Penny-Pinching PCs
from IBM, Compaq, DEC, AST, Dell, and Apple:
How They Did It

PLUS
Xerox PARC's Information Theater
Compaq Unveils Network Printers
Digital Photography Pros and Cons
Once upon a time, a band of young rebels known as Gateway 2000 launched a crusade against the tyranny of the PC Titans’ bloated prices. Price Wars raged between the Titans and the value-driven upstarts, but the lumbering giants could not match the speed or strength of the rebel attacks.

So the Titans plotted a crafty revenge. They’d cut quality and features, thereby to match the renegades’ prices – an evil plan to fool PC buyers and chase the merry Gateway band right out of the forest!

With great fanfare, the Titans charged – only to fall into a clever trap! The woodsmen had crafted powerful new weapons – weapons smarter, better, harder-working and more value-packed than ever.

**New Legends Are Born!**

The rebels introduced a new product line with faster video, bigger hard drives, local bus and the latest processors. True to form, they boosted performance and lowered prices!

**VESAs Local Bus Systems**

Unlike most proprietary implementations on the market, Gateway’s local bus met VESA (Video Electronics Standards Association) compatibility standards. To get optimal performance from the local bus, the woodsmen added ATI’s™ new Graphics Ultra Pro video system, with 1MB VRAM. The Ultra Pro is nearly three times faster than the older ATI Graphics Ultra, giving the new rebel systems incredible speed – up to 28 million Winmarks!

Amazing as 28 million Winmarks is, this benchmark doesn’t adequately show local-bus video performance. You just have to see it to believe it! The wily woodsmen also put the IDE hard drive controller on the local bus for shining disk performance.

**Faster Mini Desktop Systems**

The renegades made powerful improvements to mini desktop systems, too. On these compact models, they put better, integrated motherboards, faster video, and on 486 models, high-performance local-bus hard drives.

**And They Lived Happily Ever After**

The Gateway arsenal was further fortified by other valuable features and products (described on the next page). And the people turned against the Titans’ trickery and flocked to the banner of value.

Once again, there proved to be one strong and true victor in the Price Wars. Gateway 2000 remains the Champion of the People, and the best value prevails.
Gateway 2000

Remains The Champion Of The People!

With Great New Products.
The PC Titans
Are Conjuring Up
A New Plan
To Catch The
Rebel Leader,
But...
More Champion Values From Gateway 2000!

**Road Warriors**

Wherever you journey, our lightweight Nomad notebook computers give you desktop performance – in 386SX-25, 486SX-20 and 486DX-25 models.

You get 4MB RAM and 80 or 120MB hard drive, depending on the model; one of the biggest and brightest 10-inch backlit screens in the industry, with 640 x 480 resolution, 64 gray scale, on the LCD; our compact FieldMouse portable pointing device; patented power-management features for over six hours of operation from a single battery – and the Nomad with battery weighs less than six pounds! Plus it's made in the U.S.A.!

The HandBook™ is a one-of-a-kind, real PC in miniature form! HandBook owners tell us you can carry it with you everywhere; do all kinds of work – and it weighs so little, you have to check your briefcase to make sure it's there!

The HandBook weighs just 2.75 pounds and measures about 6 x 9 inches, yet delivers 286-class performance for all your DOS applications: You get a bright, backlit screen; 40MB hard drive; a comfortable 78-key keyboard and up to 4.5 hours of battery life with power management.

**Bountiful Software**

Every Gateway system includes free software; check our system configurations on the back page of this ad for details. All software is installed at our factory, tested, and ready to run – master diskettes and comprehensive manuals provided.

- NEW! Our Cool Tools for DOS is a utilities software package that comes with all Gateway desktop systems, including: QA Plus™, from DiagSoft™ (for diagnostic hardware testing), Central Point® Anti-Virus, RAM Boost, Defrag and Emergency Disk (for recovering your precious data if you have hard drive problems).

If your system includes "choice of application software," pick one from the following popular applications, all latest versions:

- **NEW!** Microsoft® Word and Bookshelf® 92, CD-ROM edition, takes the most popular word processor for Windows and adds an entire electronic reference library full of multimedia sights and sounds.
- Microsoft Excel for Windows™
- Microsoft Word for Windows™
- Microsoft PowerPoint for Windows™
- Microsoft Project for Windows™
- Borland Paradox® and Turbo Pascal or C++

- The MS Entrepreneur Pack (Works™, Publisher™, Money™, and Games)
- The Windows Programmer Pack (MS QuickC™, Visual Basic and more)

You can also upgrade to Microsoft Office™ for $175.

