world environment, just the way your staff uses equipment. Except our trials are more punishing.

Our publications, and others that publish our work.

In a separate facility we also do comparison testing for our own Ratings Reports: Software Digest®, PC Digest® and LAN Reporter®. They're read by people who purchase an average of more than $500,000 in microcomputer hardware and software annually.

And because of the respect we've earned, some of the industry's leading publications, like Data Communications, LAN Times, Unix World and Datapro Research Group publish our test results.

Look for the NSTL seal and be sure.

Experts rely on the NSTL name: now you can, too. The final test of a product is its compatibility in a business environment. The NSTL mark tells you it's already met that test. Look for it when you compare products.
## Floppy Drives

<table>
<thead>
<tr>
<th>Model</th>
<th>Size</th>
<th>Speed</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>360K</td>
<td>5.25</td>
<td>360K</td>
<td>1/2</td>
<td>$34</td>
</tr>
<tr>
<td>360K</td>
<td>5.25</td>
<td>360K</td>
<td>3/4</td>
<td>$38</td>
</tr>
<tr>
<td>520K</td>
<td>5.25</td>
<td>520K</td>
<td>3/4</td>
<td>$38</td>
</tr>
<tr>
<td>720K</td>
<td>5.25</td>
<td>720K</td>
<td>3/4</td>
<td>$40</td>
</tr>
<tr>
<td>1.2M</td>
<td>5.25</td>
<td>1.2M</td>
<td>3/4</td>
<td>$50</td>
</tr>
<tr>
<td>1.44M</td>
<td>3.5</td>
<td>1.44M</td>
<td>1/2</td>
<td>$75</td>
</tr>
<tr>
<td>2.88M</td>
<td>3.5</td>
<td>2.88M</td>
<td>1/2</td>
<td>$90</td>
</tr>
</tbody>
</table>

## SCSI

<table>
<thead>
<tr>
<th>Model</th>
<th>Size</th>
<th>Speed</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>500K</td>
<td>5.25</td>
<td>500K</td>
<td>1/2</td>
<td>$38</td>
</tr>
<tr>
<td>500K</td>
<td>5.25</td>
<td>500K</td>
<td>3/4</td>
<td>$40</td>
</tr>
<tr>
<td>720K</td>
<td>5.25</td>
<td>720K</td>
<td>3/4</td>
<td>$40</td>
</tr>
<tr>
<td>1.2M</td>
<td>5.25</td>
<td>1.2M</td>
<td>3/4</td>
<td>$50</td>
</tr>
<tr>
<td>1.44M</td>
<td>3.5</td>
<td>1.44M</td>
<td>1/2</td>
<td>$90</td>
</tr>
</tbody>
</table>

## MODEM SALE

All models come with software, cables, manuals, and a one-year warranty. Most are in-stock, while others are in transit.

<table>
<thead>
<tr>
<th>Modem</th>
<th>Speed</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>300BPS</td>
<td>$34</td>
<td></td>
</tr>
<tr>
<td>1200BPS</td>
<td>$75</td>
<td></td>
</tr>
<tr>
<td>2400BPS</td>
<td>$110</td>
<td></td>
</tr>
</tbody>
</table>

## PRICES

**Floppy Drives**

- REDUCED
- CP'302.S
- CP'006.0

**SCSI**

- SCSI 801
- SCSI 1801
- SCSI 2801
- SCSI 3801
- SCSI 4801

## Mode 3.0

- Mode 3.0
- Mode 3.0

## IBM P5/2 Memory

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

## Laser Printer Memory

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

## Prices Reduced Floppy Drives

- 300BPS $34
- 1200BPS $75
- 2400BPS $110

**Drive Controllers**

- 80/160/320MB Drives
- 520MB Drives
- 1.44MB Drives
- 2.88MB Drives

**Cartridge Tape Drives**

- IBM 3380
- IBM 3390

**IBM Laptop Memory**

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

**Simm Modules**

- Prices charged are for loose modules, add $5.00 for Simm modules. Description

<table>
<thead>
<tr>
<th>Module</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

**D-Ram Chips**

- Prices charged are for loose modules, add $5.00 for D-Ram modules. Description

<table>
<thead>
<tr>
<th>Module</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

**Cache Memory**

- Prices charged are for loose modules, add $5.00 for Cache Memory. Description

<table>
<thead>
<tr>
<th>Module</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

## Memory

**SCSI MEMORY**

- Prices charged are for loose modules, add $5.00 for SCSI Memory. Description

<table>
<thead>
<tr>
<th>Module</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

**Addressable Memory**

- Prices charged are for loose modules, add $5.00 for Addressable Memory. Description

<table>
<thead>
<tr>
<th>Module</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

## 386SX Upgrade

- Prices charged are for loose modules, add $5.00 for 386SX Upgrade. Description

<table>
<thead>
<tr>
<th>Module</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

## 486SX Upgrade

- Prices charged are for loose modules, add $5.00 for 486SX Upgrade. Description

<table>
<thead>
<tr>
<th>Module</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

## MODEMA/3 PLUS

- Prices charged are for loose modules, add $5.00 for MODEMA/3 PLUS. Description

<table>
<thead>
<tr>
<th>Module</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512M</td>
<td>512M</td>
<td>$50</td>
</tr>
<tr>
<td>1G</td>
<td>1G</td>
<td>$150</td>
</tr>
</tbody>
</table>

## Promotion

We now have a full page ad-.. m Byte

- Some more Phone
- Some more
- Some more

Circle 159 on Inquiry Card.
### Computerlane Inc.

**Corporate Accounts**
**Volume Discounts**
**And Consultant Orders**
**Welcome**

---

**Notes:**
- Thinkpad TFC 486SL/33 4/140MB CALL
- Thinkpad 750 486SL/33 4/140MB CALL
- Thinkpad 7500 486SL/33 4/140MB CALL
- Thinkpad 600 486SL/33 4/140MB CALL
- Thinkpad 600 486SL/33 4/140MB CALL
- Thinkpad 720C 4/160MB 4399
- Thinkpad 720C 4/160MB 3150
- Thinkpad 720C 4/160MB 2871
- Thinkpad 500 486SL/33 4/140MB 1915
- Thinkpad 500 486SL/33 4/140MB 2395

---

**Networks:**
- Ethernet 3.12 Netware 4.01
- 5 users 500
- 5 users 740
- 10 users 1299
- 10 users 1788
- 25 users 2365
- 25 users 3449
- 100 users 3399

---

**Toshiba:**

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3190C</td>
<td>4/120MB</td>
<td>$240</td>
</tr>
<tr>
<td>3190C</td>
<td>4/120MB</td>
<td>$315</td>
</tr>
<tr>
<td>3190C</td>
<td>4/120MB</td>
<td>$360</td>
</tr>
</tbody>
</table>

---

**Notebook Specials:**

- **Texas Instruments:**
  - 4000E 256/400MB (active color) $399
  - 4000E 256/400MB (color) $209
  - 120/256MB $255
  - NEC (ultrafast active color) Versus 486 SL/25 4/120MB/160MB $370/305
  - Versus 486 SL/33 4/180MB $420

---

**Hard Disks:**

- Conner
  - 120/250MB 230/249
  - 340/540MB 334/475
  - 1.2GBB 1.2GBB
  - 1.2MB floppy drive

---

**Configurations & Controller:**

- Adapter 832 ISA $360
- Adapter 1542C kit $225
- Adapter 2842 VLB Kit $285
- Adapter 16 ISA $165

---

**Graphics Cards:**

- Diamond Stealth 24 HD $173
- Diamond Viper VLB 2MB $388
- ATI Ultra Pro EISA 2MB $379
- ATI Ultra Pro ISA $335
- ATI Wonder 1MB/512 $124

---

**Printers:**

- OKI ML590/591 $440
- Panasonic 4450/4850 $525
- Canon BJ 820 $1599

---

**Network Accessories:**

- NEC 396/446E $620/720
- NEC 596 396/396 $1120/1399
- NEC 696/666 $2320/2420

---

**Software:**

- Windows NT Server $300
- Windows NT Server $300
- Lotus SmartSuite $340
- Lotus SmartSuite $340
- Lotus SmartSuite $340

---

**Network Support:**

- Acer Notejet $325
- Canon Notejet $325

---

**Network Support:**

- IBM 486/33 Processor $120MB

---

**Customer Support:**

- Call 800-526-3482

---

**Hardware:**

- Compaq Deskpro XE 486SX $185
- Compaq Deskpro XE 486DX $419
- Compaq Deskpro XE 486DX $419
- Compaq Deskpro XE 486DX $419

---

**Special Offer:**

- Call for all new models

---

**New Releases:**

- Proliant 1000 4/330M $275
- Proliant 2000 4/66M $275

---

**Customer Service:**

- 750 Topanga Canyon Boulevard, Canoga Park, CA 91303

---

**Contact Us:**

- Hours: Monday - Friday 9-6, Saturday 10-5

---

**Happy Holidays!**

---

**Computerlane Inc.**

**Outside California:** 1-800-526-3482

**Corporate Accounts**

**Volume Discounts**

**And Consultant Orders**

**Welcome**

---

**Compaq**

**All ProLinea systems are Local SPECIAL!**

---

**Visa, MasterCard, and American Express also accepted.**

---

**Prices subject to change without notice.**

---

**Circle 153 on Inquiry Card.**
LEAVE IT TO US TO RACK THINGS UP

RECORTEC's Rack Mount PC compatible computers, monitors, keyboards and printer continue the tradition of manufacturing excellence RECORTEC started in 1969. With our broad product line, fast delivery, excellent pre and post sale service, it's no wonder more and more people "leave it to us to rack things up".

QUALITY
All products 100% tested and verified prior to shipment.

RELIABILITY
Field proven components backed by a comprehensive warranty.

SERVICE
Large stock for fast delivery plus assistance by knowledgeable sales and support personnel.

SOLUTIONS
Choose from many models which offer a wide range of solutions for a variety of rack mount needs. We also offer custom designs when a standard product just won't do.

CALL OR FAX FOR MORE INFORMATION.
1-800-729-7654

RECORTEC, INC.
1290 Lawrence Station Road Sunnyvale, CA 94089    Tel: (408) 734-1290    Fax: (408) 734-2140

Circle 165 on Inquiry Card.
SmartCache III is the total, growable SCSI solution!

The world's best SCSI adapter is now the world's greatest bargain—priced lower than any major competitor. An unprecedented value, SmartCache III offers top performance and universal connectivity with all major SCSI-1, SCSI-2 and Fast SCSI devices, including hard drives, tape, CD-ROM and WORM.

It also comes with built-in support from all major operating systems, including DOS, Windows, OS/2, NetWare, Windows NT, NextStep and all versions of Unix.

And only SmartCache III gives you a growth path. Optional plug-on modules let you migrate easily to caching (with up to 64Mb cache), as well as full RAID capability. Storage Manager, our GUI utility, makes installation quick, easy and automatic. Plus, it gives you on-line and remote control over subsystem management, diagnostics, performance monitoring, and disk array configuration and control.

Call DPT, today!
800-322-4DPT
FAX 407-260-5366
It's all up to you! The skies are swarming with bandits. Only you stand between the threat and your carrier battle group.

Lock on your radar and launch the Navy's advanced weapons to destroy the most sophisticated enemy targets ever developed for a MicroProse simulation. Roll, turn, climb, and dive to out-maneuver enemy aircraft using an artificial intelligence developed right out of Soviet and Third World military doctrine.

A computer-controlled wingman responds to your every command. And, you'll interact with strike packages that include F/A-18 Hornets, A-6 Intruders, A-7 Corsairs and E-2C Hawkeye AWACS.

Featuring the latest in 3-D terrain technology derived from digitized information taken from LANDSAT geological surveys, you'll pilot your F-14 through actual locations.

Fleet Defender from MicroProse. We brought you the F-15 Strike Eagle, now try the F-14 Tomcat featuring the most authentically modeled F-14 systems available anywhere outside of the Navy.
EMBARC Unlocks the Potential of Your Personal Digital Assistant

At EMBARC, we've expanded our wireless reach to include today's newest, most portable class of computer — the personal digital assistant! Now, a wealth of wireless news and information comes straight to your PDA over the EMBARC wireless network. All you need is the EMBARC Motorola NewsCard wireless data receiver.