**Periodicals At Gallant Prices**

**NEW! Microsoft Windows Sound System™**

Designed especially for business use. Voice recognition lets you "speak" commands to your PC for hands-free operation – and your PC can read numbers back to you for proofreading! Embed audio messages in Windows OLE applications, and add audio to screen savers. Full Adlib compatibility. Package includes soundboard, microphone, headset and software.

$149 (with the purchase of a system)

**NEW! CD-ROM Kit**

Includes interface card and everything you need to add CD-ROM to your PC. Manufactured for Gateway by Sony® MPC-compliant.

$225

**CrystalScan 15-Inch Monitor**

Non-interlaced 15-inch color monitor with flat, square screen – an upgrade option with the purchase of any Gateway 2000 desktop system.

$125 (upgrade price)

**The TelePath™ Fax/Modem**

A 14,400 bps mode, V.32bis, with 9,600 bps fax capability. Includes WinFax Pro™, Crosstalk™ for Windows, Qmodem™ and more.

$195

Also available – printers, tape backups and other peripherals. Call for details. (Sorry – we sell components, peripherals and software only with the purchase of a system, or to previous customers.)

**Extras From Merry Gateway**

- One-year limited warranty
- 30-day money-back guarantee
- Free on-site service to most locations (factory service only for notebooks)
- Lifetime BBS membership and toll-free technical support
## PORTABLE SYSTEMS

<table>
<thead>
<tr>
<th>Model</th>
<th>Processor</th>
<th>RAM</th>
<th>Diskette Drive</th>
<th>Screen</th>
<th>Battery</th>
<th>Accessories</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOMAD 325XSL</td>
<td>25MHz Intel 386SX Processor</td>
<td>4MB RAM</td>
<td>3.5&quot; Diskette Drive</td>
<td>Backlit 10&quot; VGA Screen</td>
<td>64 GB RAM</td>
<td>MS Works for Windows 2.0</td>
<td>$1295</td>
</tr>
<tr>
<td>NOMAD 420XSL</td>
<td>20MHz Intel 486SXLP Processor</td>
<td>4MB RAM</td>
<td>3.5&quot; Diskette Drive</td>
<td>Backlit 10&quot; VGA Screen</td>
<td>64 GB RAM</td>
<td>MS Works for Windows 2.0</td>
<td>$1995</td>
</tr>
<tr>
<td>NOMAD 425DXL</td>
<td>25MHz Intel 486DXLP Processor</td>
<td>4MB RAM</td>
<td>3.5&quot; Diskette Drive</td>
<td>Backlit 10&quot; VGA Screen</td>
<td>64 GB RAM</td>
<td>MS Works for Windows 2.0</td>
<td>$2495</td>
</tr>
</tbody>
</table>

## DESKTOP SYSTEMS

<table>
<thead>
<tr>
<th>Model</th>
<th>Processor</th>
<th>RAM</th>
<th>Hard Drive</th>
<th>Screen</th>
<th>Battery</th>
<th>Accessories</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3SX-25</td>
<td>25MHz Intel 386SX Processor</td>
<td>4MB RAM</td>
<td>80MB IDE Hard Drive</td>
<td>14&quot; Color CrystalScan</td>
<td>6-Hr. NiCad Battery</td>
<td>MS-DOS, Windows &amp; Mouse</td>
<td>$1295</td>
</tr>
<tr>
<td>4SX-25</td>
<td>25MHz Intel 486SX Processor</td>
<td>4MB RAM</td>
<td>120MB IDE Hard Drive</td>
<td>14&quot; Color CrystalScan</td>
<td>Local Bus IDE Interface</td>
<td>MS Works for Windows 2.0</td>
<td>$1495</td>
</tr>
<tr>
<td>4DX-25</td>
<td>25MHz Intel 486SX Processor</td>
<td>4MB RAM</td>
<td>120MB IDE Hard Drive</td>
<td>14&quot; Color CrystalScan</td>
<td>Local Bus IDE Interface</td>
<td>MS Works for Windows 2.0</td>
<td>$1495</td>
</tr>
<tr>
<td>4DX-33</td>
<td>33MHz Intel 486DX Processor</td>
<td>8MB RAM, 64KB Cache</td>
<td>5.25&quot; &amp; 3.5&quot; Diskette Drives</td>
<td>5.25&quot; &amp; 3.5&quot; Diskette Drives</td>
<td>Local Bus IDE Interface</td>
<td>Choice of Application Software</td>
<td>$1695</td>
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<tr>
<td>4DX-33</td>
<td>33MHz Intel 486DX Processor</td>
<td>8MB RAM, 64KB Cache</td>
<td>5.25&quot; &amp; 3.5&quot; Diskette Drives</td>
<td>5.25&quot; &amp; 3.5&quot; Diskette Drives</td>
<td>Local Bus IDE Interface</td>
<td>Choice of Application Software</td>
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<td>Local Bus IDE Interface</td>
<td>Choice of Application Software</td>
<td>$1995</td>
</tr>
</tbody>
</table>

Please call for other configurations. We custom-build each Gateway 2000 system to your specifications.
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Transform Your PC With The INTERACTIVE UNIX System.
Unleash the 32-bit power in your PC with the INTERACTIVE™ UNIX* System from SunSoft. Charge through applications at record speeds. Use real-world multitasking and networking. Get on the path to a distributed computing future.

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Low-priced PCs bring benefits—and risks—to buyers.

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By Steve Apiki and Tom Thompson

Smile for the Computer
By Philip Chien
Your computer might be your camera's best accessory.

The Information Theater
By Mark A. Clarkson
Xerox PARC presents a new way to view your data.

States of the Art

Overview: Signal Computing
By Eric C. Anderson, Stephen Shepard, and Phil Sohn
Watch for hazards when moving information from the analog to the digital realms.

Digitally Speaking
By Georges Zanelato and Bart Verhaeghe

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By John Bryan
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By Peter Wayner
The architecture of DSP chips mirrors the functions they perform.

A Platform for Signal Computing
By Tim Counihan
The signal-computing environment tries to set a signal-computing standard.

Resource Guide: DSP-Based Products
192 SOLUTIONS FOCUS
Stalking the Ultimate Workstation
by Ben Smith and Raymond GA Côté
Eight powerhouses reviewed.

By BYTE Lab Product Report
486 Systems for a Graphical World
by Howard Eglowstein
and Stan Wozola
The best 33-MHz 486 systems for today's demanding applications.

238 Cut to Video: Four Programs for Moving Presentations
by Tom Yager
The BYTE Lab looks at four video-presentation programs.

249 Compaq Unveils a New Network Printer
by Greg Laveria
Compaq enters the printer market with the powerful Pagemarq line.

253 Borland Targets Windows Developers with Latest C++ Release
by Other Hansson
Borland C++ 3.1 contains some features we've been waiting for.

256 Sophisticated Graphing Under Windows
by D. Barker
DeltaGraph Professional brings good chart-making tools to Windows.

261 Style Meets Substance in Matrox Studio
by Tom Yager
Studio turns your PC into a video powerhouse.

265 LANlord Evicts LAN Problems
by Barry Nance
Microcom's high-level LAN manager uses OS/2 to manage DOS and Windows workstations.

269 Network Modem's Dial In, Dial Out, and Route Packets
by Steve Apiki, Tom Thompson, and Jon Udell
Microway's Net laminates versus Shiva's NetModem/E.

276 Reviewer's Notebook: The BYTE Lab, Behind the Scenes
by Alan Joch
An invitation to look over the shoulders of our testing editors.

281 SOME ASSEMBLY REQUIRED
Approximate Pattern Matching
by Udi Member and Sun Wu
Agrep's algorithms let you perform text searches using an approximate pattern.

293 UNDER THE HOOD
A Call to ARM
by Dick Pounrain
The 32-bit ARM610 is a high-performance, power-saving RISC CPU in a tiny package.

299 SOFTWARE CORNER
BASH, the Bourne Again Shell
by Ben Smith, Tom Thompson, and Steve Apiki
A free Korn-shell replacement, a JPEG viewer for Macs, and a Windows file utility.

301 BEYOND DOS
An Objective Way to Compute
by Bruce D. Schutzman
The object-based model in Windows NT forms the foundation for Microsoft's future operating systems.

303 ASK BYTE
Winnowing down Windows;
BYTE listings on UUNET;
getting from CP/M to MS-DOS; and more.

109 USER'S COLUMN
Pondering OS/2
by Jerry Pournelle
OS/2 invades Chaos Manor.

278 BOOK AND CD-ROM REVIEWS
Amok in Cyberspace
by Hugh Kenner, Raymond GA Côté, Tom Thompson, and Stanford Diehl
A look at The Hacker Crackdown, Macintosh Programming Secrets, Support on Site, and other selections.

372 STOP BIT
Artificial Life and Natural Markets
by Esther Dyson
Parallels between artificial life experiments and competitive markets demonstrate the advantages of a free-market system.