Virtually anywhere you travel in the U.S. and Canada, the EMBARC wireless network keeps you sharp and productive with a broad array of subscription news and information services. Dozens of subject options from such leading sources as USA TODAY, REUTERS and INDIVIDUAL, Inc. keep you up to speed with everything from financial market updates, to industry-specific news, to sports and weather. Plus, you'll be on top of business with full-text wireless E-mail and file transfers from your office.

The EMBARC Motorola NewsCard fits many of today's popular PDAs, including the Casio Z-7000, Tandy Z-PDA and GRID 2390, and operates for a full month on one AAA battery. For a mere $249, it turns your personal digital assistant into a wireless wonder! To learn more about EMBARC wireless service for PDAs, and to ask about EMBARC compatibility with other platforms, call 800-EMBARC4, Ext. 330.

Motorola and NewsStream are registered trademarks of Motorola, Inc. All other names and products mentioned are the property of their respective organizations.

Circle 171 on Inquiry Card (RESELLERS: 172).
### Jameco Computer Products

#### Floppy Disk Drives
- **8088/80286/80386 and compatible**:
  - 3.5/5.25"...$149.95
  - 5.25"...$129.95
- **2MB**...$89.95
- **4MB**...$69.95

#### Jameco Portable IC Tester
Our hand-held IC tester is an easy-to-operate, cost effective unit that includes excellent functions.

- **Supports TTL, CMOS, DRA1, and ORAM 4 Series**
- **Size**: 7.L x 3.625W
- **One-year warranty**

- **Price**: $139.95

#### UVP EPROM Eraser
- **Erases all EPROM's**
- **Erases 1 Chip in 15 minutes**
- **8 chips in 21 minutes**
- **UV intensity**: 6800 µW/cm²
- **Size**: 0.9L x 3.7"W x 2.6H
- **Operating temperature**: -40°C to 70°C

- **Price**: $89.95

#### Apple II, III, and Ile Switching Power Supply
- **Can drive four floppy disk drives and up to eight expansion cards**
- **Short circuit and overload protection inside the Apple II, III, and Ile**
- **Fully regulated +5VDC @ 0.5A, +12VDC @0.5A**
- **Size**: 9.0L x 3.5W x 2.25H
- **Weight**: 2.8 lbs.
- **Data Included**:
  - 400 volts
  - 500 watts
  - 1000 watts
  - 2000 watts
  - 5000 watts

- **Price**: $44.95

#### Surge Protectors
- **Full-time protection for Apple II, III, and Ile**
- **Input Voltage**: 115VAC
- **Output Voltage**: 120VAC
- **Ultra low noise**
- **Weight**: 2.8 lbs.
- **Data Included**:
  - 1000 watts
  - 2000 watts
  - 4000 watts

- **Price**: $59.95

### Graphic and Memory Cards
- **BGA HI-color and compatible**
- **Expand your memory or enhance your graphics capabilities**
- **16 MB**...$34.95
- **32 MB**...$54.95
- **64 MB**...$84.95
- **128 MB**...$159.95

#### Candle Cables
- **Parallel Printer**
- **Cables and Adapter**
- **9-pin Serial Cable**
- **25-pin Extension Cables**

#### Jameco Floppy Controllers and I/O Cards
- **Multi I/O with Floppy Controller**
- **Floppy Disk Drive Controller Cards**
- **Conner IDE Hard Drives**
- **Silicon Valley IDE Disk Drive Adapter Cards**
- **Jameco Cables**
- **Parallel Printer**
- **Cables and Adapter**
- **5-pin Serial Cable**
- **25-pin Extension Cables**

### Jameco Motherboards
- **Built-in fan**
- **1819465 150 Watt (8088) $69.95**
- **1867467 200 Watt $89.95**
- **1819545 200 Watt $89.95**
- **1819553 200 Watt mini $89.95**
- **1865728 300 Watt $149.95**
- **1893542 VGA HL-color $159.95**
- **1819781 Super VGA card $129.95**
- **1867459 VGA card Monochrome Graphics $34.95**
- **1829313 32MB Memory Card $49.95**
- **1819975 (8088) Memory Card $19.95**

### Keyboards & Keypad
- **8088/80286/80386 and compatible**
- **16-key keyboard**...$59.95
- **16-key keyboard (compatible)**...$34.95
- **10-key enhanced**...$79.95
- **101-key enhanced**...$99.95

### RAM
- **SIMMs**
- **1814123 2MB x 8 80ns $3.45**

### Surge Protectors
- **1827158 KF4007 Switching $44.95**

### Apple IIGS Switching Power Supply
- **Fully regulated +5VDC @ 0.5A, +12VDC @0.5A**
- **Size**: 100 watts
- **Data Included**:
  - 1000 watts
  - 2000 watts
  - 4000 watts

- **Price**: $59.95

### Metex Digital Multimeters
- **Hand-held high accuracy**
- **Measures AC/DC voltage, AC/DC current, resistance, diodes, and continuity test transistor NFE**
- **Manual ranging waveform protection**
- **Comes with probes, batteries, case and manual**
- **One-year warranty**

- **Price**: $29.95

### Your One Stop Component & Computer Source

Call 1-800-831-4242 to order today!
Subscription Problems?

We want to help!

If you have a problem with your BYTE subscription, write us with the details. We’ll do our best to set it right. But we must have the name, address, and zip of the subscription (new and old address, if it’s a change of address). If the problem involves a payment, be sure to include copies of the credit card statement, or front and back of cancelled checks. Include a “business hours” phone number if possible.
Tests Prove Our Boards Withstand Surges That Make Other Boards Fail

Direct buyers want the best products. The best performance for the price, and — above all — reliability.

That's why Arnet uses a unique feature called SurgeBlock to protect every port on its I/O boards from power surges. They're the leading cause of I/O board failures because they're caused by countless sources — from lightning storms to simply walking across the floor.

SurgeBlock gives our I/O boards unbeatable reliability. It was the first onboard surge protection, and independent tests prove it's still the best. Call us and we'll send you the results that prove it.

The Best I/O Boards to Buy Direct

Not only are our boards the most reliable — with a field failure rate of less than 1% — they're also the best direct buy around. Here's why:

Unmatched Price/Performance

Our I/O solutions support from two to 512 users and operate at speeds from 2400 to 115K baud — with prices starting at less than $70 per port!

Compatibility

Our I/O boards are compatible with more than 30 operating systems, including UNIX, Windows, DOS, Multiuser DOS and NetWare.™

30-Day Money-Back Guarantee Plus a Lifetime Warranty

We back our reliability with a 30-day, hassle-free money-back guarantee plus a Lifetime Warranty.

24-Hour Hot Swaps

If your board does fail, you can have a replacement at your site within 24 hours.

Attractive Terms

Qualified customers can buy with our convenient Arnet Gold credit card or other major credit cards. And we offer next day delivery!

Reseller Discounts Available

Cost-Effective, Expandable Intelligent Serial I/O

SmartPort and SmartPort Plus

Create PC systems that can grow as you do with SmartPort and SmartPort Plus. SmartPort is best suited for systems supporting up to 8 users per slot. SmartPort Plus is most cost-effective for systems requiring 16 to 32 users per slot. A powerful onboard processor offloads serial I/O from the host PC to dramatically improve data throughput.

- Supports I/O speeds up to 38.4K baud per port
- Up to 64 Kb of dual ported RAM
- Full signal support for modems and other devices
- RS-422 support on SmartPort Plus for longer distances
- SimulPort terminal paging software
- SimulPrint transparent printing utility

From $446

Intelligent I/O Communications Subsystem for PCs

COMStax

Add a COMStax host card to your PC to support up to 128 users per slot. An onboard high performance 20 MHz RISC processor enables transmission rates up to 115.2K baud per port.

- Desktop stackable modules for asynchronous, synchronous and high-speed parallel printing
- Up to 8 stackable communication modules per host card
- RS-422 support for longer distances

Host Adapter From $596

Modules From $371

Workgroup Concentrator for Local and Remote Users

ClusterPort

Build large systems that can support remote users with ClusterPort. A host adapter card with two high-speed synchronous links connects to multiple 16-port Cluster Boxes or to modems for remote locations. Remote users can be connected without using costly multiplexers.

- Supports 128 ports per slot, 512 ports per system
- Supports local users thousands of feet from the host without modems (miles with optional Fiber Link Kit)
- 1.2 Mbps RS-422 synchronous link between host adapter and local Cluster Boxes; Up to 64Kbps synchronous for remotely-attached Cluster Boxes.

Host Adapter From $1721

Cluster Boxes From $1121

Ask for Your FREE Catalog of Arnet PC Connectivity Solutions!

800-377-5515
FAX: 600-377-8848

Circle 177 on Inquiry Card (RESELLERS: 178).

Arnet PC Connectivity Solutions

618 Grassmere Park Drive
Nashville, TN 37211

(615) 834-8000, (615) 834-5399 FAX

Arnet and the Arnet logo are registered trademarks of Arnet Corporation. All other trademarks are the property of their respective corporations. Test conducted by Wyle Laboratories, September 1993.
Circle 170 on Inquiry Card.

**PRINTER SHARING & MEMORY**

800-238-9415

---

**LOGICAL CONNECTION**

4660 Portland Road NE #108 Salem, OR 97305-1658 Tech.: (503) 390-9375 FAX: (503) 390-9372

---

It's FREE! Absolutely, positively, totally FREE!

No strings! No commitment! No shipping! No handling! No nothing! FREE! FREE! FREE! FREE! FREE!

It's your FREE introductory issue of

NautilusCD

The Multimedia Magazine

---

This is not a misprint. It's an honest-to-gosh offer for a FREE introductory issue of NautilusCD, The Multimedia Magazine on CD ROM.

NautilusCD is the premier showcase of multimedia creativity. Our contributors are multimedia's superstars, wizards who can make your computer screen flash to life with moving pictures...play music or sing for you...dazzle your eyes with 3-D graphics...and even talk to you! It's an experience not to be missed.

Yeah, you'll get a subscription offer with your FREE issue of NautilusCD, but no more will come—and neither will any bills—until you tell us "OK, I've gotta have it!" You've got hours of thrilling multimedia entertainment to gain and nothing to lose. So call the number and ask for your FREE issue now!

---

To order your absolutely, positively, totally FREE issue, call toll-free

1-800-448-2323.

Available in Macintosh and Windows versions. CD ROM drive required.