12 EDITORIAL
PCs Will Become More Personal
by Dennis Allen

22 LETTERS
How to get Unix for free;
OS/2 2.0 defended; clarifying the A20 problem; and other issues.

370 READER SERVICE
Editorial Index by Company
Alphabetical Index to Advertisers
Index to Advertisers by Product Category
Inquiry Reply Cards: 144A, 368A

307 BUYER'S GUIDE
Mail Order
Hardware/Software Showcase
Buyer's Mart

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This index helps you find articles that contain information on each of the listed topics. (The topic list changes each month.) Combined with the table of contents (page 4) and the Editorial Index by Company (page 370), you can identify articles by type, subject, title, author, or product discussed.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMIGA</td>
<td>22, 109, 192, 278</td>
</tr>
<tr>
<td>ADVANCED RISC MACHINE</td>
<td>293</td>
</tr>
<tr>
<td>ARTIFICIAL LIFE</td>
<td>372</td>
</tr>
<tr>
<td>BUSINESS</td>
<td>58, 76, 238, 256, 261</td>
</tr>
<tr>
<td>CAD</td>
<td>76, 192, 209</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>22, 28, 58, 76, 109, 128, 139, 167, 192, 278</td>
</tr>
<tr>
<td>CHIPS</td>
<td>28, 128, 293</td>
</tr>
<tr>
<td>COMMUNICATIONS</td>
<td>22, 249</td>
</tr>
<tr>
<td>COMPLIER</td>
<td>253</td>
</tr>
<tr>
<td>DATABASES</td>
<td>145</td>
</tr>
<tr>
<td>DESKTOP PUBLISHING</td>
<td>192, 303</td>
</tr>
<tr>
<td>DOS</td>
<td>22, 28, 45, 52, 76, 109, 167, 192, 209, 349, 253, 265, 269, 276, 303</td>
</tr>
<tr>
<td>DRAWING</td>
<td>256</td>
</tr>
<tr>
<td>DRIVES</td>
<td>76, 109, 128, 209, 303</td>
</tr>
<tr>
<td>DIGITAL SIGNAL PROCESSORS</td>
<td>128, 154, 167, 177, 185, 190</td>
</tr>
<tr>
<td>E-MAIL</td>
<td>28, 52, 145, 276</td>
</tr>
<tr>
<td>ETHERNET</td>
<td>76</td>
</tr>
<tr>
<td>FAX/MODEMS</td>
<td>58, 76, 109, 249, 269</td>
</tr>
<tr>
<td>FREEWARE/SHAREWARE</td>
<td>299</td>
</tr>
<tr>
<td>GRAPHICS</td>
<td>58, 238</td>
</tr>
<tr>
<td>GUI</td>
<td>76, 167</td>
</tr>
<tr>
<td>KEYBOARDS</td>
<td>76, 209</td>
</tr>
<tr>
<td>LAN MANAGER</td>
<td>265</td>
</tr>
<tr>
<td>LAPTOP</td>
<td>22, 28</td>
</tr>
<tr>
<td>LOW-COST SYSTEMS</td>
<td>50, 128</td>
</tr>
<tr>
<td>MACINTOSH</td>
<td>28, 58, 76, 128, 167, 256, 269, 276, 278, 299</td>
</tr>
<tr>
<td>MIDI</td>
<td>58</td>
</tr>
<tr>
<td>MONITORS</td>
<td>58, 76, 109, 128, 139, 209, 238</td>
</tr>
<tr>
<td>MULTIMEDIA</td>
<td>58, 76, 109, 238, 261</td>
</tr>
<tr>
<td>MUSIC</td>
<td>109</td>
</tr>
<tr>
<td>NETWORK MANAGEMENT</td>
<td>265</td>
</tr>
<tr>
<td>NETWORKING</td>
<td>22, 52, 58, 76, 265, 269</td>
</tr>
<tr>
<td>OPTICAL CHARACTER RECOGNITION</td>
<td>109, 303</td>
</tr>
<tr>
<td>OS/2</td>
<td>22, 28, 109, 192, 209, 265</td>
</tr>
<tr>
<td>PASCAL</td>
<td>28</td>
</tr>
<tr>
<td>PCMCIA</td>
<td>28, 58</td>
</tr>
<tr>
<td>PIN COMPUTING</td>
<td>50, 58, 76</td>
</tr>
<tr>
<td>PHOTO CD</td>
<td>139</td>
</tr>
<tr>
<td>PHOTOGRAPHY</td>
<td>139</td>
</tr>
<tr>
<td>PORTABLES</td>
<td>22, 28, 45, 50, 76</td>
</tr>
<tr>
<td>PRESENTATIONS</td>
<td>238</td>
</tr>
<tr>
<td>PRINTERS</td>
<td>58, 76, 249, 256</td>
</tr>
<tr>
<td>PROGRAMMING</td>
<td>28, 76, 109, 253, 278, 281, 293, 299, 301</td>
</tr>
<tr>
<td>RISC</td>
<td>58, 177, 192, 278, 299</td>
</tr>
<tr>
<td>SCANNERS</td>
<td>58, 76, 192</td>
</tr>
<tr>
<td>SCHEDULING</td>
<td>76</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>76, 209, 372</td>
</tr>
<tr>
<td>SCSI</td>
<td>109</td>
</tr>
<tr>
<td>SOUND</td>
<td>58, 109, 128, 238, 261</td>
</tr>
<tr>
<td>SPARC</td>
<td>177</td>
</tr>
<tr>
<td>SPEECH</td>
<td>154, 167</td>
</tr>
<tr>
<td>STORAGE</td>
<td>76, 303</td>
</tr>
<tr>
<td>TEXT RETRIEVAL</td>
<td>145, 281</td>
</tr>
<tr>
<td>UNIX</td>
<td>22, 45, 76, 192, 209, 253, 276, 281, 299, 303</td>
</tr>
<tr>
<td>VGA</td>
<td>58</td>
</tr>
<tr>
<td>VIDEO</td>
<td>238, 261, 303</td>
</tr>
<tr>
<td>VOICE</td>
<td>76</td>
</tr>
<tr>
<td>WINDOWS</td>
<td>22, 28, 45, 52, 58, 76, 109, 209, 249, 253, 256, 261, 269, 299, 301, 303</td>
</tr>
<tr>
<td>WORKSTATIONS</td>
<td>192, 265, 276</td>
</tr>
<tr>
<td>X WINDOW SYSTEM</td>
<td>22, 76, 192</td>
</tr>
<tr>
<td>DIGITAL SIGNAL PROCESSORS</td>
<td>128, 154, 167, 177, 185, 190</td>
</tr>
<tr>
<td>MUSIC</td>
<td>109</td>
</tr>
<tr>
<td>NETWORK MANAGEMENT</td>
<td>265</td>
</tr>
<tr>
<td>NETWORKING</td>
<td>22, 52, 58, 76, 265, 269</td>
</tr>
<tr>
<td>OPTICAL CHARACTER RECOGNITION</td>
<td>109, 303</td>
</tr>
<tr>
<td>OS/2</td>
<td>22, 28, 109, 192, 209, 265</td>
</tr>
<tr>
<td>PASCAL</td>
<td>28</td>
</tr>
<tr>
<td>PCMCIA</td>
<td>28, 58</td>
</tr>
<tr>
<td>PIN COMPUTING</td>
<td>50, 58, 76</td>
</tr>
<tr>
<td>PHOTO CD</td>
<td>139</td>
</tr>
<tr>
<td>PHOTOGRAPHY</td>
<td>139</td>
</tr>
<tr>
<td>PORTABLES</td>
<td>22, 28, 45, 50, 76</td>
</tr>
<tr>
<td>PRESENTATIONS</td>
<td>238</td>
</tr>
<tr>
<td>PRINTERS</td>
<td>58, 76, 249, 256</td>
</tr>
<tr>
<td>PROGRAMMING</td>
<td>28, 76, 109, 253, 278, 281, 293, 299, 301</td>
</tr>
<tr>
<td>RISC</td>
<td>58, 177, 192, 276, 299</td>
</tr>
<tr>
<td>SCANNERS</td>
<td>58, 76, 192</td>
</tr>
<tr>
<td>SCHEDULING</td>
<td>76</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>76, 209, 372</td>
</tr>
<tr>
<td>SCSI</td>
<td>109</td>
</tr>
<tr>
<td>SOUND</td>
<td>58, 109, 128, 238, 261</td>
</tr>
<tr>
<td>SPARC</td>
<td>177</td>
</tr>
<tr>
<td>SPEECH</td>
<td>154, 167</td>
</tr>
<tr>
<td>STORAGE</td>
<td>76, 303</td>
</tr>
<tr>
<td>TEXT RETRIEVAL</td>
<td>145, 281</td>
</tr>
<tr>
<td>UNIX</td>
<td>22, 45, 76, 192, 209, 253, 276, 281, 299, 303</td>
</tr>
<tr>
<td>VGA</td>
<td>58</td>
</tr>
<tr>
<td>VIDEO</td>
<td>238, 261, 303</td>
</tr>
<tr>
<td>VOICE</td>
<td>76</td>
</tr>
<tr>
<td>WINDOWS</td>
<td>22, 28, 45, 52, 58, 76, 109, 209, 249, 253, 256, 261, 269, 299, 301, 303</td>
</tr>
<tr>
<td>WORKSTATIONS</td>
<td>192, 265, 276</td>
</tr>
<tr>
<td>X WINDOW SYSTEM</td>
<td>22, 76, 192</td>
</tr>
</tbody>
</table>

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The real impact of low-price computers is empowered users

When we first set out to learn how the major computer makers cut corners to lower prices, we didn’t know exactly what we would find. All we knew for sure was that manufacturers must be doing something different to lower prices so dramatically. And to be honest, we were cynical enough to think we just might find that corners had been cut so much that the resulting computers would be less than desirable.