NautilusCD The Multimedia Magazine

7001 Discovery Boulevard, Dublin, Ohio 43017

---

Circle 176 on Inquiry Card.
INTERFACE CARDS

Fast Multi I/O Card
- Includes two 8216550 serial ports, on parallel port and one game port
- 8-bit 286/386/486 PC compatible
MCT-AIO-MIC $89.95
MCT-AIO-16 As above with one 8216450 $99.95
MCT-IDEIO-16 IDE w/8216550 compatible serial $99.95
MCT-IDEIO-32 IDE w/8216450 compatible serial $99.95
MCT-IDEIO-64 IDE w/68216450 compatible serial $99.95
MCT-DEFIP-16 8-bit IDE and Multi I/O card $29.95
MCT-DEFIP-32 16-bit IDE floppy card $29.95
MCT-VFI-32 VESA Local bus cache IDE controller $229.95
MCT-VFSC-32 VESA Local bus SCSI-2 controller $299.95

SYSTEM BASICS

3-Button Mouse $14.95
- Accuracy 290-1450 DPI
- Opto-mechanical design
- JMR-MOUSE-3 $14.95
MICE-PAD Keeps mouse ball free of dirt $4.95
MCT-GAME Dual port game card $29.95
JSTK-300 14-bit mouse joystick $19.95
JSTK-500 Pilot-style joystick $19.95

MULTIMEDIA

Low Cost Internal CD Drive
- 5'/4" half-height internal card with 1/2 length interface card
- 150kHz-175kHz per second, 250ms average access time
- Includes drive, interface card, cables and manual
CDROM-1 $199.95
CDR-84 NEC internal dual speed CD-ROM drive $499.95
MCT-SOUND 8-bit sound card $49.95
5X-OLX SoundsBlaster 8-bit sound card $80.95
VIDEOBLASTER 16-bit video card with sound $329.95

STORAGE DEVICES

5-1/4" & 3-1/2" Combination Drive
- 5-1/4" half-height belle drive
- Supports 1.44Mb, 1.2Mb, 720K & 360K diskettes
- FD-605 $149.95
- FDD-2.88A 2.88Mb 3-1/2" Beige $99.95
- FDD-1.44A 1.44Mb 3-1/2" Beige $99.95
- FDD-1.2 1.2Mb 5-1/4" Black $99.95
- FD-360K 360K 5-1/4" Black $99.95
- Preformatted Bulk Diskettes In Quantities of 250
- MZDZ-BULK 5-1/4" 360K DOS diskettes $25.95 ea
- MZDN-BULK 3-1/2" 1.44Mb DOS diskettes $25.95 ea
- 3.5HD-BULK 3-1/2" 1.2Mb HD diskettes $25.95 ea
- 3.5D-BULK 3-1/2" 1.2Mb DD diskettes $25.95 ea

250Mb Tape Drive $169.95
- 286/386/486 PC compatible
- QIC-40 read and QIC-80 write compatible
- Up to 3.5Mb/minute transfer rate
- 5-1/4" internal half-height drive
- Includes DOS backup software and manual
92501 $189.95

IDE Hard Drives

PART # BRAND CAP. SPEED TYPE PRICE
CP-3088C Conner 844M 18ms 3-1/2 IDE $189.95
ST-3095A Seagate 896M 17ms 3-1/2 IDE $189.95
ST-3144A Seagate 131M 17ms 3-1/2 IDE $189.95
AP-30174 Conner 170M 17ms 3-1/2 IDE $229.95
AP-30254 Conner 250M 17ms 3-1/2 IDE $259.95

Seagate IDE Drive Kits
- 16-bit 286/386/486 PC compatible card
- Includes hard drive
- 16-bit controller interfaces two hard and two floppy drives
HDKIT-80 Kit with 89Mb ST-3096A drive $209.95
HDKIT-100 Kit with 128Mb ST-3144A drive $229.95
HDKIT-200 Kit with 250Mb ST-3096A drive $259.95

UPGRADE COMPONENTS

Dynamic RAM
- PART # SPEED TYPE PRICE
41256-60 256K x 1 $2.30
1MB-60 1M x 1 $4.99
2MB-60 2M x 1 $9.99
4MB-60 4M x 1 $16.99
8MB-60 8M x 1 $35.99
16MB-60 16M x 1 $59.99
32MB-60 32M x 1 $159.99
64MB-60 64M x 1 $179.99

Math Co-Processors
- PART # SPEED TYPE PRICE
8087-7 7Mhz $129.95
8087 8Mhz $149.95
8087 10Mhz $169.95
80287-10Mhz $25Mhz $269.95

OverDrive Processors
- PART # SPEED TYPE PRICE
ODP488-SX25 25MHz 486SX OverDrive socket $299.95
ODP488-SX33 33MHz 486SX OverDrive socket $359.95
ODP488-SX40 40MHz 486SX OverDrive socket $599.95
ODP488-SX50 50MHz 486SX OverDrive socket $799.95
ODP488-SX60 60MHz 486SX OverDrive socket $999.95

MODEMS & FAX

14,400 Baud Internal Fax/Modem
- 14,400/1200/9600/2400 baud modem & fax
- Full Hayes command set compatibility
- QuickLink II communications software
MCT-144IF+ 14,400 baud internal fax/modem $149.95
MCT-241 2400 baud internal modem with a/s $49.95
FAXM-SWITCH Connect fax/modem/phone on 1 line $59.95
FAX-SWITCH Above without modem connection $59.95

MOTHERBOARDS

VESA Local Bus Board 486DX Motherboard $599
- 33MHz Intel 6046DX or 66MHz 6046DX2 CPU
- Uses 256K x 16 1M x 16 & 4M x 16
- 250Mb Tape Drive $169.95
- QIC-40 read and QIC-80 write/read/write compatible
- Up to 3.5Mb/minute transfer rate
- 5-1/4" internal half-height drive
- Includes DOS backup software and manual
92501 $189.95

Math Co-Processors
- PART # SPEED TYPE PRICE
8087-7 7Mhz $129.95
8087 8Mhz $149.95
8087 10Mhz $169.95
80287-10Mhz $25Mhz $269.95

OverDrive Processors
- PART # SPEED TYPE PRICE
ODP488-SX25 25MHz 486SX OverDrive socket $299.95
ODP488-SX33 33MHz 486SX OverDrive socket $359.95
ODP488-SX40 40MHz 486SX OverDrive socket $599.95
ODP488-SX50 50MHz 486SX OverDrive socket $799.95
ODP488-SX60 60MHz 486SX OverDrive socket $999.95

MODEMS & FAX

14,400 Baud Internal Fax/Modem
- 14,400/1200/9600/2400 baud modem & fax
- Full Hayes command set compatibility
- QuickLink II communications software
MCT-144IF+ 14,400 baud internal fax/modem $149.95
MCT-241 2400 baud internal modem with a/s $49.95
FAXM-SWITCH Connect fax/modem/phone on 1 line $59.95
FAX-SWITCH Above without modem connection $59.95

MOTHERBOARDS

VESA Local Bus Board 486DX Motherboard $599
- 33MHz Intel 6046DX or 66MHz 6046DX2 CPU
- Uses 256K x 16 1M x 16 & 4M x 16
- 250Mb Tape Drive $169.95
- QIC-40 read and QIC-80 write/read/write compatible
- Up to 3.5Mb/minute transfer rate
- 5-1/4" internal half-height drive
- Includes DOS backup software and manual
92501 $189.95
Polaroid
Circular Polarizing Filters
The Ultimate Glare Control
And Contrast Enhancement Technology

Polaroid's C-P Filters for computer monitors feature a two-layer circular polarizer and multi-layer optical coatings to provide the ultimate technology for glare reduction and contrast enhancement - the difference is immediate and dramatic. Because of the very efficient ambient light trapping properties of circular polarizers, Polaroid CP-Filters suppress up to 99% of unwanted reflected light and are as much as 14 times more effective than other filters in improving contrast. Most models also include an electrically conductive coating that eliminates static and reduces up to 98% EMI for electric field radiation. Polaroid produces a full range of optical quality anti-glare filters in glass and triacetate to fit most 9”-21” monitors.

Polaroid Corporation, Polarizer Division, N2, 1 Upland Road, Norwood, MA 02062
1-800-225-2770 Fax 617-446-4600

Circle 203 on Inquiry Card.

Tough and durable.
For multiport serial controllers in demanding environments, you need Star Gate.

Built to withstand the rigors of industrial and commercial environments, Star Gate I/O controllers are offered in a broad range of price and performance options for ISA, EISA and Micro Channel.

Added Benefits: Enables a single PC expansion slot to support from 2 to 128 serial devices • Unmatched reliability in harsh, noisy environments with fully-shielded cables and rugged metal connection panels • Exclusive SureGuard™ option includes complete transient surge suppression • EIA-232, -422, -485 • Supports DOS, OS/2, Unix, Novell, Windows, TCP/IP.

Find out more. Call 1-800-782-7428.

Circle 222 on Inquiry Card.

Communicating with a Higher Intelligence
GMM Sync4/CCP™
• High Performance 16 MHz 16 bit CPU,
• 80X66 code compatible
• 4 Sync/Async Ports, RS232, RS422, RS485 (2 Serial Ports with Full Duplex DMA)
• Uses 256K 85230, 85320 SCC chip
• 512K Dual Ported Ram (STD) (1, 2, or 4 MEG Dual Port Ram - optional).
• 8k, 16k, 32k, 64k Window Size (Programmable)
• 8 Software Selectable and Shareable Interrupts.
• Two Port COM, CoProcessor also available (GMM Sync/CCP™).

GMM Products Are Made in USA.
GMM Research Corporation
21909 Sky Park South - Unit E, Irvine CA 92714
(714)752-9447 Fax (714)752-7335

Circle 213 on Inquiry Card.
Rhetorex Voice Processing boards make CTI a reality.

If you’re asking “what’s CTI,” you’re missing one of the hottest new technologies going. Computer Telephony Integration links PC-based computer applications to the telephone network, providing voice/fax mail, interactive voice response, voice/fax servers and more.

Interested? Maybe you’re already developing a CTI application. Then it’s time to discover Rhetorex™.

For the best value in CTI technology—from our 2 and 4 port DSP-based voice and fax processing boards, to our 24-port platform—give Rhetorex a call. And start making CTI a reality today.

Rhetorex, Inc., 200 E. Hacienda Ave., Campbell, CA 95008-6617
Tel. (408) 370-0881; Fax (408) 370-1171

All trademarks identified by the ™ symbol are trademarks of Rhetorex, Inc. All other trademarks belong to their respective owners. © 1993 Rhetorex, Inc.
Data Acquisition

**PC-based Solutions for Industrial Automation**
- Industrial PCs & Workstations
- Enclosures and Card Cages
- 486/336/286 CPU Cards
- RAM/ROM Disks
- Industrial I/O Cards
- RS-232/422/485

1-800-800-6889
1-410-245-6678 in CA
Fax: 410-245-8266

**ADVANTECH**
720 East Arques Ave.
Sunnyvale, CA 94086

New 96-page Solution Guide FREE!

**24-BIT A/D CONVERTER**

$495

Money back guarantee
800-321-5355

**Lawson Labs, Inc.**
74th Ave. NW
Kahului, MA 98901
406-257-5355 or FAX 257-5572

We manufacture a broad line of data acquisition products.

**Measurement & Control**

Remote monitoring? Unique measurement problem? These are our specialties. Contact Eleox. We'll help you find a solution...fast!

**ELEXOR**
...The Solutions Company!

**Data Acquisition for Notebook PCs**
- High-speed, PC parallel-port connection
- 2-ch D/A & 16-ch, 100-kHz A/D
- 32 digital I/Os
- 16 high-speed digital inputs
- 5 counter/timer channels
- AC or battery operable
- MS Windows graphical software

**DaqBook/100**

**The Intelligent Solution For Data Acquisition**

**DAP 3200e™ Data Acquisition Processor**
- Analog I/O to 32K samples per second
- Digital I/O to 2M samples per second
- Up to 512 analog inputs on one DAP
- Up to 128 digital inputs/output
- 16-bit or 32-bit resolution ADCs
- FFT and FIR-filtering on board DSP
- CPIC 1186 or 1486

Send for FREE catalog and demo diskette.
Or call us at (206) 453-2345.

**The Classic Color Transportable PC**
- Available in 486-33/50/66 system or in a 386 enclosure
- Build-in 10" color SVGA Sony Trinitron monitor
- 6 Slots with full 3 half arrangement
- 2 x 5.25" DD and 1 x 3.5" HDD bay

** WRITE ONCE CD SYSTEM**

Including a Phillips CDD-521 write once drive, SCSI interface card, cable, software for CD-ROM and CD-Audio and 5 blank discs.
**Disk & Optical Drives • Diskettes/Duplicators**

---

**SyQuest**

**REMOVABLE CARTRIDGE DRIVE SOLUTIONS**

**INTERNAL SUBSYSTEMS**

- 44MB
- 88MB
- 105MB

**$325**

**EXTERNAL SUBSYSTEMS**

- 44MB
- 88MB
- 105MB

**$395**

All subsystems include drive, cartridge, 16-bit SCSI adapter, cables, and documentation. External subsystems are FCC Class B and UL approved.

**ACCESSORIES**

- SQ-3105A (105MB IDE Drive): **$350**
- SQ-400 (44MB Cartridge): **$55**
- SQ-800 (88MB Cartridge): **$65**
- SQ-310 (105MB Cartridge): **$60**
- 16-Bit SCSI, IDE & Floppy Ctrl.: **$150**

Circle 230 on Inquiry Card.

---

**Take SCSI To It’s **Speed Limit!**

**SCSI Vue Terminator**

**High-Performance Active Diagnostic**

**$59**

**Features**

- Active Regulation
- Status Indicators
- Gold Contacts
- Faster
- Improved SCSI Bus Performance
- More Reliable Data Transfer
- Improved SCSI Diagnostic
- Analyses Signal Quality

**patent pending**

**DOS • MAC • UNIX**

Circle 227 on Inquiry Card (RESELLERS: 228).

---

**Victory Printing Disk Factory**

**800-727-DISK (3475)**

**Features**

- Automatically loads, formats, copies, verifies, and prints
- 100% 0.7-inch gold plating
- Designed for use with a network or any application
- Perfect for serializing or otherwise identifying specific diskettes.

Circle 231 on Inquiry Card.
AX 1000 DISKETTE DUPLICATORS
RAPID REPRODUCTION
Simple Fast Smart Reliable

- Formats, copies & verifies
- New High Speed Controller Brd.
- Up to 180 MB/hr.
- 100,000 Diskette Life Cycle
- Reliable Teac Drives
- 1 year warranty (except drives)
- 30 Day warranty on drives

UNFORMATTED 360K 1.2MB 720K 1.44MB 2.88M
Time for 1 Disk 40S 68S 80S 80S 80S
Disk Copied 10S 17S 20S 20S 20S
Disks/hr. 360 211 189 180 180
Disks/8 hrs. 2880 1688 1440 1440 1440

AXIOMATIC TECHNOLOGIES CORPORATION
4995 TIMBERLEA BLVD., UNIT 9
MISSISSAUGA, ONT. L4W 2S9
TEL: (905) 602-9270 FAX: (905) 602-9279
Circle 185 on Inquiry Card (RESELLERS: 186).

Money Back Guarantee & 1 Yr. Warranty

Popular Space-Saver Keyboard $98.00
Saves 60% desk space. Footprint 27.3 x 15.2 cm. 100 full-travel tactilely responsive keys. Standard left-right spacing for easy touch typing. IBM XT/AT PS/2 compatible. Many language versions available.

Call Toll Free To Order: 1-800-DATALUX
DATALUX
155 Aviation Dr. Winchester, VA 22602
Tel 1-703-662-1500 FAX 1-703-662-1682
Auto-FAXed Specs FAX 1-703-662-1675
Circle 190 on Inquiry Card.

International Marketers:
Sell your computer products in one of the fastest growing markets today!
REACH 78,000 LATIN AMERICAN BYTE READERS
Now you can advertise in 1, 2, or all 3 Latin editions of BYTE:
BYTE Mexico
BYTE Brazil
BYTE Argentina
Give Liz at Global Ad-Net a call today for more info: 603-876-4311.

Circle 187 on Inquiry Card.
Most Cost-effective Pen Based Personal Information Processor Meets Your Specific Needs.

Infomax
- Model J: For project design
- Model CFX: Universal Fax computer

Programmability
- Very easy-to-use 4GL for different information processing
- Development System on VGA PC for downloading the applications

Data Compatibility
- DOS file system compatible
- dbt, wtx, pnc, bmp, txt, etc. compatible

Communication
- RS232, Modem, Fax, Infrared, Radio frequency links available

Cost
- Very reasonable

DIALOGUE TECHNOLOGY CORP.
2nd Fl., 38, Ching Shing Rd., Wen Shan District. 117,
Taipei, Taiwan, R.O.C.
TEL: 886-2-9327680
FAX: 886-2-9317814

Circle 235 on Inquiry Card.

Boost data entry speed, accuracy and convenience with Genovation’s Micropad™ the innovative numeric keypad for portable computers.

Is the unhandy numeric section of your portable computer’s keyboard dragging you down?...Give your productivity a boost by using our Micropad. The ergonomically designed Micropad is ideal for spreadsheets and accounting applications that require fast and accurate entry of numeric data.

The Micropad attaches to the parallel port of any MS-DOS computer while providing a clean pass through connection to the printer. Power usage is negligible. Lightweight and compact, the Micropad is fully compatible with and programmable under both DOS and Windows. It is also available with connectors to fit keyboard and serial ports.

TO COMPUTER

TO PRINTER

17741 Mitchell, North Irvine, CA 92714 USA
TEL: (714) 833-3355
FAX: (714) 833-0922
(800) 822-4333

Circle 192 on Inquiry Card.

Convert obsolete RAM into useful RAM
NEW BOARD retrofits surplus memory into a SIMM module format

DIP to SIMM
Board Only (You Solder) $ 6.50
Send your Chips (We Solder) $ 8.50

SIP to SIMM
Send Your SIP Modules & We Retrofit to SIMM $13.50

AUTO TIME
24 Hr Faxback (943)-452-9488

Circle 236 on Inquiry Card.

DIP to SIMM

Circle 231 on Inquiry Card.

STAND-ALONE LCD MONITORS
STN Color or Monochrome

New Dual-Scan!

$1595 | DATALUX introduces its new high quality, high brightness color LCD monitor in the same case as the popular Monochrome version.
- 640 X 480, 236 Colors, VGA compatible, 2 CCFL backlight
- Driven by ISA Bus Controller Card, no external power supply, optional CRT output
- Adjustable desk stand, folds for wall mounting or portability, 1.75Kg weight
- 197 X 147m display (9.4 inch diag), non-reflective glass face
- Contrast ratio of 151:1, 200ms Rise and 150ms Fall time

$795 | Monochrome version 640 X 480, 64 gray shades.
- Wide viewing angle.

Also Available
- Mobile/Industrial model sealed against spills and splashes in rugged drawn aluminum housing with optional swivel mount.
- Touch Screen Version. Capacitive technology. Provides high resolution, fast response, all glass scratch proof optically clear sensor. Complete with built-in controller and software.

To Order Call Toll-Free: 1-800-DATALUX

DATALUX
185 Aviation Drive • Winchester, VA 22602

Circle 189 on Inquiry Card.

January 1994 Byte 297
Programmable Hardware

Special Introductory Price
32-pin version: $895
48-pin version: $1495

To order, call:
1-800-3-DatalO,
Ext. 911
(1-800-332-8246)

Also distributed by:
Promark Technology West
(1-800-227-3345)

JDR Microdevices
(1-800-538-5000)

DATA I/O

Circle 219 on Inquiry Card.

Scanners/OCR/Digitizers • Tape Drives

SPECIAL DEALS ON SCANNERS

AV1 00 - AVISION Gray, Desk/Laptop Scanner
600 DPI, Built-in ADP, Direct print to Printer
iPhoto Plus & OCR (Laptop adapter additional)
$1000.00 $556.67

AV680G - AVISION 256 Gray, Batch scanner
Max. 1,600x1,600 DPI, Legal Size, OCR
$1300.00 $780.99

AV660C - AVISION 24-Bit, True Color Flash Photo Scanner
Max. 1,200 DPI, Legal Size, iPhoto Plus & OCR
$1300.00 $890.99

AV680C - AVISION 24-Bit, True Color Flash Photo Scanner
24 Bit, 1,200 DPI in Flashed Image, Fast OCR
$1300.00 $1440.00

AV 900 - AVISION High-speed (105mm) Scanner
$1200.00 $855.99

Flashy Transparence Scanning Adapter
$600.00 $250.00

MOTHERBOARDS WITH CPU STARTING FROM $890.67 CP

COMPUTERS • MORE

A DIVISION OF LITECH CORPORATION
1-800-548-3246
LITECH CORP. • 164 N. MAIN ST., LOUISBURG, N.C. 27549
TECHNICAL SUPPORT: 1-800-LITECH-5

VARs and Dealers welcome! PHONE (919) 496-2669 FAX (919) 496-7111
VISION IS THE REGISTERED TRADE NAME OF AVISION INC. • PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

Circle 239 on Inquiry Card.

UNIVERSAL/GANG PROGRAMMERS

ALL-07

Fill ALL of your EPROMs, PLDs, GAL, FGPA, MPU, TTL...
programming and testing needs with one unit!

• Supports virtually ALL programmable devices.
• Supports DIP, PLCC, QFP, SOP, PGA... up to 256 pins.
• Gang programming option for production.
• Free software updates via BBS.
• Algorithms approved by IC manufacturers.

HIO-Systems

4438B S. GRIMMER BLVD., FREMONT, CA 94538

TEL (510) 623-8860
FAX (510) 623-7260

Circle 239 on Inquiry Card.

MICROCONTROLLERS

• C Programmable
• Data Acquisition
• Control / Test

Excellent Support
From $159 Qty 1
New Keyboard
display Modules

Use our Little Giant™ and Tiny Giant™ miniature controllers to computerize your product, plant or test department. Features build-in power supply, digital I/O to 48+ lines, serial I/O (RS232 / RS485), A/D converters to 20 bits, solenoid drivers, time of day clock, memory, watchdog, field wiring connectors, up to 6 X 40 LCD with graphics, and more! Our $195 Interactive Dynamic C™ makes software development easy. You're only one phone call away from a total solution.

Z-World Engineering

1724 Picasso Ave., Davis, CA 95616 (916) 757-3737 Fax: (916) 753-5141
Automatic Fax: (916) 753-0618 (Call from your fax, request catalog #18)

Circle 221 on Inquiry Card.

9 Track/3480 Tape Subsystems

1/4" DAT 8mm Optical
Windows Software Now Available

• Tape Backup and Restore
• Make Your Own CD Rom
with our CD ROM Maker
• Optical Storage From $995

CALL 1-800-938-TAPE
Get The Very Best For Less

Laguna Data Systems

7340 Smoke Ranch Road, Suite C, Las Vegas, NV 89128
Tel: (702) 254-2648 Fax: (702) 254-0910

Circle 197 on Inquiry Card.

9-TRACK FOR PCs

Mainframe PC Data Interchange

Rock solid solutions, rock bottom prices.
Direct from the manufacturer. 1600/3220/6250 bpi.
• The most trusted name in 9-track, since 1980
• Powerful, easy-to-use software tools included

Overland Data Inc.

800-729-8725
7 AM - 5 PM Pacific Time

Ask about 3480 with IDR

Circle 201 on Inquiry Card.
DAQ Designer is a free software tool that helps determine which hardware and software combinations are best for your PC-based data acquisition system. DAQ Designer will (1) ask questions about your application, (2) analyze your answers to determine your system needs, and (3) describe what hardware and software you need to develop your data acquisition system.

**National Instruments**

6504 Bridge Point Parkway
Austin, TX 78730
(512) 794-0100 • (800) 433-3488

Circle 200 on Inquiry Card.
dBASE Data Entry

The TransTerm 5 is a work station data entry/display terminal for on-line shop floor data collection into PC/AT/PS-2 systems. The unit is one of a family of such terminals which feature LC displays for operator prompting and data entry via sealed touch keys or an optional barcode scanner or badge reader (Code39, UPC+). A multiple-arrival network controller (up to 250 stations) and a dBASE IV compatible software package are also available. System costs start below $300 per station. Options include display backlighting, barcode scanning, counter inputs, control output.

COMPUTERWISE®
302 N. Winchester • Olathe, KS 66062
913-829-0600 • 800-255-3739 • FAX 913-829-0810

Circle 188 on Inquiry Card.

PCTeX
Typesetting Software

This complete typesetting system makes your books, manuals, articles, & math formulas look their best!

For a FREE CATALOG & DEMO DISK, call 800/808-7906
Penomal TEC, Inc. 12 Madrona Street Mill Valley, CA 94941 Fax: 415/388-8865

Circle 202 on Inquiry Card.

TCP/IP
Windows Developer's Kit
• Binary TCP/IP Transport
• PDS for DOS
• Windows Sockets API
Development Components

winsock.dll is a dynamic link library (DLL) which allows windows applications to dynamically bind for TCP/IP services. The winsock.h, .lib, .def files are also provided for the C/C++ developer.
build contains the source and executables for Windows Sockets finger client. This is useful for testing winsock, configuring the build environment, and as an example of both message-based and synchronous Windows Sockets programming.

winsock.HTL provides online help for Windows Sockets versions 1.1.

For More Information Call 1 (800) 541-9506 (805) 494-2129 • Fax (805) 494-3928

Circle 221 on Inquiry Card.