Our cynicism proved to be invalid, but that gives us something else to consider: Given that manufacturers can make low-price computers without necessarily sacrificing quality, what impact will low-price computers have?

Before answering that question, consider the current situation. So far, the price war has yielded 486-based computers with enough memory, disk storage, and adequate graphics to run virtually any major software application satisfactorily at prices that start under $2000. And if you shop around, you can find 386SX-based systems for less than $1000 that are adequate for many applications.

Plus, you can buy those systems not just through mail-order suppliers, but also at department stores. Remember that we’re not talking about toy computers; these are high-powered computer systems that you can buy in the same stores where you might purchase a VCR or camcorder. In fact, nowadays you might even pay more for a camcorder than for a computer.

The point is that a lot of high-powered computers are being offered—and sold—through traditional consumer channels. To be sure, some of those sales are for businesses, but often individual consumers are buying single units. To put it another way, the home computer has arrived, and it’s not exactly wimpy.

It’s too soon to have hard numbers on exactly how many computers are being sold into the home, but it is happening in a big way. The next time you visit the local shopping mall, stop by the computer section of one of the department stores and watch what is happening. You’ll see people—sometimes whole families—buying a computer system for their home just as they would buy a new VCR. Even if you don’t have time to visit the mall, your friends have probably asked you for advice as to which computer they should buy for their home.

These home-computer users will undoubtedly have new and different needs from current business users. Instead of complex workgroup solutions, their needs are likely to be of a more “personal” nature that a single user experiences. And you can bet that some creative folks are ready and willing to address those needs.

It’s even ironic that when most of the computer industry is focused on solving enterprise-wide computing problems with complex operating systems and workgroup software, a new community of users is emerging that will demand that their computers be more personal.

The result will be more emphasis on solving a single user’s problems, whether it be managing disk files or improving personal productivity. In many ways, this shift will mean a return to the roots of personal computing. In other words, even though network administrators may be taking greater control of PCs, a move is afoot to once again empower users.

As the price war causes the number of individual users to grow, more and more programs and peripheral hardware will be developed to address the specific needs of individual users, and that’s good news for businesses.

Not everything should be networked and shared. There always has been and always will be a need for personal information in every organization. Maybe it’s notes, confidential memos, a private phone directory, or background information on client contacts. Or maybe it’s a PIM (personal information manager), a utility to automate particular tasks, or a software application peculiar to a particular job.

It all boils down to a matter of empowerment, and it was the concept of empowerment that started the PC revolution over a decade ago. Back then, it was a matter of processing information without being dependent on the company’s mainframe. Now, it’s a matter of regaining some of the personal control of networked PCs.

Of course, the trend is only emerging, yet it seems clear that something big—something important—is happening. Simply put, many products that will be created for individual users will transcend their home-computer beginnings and benefit networked users in business. And that’s the real impact of low-price computers: empowered users.

—Dennis Allen
Editor in Chief
Introducing Paradox 4.0 for DOS

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NS TL tests confirm Paradox 4.0: Quicker than a Fox

Single-user performance tests (in seconds)

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Paradox</th>
<th>FoxPro/LAN 2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five-table join query</td>
<td>72</td>
<td>363</td>
</tr>
<tr>
<td>Three-table join query</td>
<td>30</td>
<td>187</td>
</tr>
<tr>
<td>Single-table query based on list of values</td>
<td>Paradox</td>
<td>FoxPro/LAN 2.0</td>
</tr>
<tr>
<td>Grouped query with outer join</td>
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<td>83</td>
</tr>
</tbody>
</table>

Multiuser performance tests (in seconds)

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Paradox</th>
<th>FoxPro/LAN 2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author transaction test</td>
<td>Paradox</td>
<td>FoxPro/LAN 2.0</td>
</tr>
<tr>
<td>Title transaction test</td>
<td>Paradox</td>
<td>FoxPro/LAN 2.0</td>
</tr>
<tr>
<td>Payment transaction test</td>
<td>Paradox</td>
<td>FoxPro/LAN 2.0</td>
</tr>
</tbody>
</table>

Multiuser Legend:

1 station | 3 stations | 8 stations
To test the speed of transaction performance, NS TL designed a database for book order entry. Each record contained an author, a title, an ISBN number, a price and inventory information. The database contained 25,000 books and 5,000 authors.
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a communication link, relays statements to the database server and presents the results of your query.