Windows

You love videography. It's your life. So why get involved with a video editing system that seems attractive now, but can't accommodate your needs in the future? An editing system that shows signs of age as soon as your entry-level video devices have to be upgraded?

The beauty of AmiLink CIP for Windows editing system is that it's totally devoted to your career. AmiLink CIP for Windows has been specifically designed to stay with you all the way no matter what it all leads.

The day you're really to improve your abilities in character generation, animation techniques or special effects, AmiLink CIP for Windows will be at your side. When you make the crucial decision to build your business on larger, more sophisticated projects and build a reputation of quality of the same time, AmiLink CIP for Windows will support each and every one of your efforts.

Not too surprising when you consider that AmiLink CIP's partners are video people not computer people. AmiLink CIP for Windows is from RGB, the same company delivering pro-quality editing to pro-editors and Video Toaster users all across the country.

Are you about to marry an editing system that can't keep up with your career?

So shuffle over to your AmiLink dealer today. Or call RGB for more information about AmiLink CIP for Windows, the video editing system that will never let you down.

For more information call 1-800-515-8766 or write to:
AmiLink Product Group
4152 Blue Heron Blvd. Suite 116 Riviera Beach, FL 33404

Circle 206 on Inquiry Card (RESELLERS: 207).

POWER & PRECISION
Scientific Graphs and Statistics

Advanced Capabilities in a next generation product. Used and tested by over 35,000 scientists and engineers worldwide.

Error-free performance, total control and flexibility, hundreds of templates and samples, full support for all types of data files, ease of use, and free tech support make Plot-IT 3.0 your best scientific graphing software choice. We are so confident you will find Plot-IT 3.0 for WINDOWS to be an indispensable research tool, we offer a 60-day money back guarantee.

Circle 282 on Inquiry Card (RESELLERS: 283).

VIR TUAL OFFICE

Project Any Image!

Call: 800-969-4411 Fax: 408-444-5196

Circle 209 on Inquiry Card.
THE BUYER'S MART is a unique classified section organized by product category to help readers locate suppliers. Each ad has Inquiry numbers to aid readers requesting information from advertisers. Ad space is $195 for 2 ads/issue. Each ad will be designed and typeset by BYTE. Do NOT send logos or camera-ready artwork. Advertisers should furnish typewritten copy. 2"x1" ads can include headline (23 characters maximum), descriptive text (300 characters is the maximum recommended) plus company name, address, telephone and fax number. 2"x2½" ad has more space for descriptive text (850 characters is the maximum recommended).

DEADLINE: Ad copy is due approximately 2 months prior to issue date. For example: November issue closes on September 8. Send your copy and payment by September 30. For more information call: Margot Gnade at 603-924-2656. FAX: 603-924-2683.

RATES (Jan. 1994)

<table>
<thead>
<tr>
<th>Size</th>
<th>Issue 3</th>
<th>Issue 6</th>
<th>Issue 11</th>
<th>Issue 12</th>
<th>Issue 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>2½'x4&quot;</td>
<td></td>
<td>$696</td>
<td>$666</td>
<td>$585</td>
<td>$557</td>
</tr>
<tr>
<td>2 ads/issue</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3 ads/issue</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2&quot;x2½&quot;</td>
<td></td>
<td>$1,392</td>
<td>$1,336</td>
<td>$1,170</td>
<td>$1,114</td>
</tr>
<tr>
<td>2 ads/issue</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3 ads/issue</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

A DIRECTORY OF PRODUCTS AND SERVICES
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>228</td>
<td>294</td>
<td>214-380-0126</td>
<td>229</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>230</td>
<td>294</td>
<td>214-380-0126</td>
<td>231</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>232</td>
<td>294</td>
<td>214-380-0126</td>
<td>233</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>234</td>
<td>294</td>
<td>214-380-0126</td>
<td>235</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>236</td>
<td>294</td>
<td>214-380-0126</td>
<td>237</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>238</td>
<td>294</td>
<td>214-380-0126</td>
<td>239</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>240</td>
<td>294</td>
<td>214-380-0126</td>
<td>241</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>242</td>
<td>294</td>
<td>214-380-0126</td>
<td>243</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>244</td>
<td>294</td>
<td>214-380-0126</td>
<td>245</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>246</td>
<td>294</td>
<td>214-380-0126</td>
<td>247</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>248</td>
<td>294</td>
<td>214-380-0126</td>
<td>249</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>250</td>
<td>294</td>
<td>214-380-0126</td>
<td>251</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>252</td>
<td>294</td>
<td>214-380-0126</td>
<td>253</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>254</td>
<td>294</td>
<td>214-380-0126</td>
<td>255</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>256</td>
<td>294</td>
<td>214-380-0126</td>
<td>257</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>258</td>
<td>294</td>
<td>214-380-0126</td>
<td>259</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>260</td>
<td>294</td>
<td>214-380-0126</td>
<td>261</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>262</td>
<td>294</td>
<td>214-380-0126</td>
<td>263</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>264</td>
<td>294</td>
<td>214-380-0126</td>
<td>265</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>266</td>
<td>294</td>
<td>214-380-0126</td>
<td>267</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>268</td>
<td>294</td>
<td>214-380-0126</td>
<td>269</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>270</td>
<td>294</td>
<td>214-380-0126</td>
<td>271</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>272</td>
<td>294</td>
<td>214-380-0126</td>
<td>273</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>274</td>
<td>294</td>
<td>214-380-0126</td>
<td>275</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>276</td>
<td>294</td>
<td>214-380-0126</td>
<td>277</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>278</td>
<td>294</td>
<td>214-380-0126</td>
<td>279</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>280</td>
<td>294</td>
<td>214-380-0126</td>
<td>281</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>282</td>
<td>294</td>
<td>214-380-0126</td>
<td>283</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>284</td>
<td>294</td>
<td>214-380-0126</td>
<td>285</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>286</td>
<td>294</td>
<td>214-380-0126</td>
<td>287</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>288</td>
<td>294</td>
<td>214-380-0126</td>
<td>289</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>290</td>
<td>294</td>
<td>214-380-0126</td>
<td>291</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>292</td>
<td>294</td>
<td>214-380-0126</td>
<td>293</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>294</td>
<td>294</td>
<td>214-380-0126</td>
<td>295</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
<tr>
<td>296</td>
<td>294</td>
<td>214-380-0126</td>
<td>297</td>
<td>294</td>
<td>214-380-0126</td>
</tr>
</tbody>
</table>

To order products or request FREE information, call advertisers directly or send in the Direct Link Card by mail or fax! Let them know you saw it in BYTE!
## YOUR DIRECT LINK

### PRODUCT CATEGORY INDEX

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on Your Direct Link Card!

To receive information for an entire product category, circle the category number on Your Direct Link Card!

<table>
<thead>
<tr>
<th>Category No.</th>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ACCESSORIES/SUPPLIES</td>
<td>526</td>
<td>ANTEX ELECTRONICS 401S 10</td>
</tr>
<tr>
<td>2 ADD-IN BOARDS</td>
<td>242-243</td>
<td>AMERICAN MEGATRENDS 170</td>
</tr>
<tr>
<td>3 BAR CODING</td>
<td>214</td>
<td>VIDEK, INC.</td>
</tr>
<tr>
<td>4 COMMUNICATIONS/NETWORKING</td>
<td>248-249 DCA</td>
<td>129</td>
</tr>
<tr>
<td>5 COMPUTER SYSTEMS</td>
<td>240-241 ADVANCED LOGIC RESEARCH</td>
<td>116</td>
</tr>
<tr>
<td>6 DATA ACQUISITION</td>
<td>182-183 ALPHA PRODUCTS</td>
<td>293</td>
</tr>
<tr>
<td>7 DISK &amp; OPTICAL DRIVES</td>
<td>238</td>
<td>CD-ROM, LLC</td>
</tr>
<tr>
<td>8 DISKETTES/DUPLICATORS</td>
<td>185-186</td>
<td>AXIOMATIC</td>
</tr>
<tr>
<td>9 GRAPHICS TABLETS/MICE/PEN INPUT</td>
<td>140-141</td>
<td>ARISTO GRAPH SYSTEMS (EUROPE) 53</td>
</tr>
<tr>
<td>10 HARDWARE</td>
<td>502-503</td>
<td>COMPLEX INC (INT'L) 143</td>
</tr>
<tr>
<td>11 KEYBOARDS</td>
<td>501</td>
<td>CHERRY MICROSOFT CORPORATION (INT'L) 232-233</td>
</tr>
<tr>
<td>12 LAN HARDWARE</td>
<td>506-507</td>
<td>CYBEX CORPORATION 127</td>
</tr>
<tr>
<td>13 LAMPS &amp; NOTEBOOKS</td>
<td>238</td>
<td>AMIRA COMPUTER CORPORATION (N.A.) 44-45</td>
</tr>
<tr>
<td>14 MAIL ORDER</td>
<td>277</td>
<td>ADD NET COMPUTERS &amp; SOFTWARE 274</td>
</tr>
<tr>
<td>15 MEMORY/CHIPS/UPGRADES</td>
<td>288</td>
<td>ADVANCED MICROS 34-35</td>
</tr>
<tr>
<td>16 MISCELLANEOUS HARDWARE</td>
<td>32-33</td>
<td>ALTRONIC Microsystems 209</td>
</tr>
<tr>
<td>17 MODEMS/MULTIPLEXORS</td>
<td>326-327</td>
<td>PROXIMA CORPORATION 267</td>
</tr>
<tr>
<td>18 MONITORS &amp; TERMINALS</td>
<td>288</td>
<td>PC DIGESTRISTL 101</td>
</tr>
<tr>
<td>19 MULTIMEDIA</td>
<td>326-327</td>
<td>OPTICAL DRIVES 30</td>
</tr>
<tr>
<td>20 PRINTERS/PLOTTERS</td>
<td>288</td>
<td>PC DIGESTRISTL 101</td>
</tr>
<tr>
<td>21 PROGRAMMABLE HARDWARE</td>
<td>326-327</td>
<td>DATA ORDER 30</td>
</tr>
<tr>
<td>22 SCANNERS/OCR/DIGITIZERS</td>
<td>326-327</td>
<td>ELMIRIUM MICROCOMPUTERS 209</td>
</tr>
</tbody>
</table>

---

**YOUR DIRECT LINK**

**PRODUCT CATEGORY INDEX**

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on Your Direct Link Card!

To receive information for an entire product category, circle the category number on Your Direct Link Card!
<table>
<thead>
<tr>
<th>Category No.</th>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>282-283</td>
<td>SCIENTIFIC PROGRAMMING</td>
<td></td>
</tr>
<tr>
<td>61-62</td>
<td>ABACUS SOFTWARE</td>
<td></td>
</tr>
<tr>
<td>202</td>
<td>PERSONAL TEX</td>
<td></td>
</tr>
<tr>
<td>123-125</td>
<td>WOLFRAM RESEARCH</td>
<td></td>
</tr>
<tr>
<td>128-129</td>
<td>ITERATED SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>204</td>
<td>QUALSTAR CORP</td>
<td></td>
</tr>
<tr>
<td>233-234</td>
<td>SHAFFSTALL CORPORATION</td>
<td></td>
</tr>
<tr>
<td>181</td>
<td>S. A. G. ELECTRONICS</td>
<td></td>
</tr>
<tr>
<td>24 UPS</td>
<td>AMERICAN POWER CONVERSION</td>
<td></td>
</tr>
<tr>
<td>98</td>
<td>MINUTEXMAN</td>
<td></td>
</tr>
<tr>
<td>101-102</td>
<td>PC POWER &amp; COOLING</td>
<td></td>
</tr>
<tr>
<td>250-251</td>
<td>PC POWER &amp; COOLING</td>
<td></td>
</tr>
<tr>
<td>25 BUSINESS</td>
<td>PATTON &amp; PATTON</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>PRODEA SOFTWARE CORPORATION</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>SCITOR CORPORATION</td>
<td></td>
</tr>
<tr>
<td>26 CAD/CAM</td>
<td>ARISTO GRAPHIC SYSTEMS (EUROPE)</td>
<td>53</td>
</tr>
<tr>
<td>140-141</td>
<td>ARISTO GRAPHIC SYSTEMS (U.S.)</td>
<td>53</td>
</tr>
<tr>
<td>254-255</td>
<td>INTERGRAPH (N.A.)</td>
<td>152-153</td>
</tr>
<tr>
<td>218</td>
<td>WINTER CORP</td>
<td></td>
</tr>
<tr>
<td>27 COMMUNICATIONS/NETWORKING</td>
<td>ARINET CORPORATION</td>
<td></td>
</tr>
<tr>
<td>177-178</td>
<td>DCA</td>
<td>129</td>
</tr>
<tr>
<td>248-249</td>
<td>FUTURESOF ENGINEERING</td>
<td></td>
</tr>
<tr>
<td>247</td>
<td>WINS - NETWORKING SYSTEMS</td>
<td>40/5-7</td>
</tr>
<tr>
<td>513</td>
<td>ODYSSEY TECHNOLOGIES</td>
<td>40/5/4</td>
</tr>
<tr>
<td>517-518</td>
<td>ORION TELECOM INC</td>
<td>290</td>
</tr>
<tr>
<td>175</td>
<td>PERSOFT INC</td>
<td>76</td>
</tr>
<tr>
<td>137</td>
<td>SOFTWARE</td>
<td>184</td>
</tr>
<tr>
<td>210</td>
<td>SOFTWARE LINK, THE</td>
<td>299</td>
</tr>
<tr>
<td>276-277</td>
<td>VISIONWARE</td>
<td></td>
</tr>
<tr>
<td>28 DATA ACQUISITION</td>
<td>MICROSTAR LABORATORIES</td>
<td>296</td>
</tr>
<tr>
<td>290</td>
<td>NATIONAL INSTRUMENTS</td>
<td>296</td>
</tr>
<tr>
<td>29 DATABASE</td>
<td>COMPUTER ASSOCIATES</td>
<td>125</td>
</tr>
<tr>
<td>244</td>
<td>COMPUTER ASSOCIATES</td>
<td>133</td>
</tr>
<tr>
<td>245</td>
<td>COMPUTER ASSOCIATES</td>
<td>133</td>
</tr>
<tr>
<td>152</td>
<td>COMPUTER DISCOUNT WAREHOUSE</td>
<td>264-265</td>
</tr>
<tr>
<td>508-509</td>
<td>DR HUGGLE &amp; PARTNER GMBH</td>
<td>40/5/11</td>
</tr>
<tr>
<td>219</td>
<td>WORDERFECT CORPORATION</td>
<td>30-31</td>
</tr>
<tr>
<td>30 EDUCATIONAL</td>
<td>ABACUS SOFTWARE</td>
<td>42</td>
</tr>
<tr>
<td>61-62</td>
<td>MCGRAW HILL NRI (N.A.)</td>
<td>182-57</td>
</tr>
<tr>
<td>31 ENGINEERING/SCIENTIFIC</td>
<td>DR HUGGLE &amp; PARTNER GMBH</td>
<td>40/5/11</td>
</tr>
<tr>
<td>509-509</td>
<td>DR HUGGLE &amp; PARTNER GMBH</td>
<td>40/5/11</td>
</tr>
<tr>
<td>255</td>
<td>ITERGRAPH (N.A.)</td>
<td>152-153</td>
</tr>
<tr>
<td>128-129</td>
<td>ITERATED SYSTEMS</td>
<td>249</td>
</tr>
<tr>
<td>202</td>
<td>PERSONAL TEX</td>
<td>300</td>
</tr>
<tr>
<td>282-283</td>
<td>SCIENTIFIC PROGRAMMING</td>
<td>300</td>
</tr>
<tr>
<td>123-125</td>
<td>WOLFRAM RESEARCH</td>
<td>99</td>
</tr>
<tr>
<td>32 32 ENTERTEINMENT</td>
<td>METATEC SYSTEMS</td>
<td>288</td>
</tr>
<tr>
<td>33 33 GRAPHICS</td>
<td>AITECH INTERNATIONAL</td>
<td>235</td>
</tr>
<tr>
<td>140-141</td>
<td>ARISTO GRAPHIC SYSTEMS (EUROPE)</td>
<td>53</td>
</tr>
<tr>
<td>140-141</td>
<td>ARISTO GRAPHIC SYSTEMS (U.S.)</td>
<td>53</td>
</tr>
<tr>
<td>79</td>
<td>COREL SOFTWARE</td>
<td>25</td>
</tr>
<tr>
<td>128-139</td>
<td>USA 92 - 93 - 94 - CSE</td>
<td>156</td>
</tr>
<tr>
<td>92-93</td>
<td>NANO USA CORP (N.A.)</td>
<td>299</td>
</tr>
<tr>
<td>99</td>
<td>PASSPORT DESIGNS INC.</td>
<td>36-39</td>
</tr>
<tr>
<td>35 MAIL ORDER</td>
<td>COMPUTER DISCOUNT WAREHOUSE</td>
<td>264-265</td>
</tr>
<tr>
<td>505</td>
<td>COMPUTER-QUICK (INTL)</td>
<td>240</td>
</tr>
<tr>
<td>512</td>
<td>GREY MATTER LTD</td>
<td>40/5/17</td>
</tr>
<tr>
<td>91</td>
<td>PROGRAMMER'S PARADISE</td>
<td>90-61</td>
</tr>
<tr>
<td>36 36 MATHEMATICAL/STATISTICAL</td>
<td>MACSYMA</td>
<td>98</td>
</tr>
<tr>
<td>525</td>
<td>NAG</td>
<td>40/5/22</td>
</tr>
<tr>
<td>113</td>
<td>PERSONAL TEX</td>
<td>300</td>
</tr>
<tr>
<td>116-115</td>
<td>STATSOFT</td>
<td>244</td>
</tr>
<tr>
<td>125-125</td>
<td>WOLFRAM RESEARCH</td>
<td>99</td>
</tr>
<tr>
<td>37 37 MISCELLANEOUS SOFTWARE</td>
<td>DIAGSOFT INC</td>
<td>57</td>
</tr>
<tr>
<td>523</td>
<td>FINSON (INTL)</td>
<td>33</td>
</tr>
<tr>
<td>524</td>
<td>ON TIME MARKETING</td>
<td>40/5/21</td>
</tr>
<tr>
<td>534</td>
<td>TYPHOON SOFTWARE</td>
<td>275</td>
</tr>
<tr>
<td>38 38 ON-LINE SERVICES</td>
<td>AMERICA ONLINE INC (N.A.)</td>
<td>242A-B</td>
</tr>
<tr>
<td>565</td>
<td>SIX</td>
<td>211</td>
</tr>
<tr>
<td>564</td>
<td>COMPUSERVE</td>
<td>96A-9</td>
</tr>
<tr>
<td>276-277</td>
<td>MILLENNIUM ONLINE</td>
<td>118</td>
</tr>
<tr>
<td>39 39 OPERATING SYSTEMS</td>
<td>IBM - PERSONAL SW SYSTEMS</td>
<td>145-147</td>
</tr>
<tr>
<td>253</td>
<td>NETWORK COMPUTING DEVICES (N.A.)</td>
<td>161</td>
</tr>
<tr>
<td>107</td>
<td>QUARTERDECK OFFICE SYSTEMS</td>
<td>61</td>
</tr>
<tr>
<td>40 PROGRAMMING LANGUAGES/TOOLS</td>
<td>COBALT BLUE</td>
<td>40/5/21</td>
</tr>
<tr>
<td>504</td>
<td>COPA INTERNATIONAL LTD.</td>
<td>240</td>
</tr>
<tr>
<td>508-509</td>
<td>DR HUGGLE &amp; PARTNER GMBH</td>
<td>40/5/11</td>
</tr>
<tr>
<td>191</td>
<td>GREENVIEW DATA</td>
<td>71</td>
</tr>
<tr>
<td>292</td>
<td>IBM - NETWORKING SYSTEMS</td>
<td>100</td>
</tr>
<tr>
<td>293</td>
<td>IBM - NETWORKING SYSTEMS</td>
<td>114-115</td>
</tr>
<tr>
<td>65</td>
<td>IBM - 92 - 93 - 94 - CSE</td>
<td>156</td>
</tr>
<tr>
<td>84</td>
<td>IBM - OSI-2 - OSI</td>
<td>23</td>
</tr>
<tr>
<td>112</td>
<td>IBM - PERSONAL SW SYSTEMS</td>
<td>151</td>
</tr>
<tr>
<td>251</td>
<td>IBM - PERSONAL SW SYSTEMS</td>
<td>149</td>
</tr>
<tr>
<td>138-139</td>
<td>LEAD TECHNOLOGIES</td>
<td>198</td>
</tr>
<tr>
<td>522</td>
<td>MICROSOFT</td>
<td>130</td>
</tr>
<tr>
<td>524</td>
<td>ON TIME MARKETING</td>
<td>40/5/21</td>
</tr>
<tr>
<td>289</td>
<td>PHIL IP SOFTWARE INC</td>
<td>40/5/2</td>
</tr>
<tr>
<td>289</td>
<td>POPKIN SW &amp; SYSTEMS INC.</td>
<td>175</td>
</tr>
<tr>
<td>91</td>
<td>PROGRAMMER'S PARADISE</td>
<td>80-81</td>
</tr>
<tr>
<td>120</td>
<td>SECURITY SOFTWARE INC</td>
<td>106</td>
</tr>
<tr>
<td>532</td>
<td>SYMANTEC</td>
<td>40/5/15</td>
</tr>
<tr>
<td>534</td>
<td>TYPHOON SOFTWARE (N.E.)</td>
<td>275</td>
</tr>
<tr>
<td>121-122</td>
<td>XVT SOFTWARE INC</td>
<td>82</td>
</tr>
<tr>
<td>41 41 SECURITY</td>
<td>ALADDIN KNOWLEDGE SYSTEMS</td>
<td>65</td>
</tr>
<tr>
<td>63</td>
<td>CHERRY MIKROCHALTERN GMBH (INTL)</td>
<td>282-283</td>
</tr>
<tr>
<td>51 MISCELLANEOUS</td>
<td>BYTE BACK ISSUES (INTL)</td>
<td>153</td>
</tr>
<tr>
<td>519</td>
<td>BYTE EURODECO</td>
<td>223</td>
</tr>
<tr>
<td>520</td>
<td>BYTE EUROPEAN RESELLER (INTL)</td>
<td>161</td>
</tr>
<tr>
<td>61-62</td>
<td>BYTE REPRINTS</td>
<td>152</td>
</tr>
<tr>
<td>522</td>
<td>BYTE SUB MESSAGE</td>
<td>98</td>
</tr>
<tr>
<td>523</td>
<td>DATAFORCE</td>
<td>44-45</td>
</tr>
<tr>
<td>524</td>
<td>DIACOM TELECOM EUROPE</td>
<td>40/5/22</td>
</tr>
<tr>
<td>150</td>
<td>NATIONAL PRODUCTIONS INC</td>
<td>240</td>
</tr>
</tbody>
</table>

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on Your Direct Link Card!

To receive information for an entire product category, circle the category number on Your Direct Link Card!
For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on Your Direct Link Card. Each page number refers to the first page of the article or section in which the company name appears. IS pages appear only in the International edition.