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Design. Engineering. Testing. Service. Support. When you think about it, these are what make one computer better than the next. Which makes it all the more surprising that companies are cutting back in these areas. And, amazingly, some do little but stick their name on at the end of somebody else's assembly line.

It would be like buying a car, looking under the hood, and discovering that it was built by a company you'd never heard of from a place you'd have trouble finding on the map.

It makes you wonder about the kind of company that would do it. Why they would make the decision to put their name on a product over which they maintain little control. And why they would then sell it to their customers.

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Other PC companies do things differently, like offering substantially limited service and support for products they apparently have less confidence in. Dell has even gone so far as to withdraw their
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Circle 103 on Inquiry Card.
OS/2 in Review

I would dispute Jon Udell's claims of problems with IBM's OS/2 2.0 in "OS/2 2.0: A Mixed Blessing" (August). The WPS (Workplace Shell) is a well-designed and well-thought-out replacement for the Presentation Manager. The object-oriented system designed for WPS is far superior to the Windows Program Manager and File Manager, and once you get used to it, it is easy to use.

I have had few problems with WPS crashing. When it has crashed, OS/2 has taken care of the situation by killing it and restoring it immediately. WPS seems to run quite fast with my 40-MHz 386, and I'm happy with its speed.

I deleted Windows and never looked back. Buying OS/2 2.0 is the best decision I've made since buying a 386 system. I think a lot of people will agree, especially after the 32-bit graphics engine and Windows 3.1 enhancements become available this fall.

Timothy D. Jasionowski
Fairfax, VA

Jon Udell's review of OS/2 2.0 missed some important points. To have a stable OS/2 setup, you really need 8 MB of RAM and 40 MB of disk space. Contrast this to IBM's stated minimum of 4 MB of RAM and 30 MB of disk space. Udell would have been better off spending $50 to $60 on 2 MB of RAM for his PS/2 and leaving the HPFS (High Performance File System) cache at 256 KB.

Regardless of the disk search test, Udell made no mention of the two-to-three-speed improvement, for both OS/2 and DOS/Windows programs, that occurs when using the HPFS. Since VDMs can access HPFS partitions under OS/2, there is no reason not to use HPFS.

I beat up heavily on the WPS and have rarely seen it crash. A couple of times I have seen the WPS crash and then restart itself, bringing up all my applications as if nothing had happened. Let's see DOS/Windows try that.

All in all, OS/2 2.0, with all its faults, is the most stable operating system I have ever used. My PC has run many weeks at a time without a reboot. Looking back on my DOS/Windows days, I remember having to reboot often.

John Morris
Sparks, NV

I've used every version of OS/2 since 1.0. For my money, the best one yet was 1.3. And yes, let's be quite clear, the quality of that product is thanks to IBM, not Microsoft. I'd like to be able to say that OS/2 2.0 comes up to the same standard. But along with the WPS, 32-bitness, multiple DOS boxes, and Windows support came problems with ease of use, integration, performance, and stability.

If you follow the OS/2 conferences on BIX, ComputeServe, and the Internet, you must have noticed that I'm not alone in my indictment of the WPS. Most power users come to terms with it (myself included), but only after a struggle that IBM shouldn't have required of everyone. The WPS, several readers have reminded me, can rise phoenixlike from its own ashes. Indeed it can, but that's faint praise.

For the record, I tested the shipping version of 2.0 on two machines: a 16-MB Systempro 486x33 (using a file allocation table) and a 6-MB PS/2 Model 70 (using HPFS). File-search performance lagged behind that of Windows 3.1 on both machines by an order of magnitude. A stabler, faster, more intuitive WPS has to be a top priority for the forthcoming point release of 2.0.

Like Unix, OS/2 puts DOS/Windows to shame in many respects. Yet, like Unix, OS/2 hasn't been an easy migration choice for DOS/Windows users. I'd love to be able to install OS/2 on every PC hooked to the network I manage and have those machines keep doing everything they do now-only faster and more reliably. Unfortunately, 2.0 isn't the OS/2 that can pull that stunt off. I'd love to be shown one that can.—Jon Udell

Not for Wimps

For years, I've been reading articles that criticize the weight of laptop and, now, notebook computers. At first the reviewers complained unless a laptop was under 12 pounds, then 10 pounds, then 8 pounds. Now they say a 7-pound notebook is too heavy and advise something in the 5-pound range if you'll be lugging it to the airport.