<table>
<thead>
<tr>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>202</td>
</tr>
<tr>
<td>1105</td>
<td>202</td>
</tr>
<tr>
<td>1350</td>
<td>202</td>
</tr>
<tr>
<td>1351</td>
<td>202</td>
</tr>
<tr>
<td>1468</td>
<td>202</td>
</tr>
<tr>
<td>1076</td>
<td>202</td>
</tr>
<tr>
<td>1075</td>
<td>202</td>
</tr>
<tr>
<td>1233</td>
<td>258</td>
</tr>
<tr>
<td>1428</td>
<td>258</td>
</tr>
<tr>
<td>1301</td>
<td>258</td>
</tr>
<tr>
<td>1062</td>
<td>46</td>
</tr>
<tr>
<td>1355</td>
<td>202</td>
</tr>
<tr>
<td>1109</td>
<td>202</td>
</tr>
<tr>
<td>1357</td>
<td>202</td>
</tr>
<tr>
<td>1033</td>
<td>202</td>
</tr>
<tr>
<td>1063</td>
<td>254</td>
</tr>
<tr>
<td>1110</td>
<td>254</td>
</tr>
<tr>
<td>1121</td>
<td>254</td>
</tr>
<tr>
<td>1272</td>
<td>254</td>
</tr>
<tr>
<td>1321</td>
<td>254</td>
</tr>
<tr>
<td>1297</td>
<td>254</td>
</tr>
<tr>
<td>1074</td>
<td>254</td>
</tr>
<tr>
<td>1115</td>
<td>202</td>
</tr>
<tr>
<td>1116</td>
<td>202</td>
</tr>
<tr>
<td>1024</td>
<td>46</td>
</tr>
</tbody>
</table>

For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on Your Direct Link Card. Each page number refers to the first page of the article or section in which the company name appears. IS pages appear only in the International edition.

<table>
<thead>
<tr>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1441</td>
<td>408-13</td>
</tr>
<tr>
<td>1338</td>
<td>408-13</td>
</tr>
<tr>
<td>1448</td>
<td>408-13</td>
</tr>
<tr>
<td>1469</td>
<td>408-13</td>
</tr>
<tr>
<td>1304</td>
<td>408-13</td>
</tr>
<tr>
<td>1020</td>
<td>408-13</td>
</tr>
<tr>
<td>1026</td>
<td>408-13</td>
</tr>
<tr>
<td>1151</td>
<td>202</td>
</tr>
<tr>
<td>1267</td>
<td>202</td>
</tr>
<tr>
<td>1029</td>
<td>46</td>
</tr>
<tr>
<td>1021</td>
<td>46</td>
</tr>
<tr>
<td>1457</td>
<td>46</td>
</tr>
<tr>
<td>1471</td>
<td>408-13</td>
</tr>
<tr>
<td>1472</td>
<td>408-13</td>
</tr>
<tr>
<td>1298</td>
<td>408-13</td>
</tr>
<tr>
<td>1277</td>
<td>408-13</td>
</tr>
<tr>
<td>1030</td>
<td>46</td>
</tr>
<tr>
<td>1281</td>
<td>254</td>
</tr>
<tr>
<td>1278</td>
<td>254</td>
</tr>
<tr>
<td>1477</td>
<td>254</td>
</tr>
<tr>
<td>1031</td>
<td>46</td>
</tr>
<tr>
<td>1333</td>
<td>202</td>
</tr>
<tr>
<td>1244</td>
<td>46</td>
</tr>
<tr>
<td>1223</td>
<td>46</td>
</tr>
<tr>
<td>1430</td>
<td>46</td>
</tr>
<tr>
<td>1034</td>
<td>46</td>
</tr>
<tr>
<td>1213</td>
<td>46</td>
</tr>
<tr>
<td>1035</td>
<td>46</td>
</tr>
<tr>
<td>1447</td>
<td>408-13</td>
</tr>
<tr>
<td>1427</td>
<td>408-13</td>
</tr>
<tr>
<td>1119</td>
<td>408-13</td>
</tr>
<tr>
<td>1363</td>
<td>202</td>
</tr>
<tr>
<td>1286</td>
<td>46</td>
</tr>
<tr>
<td>1072</td>
<td>46</td>
</tr>
</tbody>
</table>

For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on Your Direct Link Card. Each page number refers to the first page of the article or section in which the company name appears. IS pages appear only in the International edition.

<table>
<thead>
<tr>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1479</td>
<td>202</td>
</tr>
<tr>
<td>1284</td>
<td>202</td>
</tr>
<tr>
<td>1326</td>
<td>202</td>
</tr>
<tr>
<td>1121</td>
<td>202</td>
</tr>
<tr>
<td>1122</td>
<td>202</td>
</tr>
<tr>
<td>1330</td>
<td>202</td>
</tr>
<tr>
<td>1166</td>
<td>202</td>
</tr>
<tr>
<td>1154</td>
<td>202</td>
</tr>
<tr>
<td>1038</td>
<td>46</td>
</tr>
<tr>
<td>1079</td>
<td>46</td>
</tr>
<tr>
<td>1027</td>
<td>258</td>
</tr>
<tr>
<td>1436</td>
<td>258</td>
</tr>
<tr>
<td>1158</td>
<td>258</td>
</tr>
<tr>
<td>1039</td>
<td>258</td>
</tr>
<tr>
<td>1132</td>
<td>258</td>
</tr>
<tr>
<td>1040</td>
<td>258</td>
</tr>
<tr>
<td>1510</td>
<td>258</td>
</tr>
<tr>
<td>1026</td>
<td>258</td>
</tr>
<tr>
<td>1110</td>
<td>258</td>
</tr>
<tr>
<td>1223</td>
<td>258</td>
</tr>
<tr>
<td>1039</td>
<td>258</td>
</tr>
<tr>
<td>1359</td>
<td>258</td>
</tr>
<tr>
<td>1021</td>
<td>258</td>
</tr>
<tr>
<td>1115</td>
<td>258</td>
</tr>
<tr>
<td>1107</td>
<td>258</td>
</tr>
<tr>
<td>1362</td>
<td>258</td>
</tr>
<tr>
<td>1382</td>
<td>258</td>
</tr>
<tr>
<td>139</td>
<td>258</td>
</tr>
<tr>
<td>1330</td>
<td>258</td>
</tr>
</tbody>
</table>

For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on Your Direct Link Card. Each page number refers to the first page of the article or section in which the company name appears. IS pages appear only in the International edition.

<table>
<thead>
<tr>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1463</td>
<td>202</td>
</tr>
<tr>
<td>1150</td>
<td>202</td>
</tr>
<tr>
<td>1431</td>
<td>202</td>
</tr>
<tr>
<td>1375</td>
<td>202</td>
</tr>
<tr>
<td>1336</td>
<td>202</td>
</tr>
<tr>
<td>1435</td>
<td>202</td>
</tr>
<tr>
<td>1377</td>
<td>202</td>
</tr>
<tr>
<td>1050</td>
<td>202</td>
</tr>
<tr>
<td>1155</td>
<td>202</td>
</tr>
<tr>
<td>1446</td>
<td>202</td>
</tr>
<tr>
<td>1051</td>
<td>202</td>
</tr>
<tr>
<td>1444</td>
<td>202</td>
</tr>
<tr>
<td>1283</td>
<td>202</td>
</tr>
<tr>
<td>1473</td>
<td>202</td>
</tr>
<tr>
<td>1376</td>
<td>202</td>
</tr>
<tr>
<td>1379</td>
<td>202</td>
</tr>
<tr>
<td>1449</td>
<td>202</td>
</tr>
<tr>
<td>1324</td>
<td>202</td>
</tr>
<tr>
<td>1451</td>
<td>202</td>
</tr>
<tr>
<td>1280</td>
<td>202</td>
</tr>
<tr>
<td>1282</td>
<td>202</td>
</tr>
<tr>
<td>1470</td>
<td>202</td>
</tr>
<tr>
<td>1405</td>
<td>202</td>
</tr>
<tr>
<td>1466</td>
<td>202</td>
</tr>
<tr>
<td>1312</td>
<td>202</td>
</tr>
<tr>
<td>1071</td>
<td>202</td>
</tr>
<tr>
<td>1372</td>
<td>202</td>
</tr>
<tr>
<td>1479</td>
<td>202</td>
</tr>
<tr>
<td>1233</td>
<td>202</td>
</tr>
<tr>
<td>1447</td>
<td>202</td>
</tr>
<tr>
<td>1324</td>
<td>202</td>
</tr>
<tr>
<td>1035</td>
<td>202</td>
</tr>
<tr>
<td>1288</td>
<td>202</td>
</tr>
<tr>
<td>1303</td>
<td>202</td>
</tr>
<tr>
<td>1455</td>
<td>202</td>
</tr>
</tbody>
</table>

For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on Your Direct Link Card. Each page number refers to the first page of the article or section in which the company name appears. IS pages appear only in the International edition.

<table>
<thead>
<tr>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1149</td>
<td>202</td>
</tr>
<tr>
<td>1289</td>
<td>202</td>
</tr>
<tr>
<td>1140</td>
<td>202</td>
</tr>
<tr>
<td>1363</td>
<td>202</td>
</tr>
<tr>
<td>1453</td>
<td>202</td>
</tr>
<tr>
<td>1332</td>
<td>202</td>
</tr>
<tr>
<td>1348</td>
<td>202</td>
</tr>
<tr>
<td>1158</td>
<td>202</td>
</tr>
<tr>
<td>1461</td>
<td>202</td>
</tr>
<tr>
<td>1054</td>
<td>202</td>
</tr>
<tr>
<td>1065</td>
<td>202</td>
</tr>
<tr>
<td>1296</td>
<td>202</td>
</tr>
<tr>
<td>1280</td>
<td>202</td>
</tr>
<tr>
<td>977</td>
<td>202</td>
</tr>
<tr>
<td>1056</td>
<td>202</td>
</tr>
<tr>
<td>1462</td>
<td>202</td>
</tr>
<tr>
<td>1435</td>
<td>202</td>
</tr>
<tr>
<td>1293</td>
<td>202</td>
</tr>
</tbody>
</table>

For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on Your Direct Link Card. Each page number refers to the first page of the article or section in which the company name appears. IS pages appear only in the International edition.

<table>
<thead>
<tr>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1149</td>
<td>202</td>
</tr>
<tr>
<td>1288</td>
<td>202</td>
</tr>
<tr>
<td>1158</td>
<td>202</td>
</tr>
<tr>
<td>1461</td>
<td>202</td>
</tr>
<tr>
<td>1054</td>
<td>202</td>
</tr>
<tr>
<td>1462</td>
<td>202</td>
</tr>
<tr>
<td>1295</td>
<td>202</td>
</tr>
<tr>
<td>1293</td>
<td>202</td>
</tr>
</tbody>
</table>
BIX: Your Coach to the Internet!

Give BIX a try with our new 5 for Free Offer! Join BIX today and get 5 hours of evening and weekend access for free! Take the rest of the calendar month to explore BIX, and then continue for our standard $13 monthly membership fee. Further details and complete rate information are provided during registration. Using any communications program, dial 1-800-695-4882. At the "logon" prompt enter bix. Then at the "name?" prompt enter bix.byte39. If you have any questions, call us at 1-800-695-4775 (voice). Or fax us at 617-491-6642. Send Internet mail to info@bix.com. Windows users can order BIXnav, our graphical interface for BIX, for easy point and click access. Details are available during registration.

The Internet connects you with more than 10 million people, at universities, companies, and other online services. Now, get full access to the Internet free of charge when you subscribe to BIX! You’ll also get expert assistance from BIX moderators who can help you find your way around the Internet.

These experts can guide you through the many services and features available, and help you find the information you’re looking for. Anytime you need help, just join our special "internet" conference and get fast answers to your questions.

As you become more familiar with the Internet, you’ll be able to download files from all over the world using FTP, connect to other sites and services through telnet, read and reply to Usenet Newsgroups, access utilities like finger and whois, and much more! BIX and the Internet together provide the largest and most effective technical resource for computing professionals.

And with over 600 local access numbers in the U.S., plus telnet access via the Internet, BIX makes it easy to connect. Try BIX today through our special 5 for Free offer - and become part of the top technical team!

If you can hack it
Commentary Thornton A. May

Shakespearean Wisdom

There are many similarities between Richard III and an MIS director

Few information technologists remember Cole Porter's admonition in Kiss Me Kate to "brush up your Shakespeare." Fewer still took action on the prolific composer's suggestion. But many contemporary computer technologists share many characteristics with that most infamous of all Shakespeare's characters—Richard III, at least as he appeared in the early pre-tragic parts of the eponymous play.

Professional thespians agree that there is no more sought after and yet no more difficult part to play than Richard III. Indeed, Richard Burbage, the actor who first played Richard III for Shakespeare (ca. 1593–1594), was heard to tell the playwright after opening night, "If you ever do this to me again, I'll kill you."

In a similar vein, the difficulties facing an MIS executive as he or she enacts the role of authoritative technologist in an organization require an ability to:

- Understand how the technology works
- Understand business problems
- Move seamlessly and rapidly between multiple platforms
- Address business problems with technology solutions
- Innovate and manipulate the evolving technological environment
- Prepare the organization for "what's next" technologically

Richard III (unlike all the other Shakespearean tragedies) omits a major fourth act break. To play Richard requires almost supernatural strength, skill, and endurance. An information technologist is also asked to play a bigger-than-life role in his or her organization.

Like Richard, many technologists have turned their uniqueness into a source of power. As organizations emerge from the planning stages of the investment programs that will revitalize their in-place technology infrastructures, the move is away from "stuff you buy cheap" to "stuff you buy smart."

The technologist plays a crucial role in the increasingly important "knowledge space," where money and technology combine to create business value.

In Richard III, the action revolves almost totally around the title character. In a similar fashion, the decisions to acquire and implement technology revolve around the technologist. The technologist, as the central actor operating in the knowledge space, is responsible for identifying, verifying, and specifying how technology budgets will be allocated. There is now a great deal of activity in the knowledge space around reengineering work processes, retraining the user, and, most important, getting the technology to work as promised. Shakespeare may have written, "The play is the thing." An appropriate information age paraphrase might be, "The technology is the thing."

While Richard and contemporary technologists share many behavior traits, it is important to realize that dissimilarities do exist. For one thing, Richard is a great actor. Technologists tend to be less theatrical in nature, less able to make protean shifts in behavior at a moment's notice. They also tend to be truthful and fact-based—nothing is further from the truth for Richard. Another dissimilarity is that Richard is malevolent. Information technologists, for the most part, are not. If they have a flaw, it is that they are too self-effacing and too honest to play the political games that constitute such a lamentably large part of today's employment picture.

A key dissimilarity is that Richard is monodimensional. He has one and only one focus: He wants to be king. When he achieves that objective, he loses momentum and initiative. Instead of being the high-energy, bustling protagonist of the play's early acts, he becomes a sedentary responder to initiatives put in play by others. He fears the future.

The contemporary technologist does not stop just with identifying or specifying a technology to buy. He or she maintains responsibility through implementation, maintenance, and return on investment. The technologist not only looks forward to the future but also plays an active role in shaping that future.

Richard manages to alienate (and in many cases execute) all those around him. Quite conversely, successful technologists draw people to them—not so much by the power of personality as by the power of thinking.

Thornton A. May is director of research for Tenex Consulting, a Burlington, Massachusetts–based management consulting firm. You can contact him on BIX c/o "editors."
"Why on earth would this bozo think I'd want to buy a 1993 Pentium with a bus that's been dragging its butt since 1984?"

INTRODUCING THE "NO BOZO" PCI BUS PENTIUM PC.

Imagine trying to pawn off a Pentium™ machine with a bus designed for a 286 antique! Well, that's not the case with the Dell Dimension™ XPS Pentium PCs. These racehorses feature a 60MHz Pentium Processor that delivers nearly twice the performance of the i486™ 66MHz CPU. And thanks to a redesigned floating point unit, these Pentium systems deliver up to five times the performance of the i486 66 processor in math-intensive applications.

What's more, Dell Dimension XPS Pentium systems feature the PCI bus. Capable of sustaining 120MBps as opposed to 16 with ISA, these systems take full advantage of the processing power of the Pentium CPU. Delivering maximum performance from even the most graphic-intensive Windows™ applications.

So don't settle for today's CPU with yesterday's I/O technology. Call Dell. And forget about those other bozos.
INTRODUCING THE HIGH PERFORMANCE DELL DIMENSION AND DELL DIMENSION XPS SYSTEMS.

When you call to order a Dell Dimension system, you'll always reach someone who speaks your language. Someone who knows the Pentium Processor, PCI, VL, and you.

Someone who can actually help you optimize the system that's ideal for your specific needs—with guaranteed compatibility between all components. Should you ever require help in the future, our technical support hotline is open twenty-four hours a day, seven days a week. We'll respond to your phone call in five minutes or less. Guaranteed.

If we can't solve your problem over the phone, we will send someone to service your machine by the next business day. And we guarantee that service, too.

We believe it's service like this that's earned Dell the Highest Ranking in the J.D. Power and Associates 1993 Desktop Personal Computer Satisfaction Study among business users.

So call Dell. And get a great price on the system you want. From someone who knows what you're talking about.

DELL DIMENSION XPS
DELL PC SYSTEMS DESIGNED FOR THE HIGH PERFORMANCE USER.

DELL DIMENSION 4425V
i486 SX 25MHz SYSTEM
$1,399
Business Lease: $52/MO.
- 4MB RAM • 64MB Max RAM • 270MB Hard Drive • Upgradeable to Pentium Overdrive • 5 16-Bit ISA Expansion Slots Available, 2 on VL-Bus • Accelerated Local Bus Video • UltraScan 14C Monitor (14", 1024 x 768, 28mm, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • MS-DOS 6.0/Windows 3.1/Mouse Order Code = 50000047

DELL DIMENSION 433V
i486 DX 33MHz SYSTEM
$1,799
Business Lease: $67/MO.
- 4MB RAM • 64MB Max RAM • 270MB Hard Drive • Upgradeable to Pentium Overdrive • 5 16-Bit ISA Expansion Slots Available, 2 on VL-Bus • Accelerated Local Bus Video • UltraScan 14C Monitor (14", 1024 x 768, 28mm, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • MS-DOS 6.0/Windows 3.1/Mouse Order Code = 50000041

DELL DIMENSION 466V
i486 DX2 66MHz SYSTEM
$1,999
BEST BUY
Business Lease: $74/MO.
- 4MB RAM • 64MB Max RAM • 270MB Hard Drive • Upgradeable to Pentium Overdrive • 5 16-Bit ISA Expansion Slots Available, 2 on VL-Bus • Accelerated Local Bus Video • UltraScan 14C Monitor (14", 1024 x 768, 28mm, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • MS-DOS 6.0/Windows 3.1/Mouse Order Code = 50000049

DELL DIMENSION 466V
i486 DX2 66MHz SYSTEM
$2,499
Business Lease: $92/MO.
- 8MB RAM • 64MB Max RAM • 320MB Hard Drive • 128KB External Cache • Upgradeable to Pentium Overdrive • 5 16-Bit ISA Expansion Slots Available, 1 on VL-Bus • VL #9GX Video Accelerator Card with Video Control Panel Software • 1MB Video RAM • UltraScan 15FS Monitor (15", 1024 x 768, 28mm, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • Multi-Session, Double-Spin CD ROM Drive • MS-DOS 6.0/Microsoft Windows 3.1/Mouse Order Code = 50000030

DELL DIMENSION XPS 450V
i486 DX3 30MHz SYSTEM
$2,999
Business Lease: $114/MO.
- 16MB RAM • 128MB Max RAM • 528MB Hard Drive • 256KB External Cache • Upgradeable to Pentium Overdrive • 5 16-Bit ISA Expansion Slots Available, 1 on VL-Bus • VL #9GX Video Accelerator Card with Video Control Panel Software • 1MB Video RAM • UltraScan 15FS Monitor (15", 1024 x 768, 28mm, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • Multi-Session, Double-Spin CD ROM Drive • MS-DOS 6.0/Microsoft Windows 3.1/Mouse Order Code = 50000047

DELL DIMENSION XPS 466V
i486 DX2 66MHz SYSTEM
$3,999
Business Lease: $144/MO.
- 16MB RAM • 128MB Max RAM • 528MB Hard Drive • 256KB External Cache • 5 Expansion Slots Available (3 16-Bit ISA, 1 PCI, 1 PCI/ISA Shared) • PCI #9GX Video Accelerator Card with Video Control Panel Software • 1MB Video RAM • UltraScan 15FS Monitor (15", 1024 x 768, 28mm, Strip Pitch, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • Multi-Session, Double-Spin CD ROM Drive • MS-DOS 6.0/Microsoft Windows 3.1/Mouse Order Code = 50000050

DELL DIMENSION XPS 600
PENTIUM 66MHz SYSTEM
$5,299
Business Lease: $292/MO.
- 256MB RAM • 512MB Max RAM • 1GB Hard Drive • 512KB External Cache • Upgradeable to Pentium Overdrive • 5 16-Bit ISA Expansion Slots Available, 2 on VL-Bus • Accelerated Local Bus Video • UltraScan 14C Monitor (14", 1024 x 768, 28mm, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • Multi-Session, Double-Spin CD ROM Drive • MS-DOS 6.0/Microsoft Windows 3.1/Mouse Order Code = 50000027

DELL DIMENSION XPS 466V
i486 DX2 66MHz SYSTEM
$2,699
Business Lease: $100/MO.
- 8MB RAM • 64MB Max RAM • 528MB Hard Drive • 256KB External Cache • Upgradeable to Pentium Overdrive • 6 16-Bit ISA Expansion Slots Available, 1 on VL-Bus • VL #9GX Video Accelerator Card with Video Control Panel Software • 1MB Video RAM • UltraScan 15FS Monitor (15", 1024 x 768, 28mm, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • MS-DOS 6.0/Microsoft Windows 3.1/Mouse Order Code = 5000051

DELL DIMENSION XPS 466V
i486 DX2 66MHz SYSTEM
$2,999
Business Lease: $114/MO.
- 16MB RAM • 64MB Max RAM • 450MB Hard Drive • 256KB External Cache • Upgradeable to Pentium Overdrive • 5 16-Bit ISA Expansion Slots Available, 1 on VL-Bus • VL #9GX Video Accelerator Card with Video Control Panel Software • 1MB Video RAM • UltraScan 15FS Monitor (15", 1024 x 768, 28mm, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • Multi-Session, Double-Spin CD ROM Drive • MS-DOS 6.0/Microsoft Windows 3.1/Mouse Order Code = 5000052

DELL DIMENSION XPS 466V
i486 DX2 66MHz SYSTEM
$3,999
Business Lease: $144/MO.
- 16MB RAM • 128MB Max RAM • 528MB Hard Drive • 256KB External Cache • 5 Expansion Slots Available (3 16-Bit ISA, 1 PCI, 1 PCI/ISA Shared) • PCI #9GX Video Accelerator Card with Video Control Panel Software • 1MB Video RAM • UltraScan 15FS Monitor (15", 1024 x 768, 28mm, Strip Pitch, NI) • One Diskette Drive (3.5") • SpaceSaver Keyboard • Multi-Session, Double-Spin CD ROM Drive • MS-DOS 6.0/Microsoft Windows 3.1/Mouse Order Code = 5000053

TOY BOX
SIGMA DESIGNS REALMAGIC: $399
SOUND UPGRADE: $199
- Soundblaster 16
- Power 220 Stereo Speakers
MULTIMEDIA UPGRADE: $399
- Soundblaster 16
- Power 220 Stereo Speakers
- Multi-Session, Double-Spin CD ROM Drive • Microsoft Home Software Sampler
US ROBOTICS 544 DATA/FAX MODEM: $179
VIPER VIDEO CARD: $199
(60 Million WINMARKS™), Available Only On Dimension XPS

TO ORDER, CALL
800-678-1190
HOURS: MON-FRI 7AM-9PM CT SAT 8AM-6PM CT SUN 12PM-5PM CT
IN CANADA CALL 800-668-3021. PLEASE REFERENCE #XPS 466/466V
“I’d rather stick needles in my eyes than talk to one of those techno-wannabees who thinks a bus is some form of public transportation.”
Just in case you missed the price in all of the excitement, we'd be happy to show you one more time: $2,799. (Business Lease: $104/Mo.).

You might find some other multimedia systems out there. But you won't find anything in the same league as the Dell Dimension XPS 450V. At least not for the price.

And it's just one of a whole family of affordably priced Dell multimedia systems.

Each one configured to give you more blast for your dollar. From the company that ranked highest in the 1993 J.D. Power and Associates Desktop Personal Computer Satisfaction Study among business users.

Call to order your Dell Dimension XPS 450V today. And come out a winner.