Who are these wimps? I'm 44 years old, weigh 135 pounds, and carry my 17-pound bag of golf clubs around 18 holes at least twice a week. And these reviewers can't make it to the airplane with 7 pounds and a carry-on bag?

These yuppies. None of your reviewers play golf? I knew it—they ride in a cart.

Ron Crisona
address unknown

The PC Gets Personal

Thank you for your generous comments about the Gateway 2000 Handbook in your July cover story, "The PC Gets More Personal." IQV Corp. designed this product and had it manufactured in Japan. Gateway private-labels it from us. We believe the day is fast approaching when people will be unwilling to carry 6- to 7-pound notebook computers on business trips. Some visionaries are even convinced that weight is so important to travelers that subnotebooks will eventually replace notebooks, just as notebooks replaced laptops.

Thomas F. Domback
President
IQV Corp.
Wheeling, IL

Thanks for the compliment. Let's hope those visionaries don't meet Ron Crisona on the golf course.—Eds.
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(Please Mention "Offer 349")
In "The PC Gets More Personal," the authors state that there is presently no affordable wireless communication technology for the consumer. They mention cellular telephones and packet radio but not second-generation cordless communications (CT2), also known as Telepoint.

This technology, in common use in Europe, is known as "Bi Bop" in France, "Birdie" in Germany, and "Rabbit" in the U.K. It's about to be implemented in Canada in an enhanced form called CT2Plus. This digital technology operates much like a cordless phone (unlike cellular, it does not support roaming). The difference is that the base station can be a public base station connected to a PBX. The handsets are relatively cheap—less than $300—and support about 10 hours of continuous talk time.

While cordless technology doesn't provide true mobile communications in the same way as cellular, it does offer affordable wireless communications in a large number of environments. Since the infrastructure requirements are less than for cellular or packet radio, the implementation of the networks is likely to occur more quickly.

Chris Shepherd
Beeston, U.K.

Unix for Nothing

I n response to Ben Smith's First Impression of Mark Williams Co.'s low-cost Unix clone, Coherent ("Coherent Grows Up," August), I'd like to bring to your attention Linux, a free Unix clone written by Linus Torvalds of Finland, with help from hundreds of programmers from all over the world. Linux is a 386-specific, mostly Posix-compliant, SYSV-like Unix clone. It rates favorably in benchmark testing against commercial versions of Unix.

One of the few reservations Smith had about Coherent was its lack of X Window System support. I run X on my Linux machine daily.

Due to the widely varying backgrounds from which Linux's contributors come, the system is blessed with very good hardware support: SCSI, several brands of Super VGA cards, nonstandard serial configurations, and many brands of motherboards. Peripheral drivers are well represented, too. I wrote most of the Logitech bus mouse driver and am working on a CD-ROM driver.

Linux lacks kernel support for TCP/IP. However, a group of programmers is working on that.

Linux is available via anonymous FTP from tsx-11.mit.edu:/pub/linux (U.S.) or nic.funet.fi:/pub/os/linux (Europe). The news group is comp.os.linux; send E-mail to linux-activists-request@niksula.hut.fi to join the mailing list.

David Giller
Los Angeles, CA

MacGuffin Rebuff

J im Manzi's Stop Bit, "The Productivity MacGuffin" (August), raises interesting questions, but I find his prescription for more LAN hardware unconvincing. A failure to achieve increased productivity through computerization may have little to do with hardware and software choices and does not necessarily say anything about the value of computerization. It more likely reflects inadequacies of management style and practice and the adoption of computerization strategies aimed mainly at bolstering the status quo.

A reasonable alternative is to take a hard look at the assumptions underlying management practice and to establish productivity-related goals regarding such things as manager/worker ratios. Then one is in a position to decide how computers might contribute to solutions.

Mike Connealy
Las Cruces, NM

A20 Issues

M ark J. Minasi’s "Exorcising the A20 Poltergeist" (August) was very educational. I was interested to learn that the A20 handler chip also processes the keyboard. However, the article had one minor error. The 386SX and 386SL processors have 32 address lines, not 24. Otherwise, how could a 386SX go to 386 extended mode in Windows? This requires the CPU to go to virtual mode, which requires access to the full 4-GB address space of the 386/486 family.

The distinction Minasi was thinking of is the number of data lines in the external data bus. The 286, 386SX, and 386SL all have 16-bit external data buses, while the 386DX and 486 have 32-bit buses. Although this error was not significant in the context of the column, I thought readers would be interested in the distinction.

In my opinion, IBM should have left out the A20 gate and written a 286 software handler back in 1983.

Charles Bretana Jr.
Apple Valley, CA

Real Time Goes Amiga

W hen I read "Real Time Goes Home" (August), I thought Ken Kaplan was describing things to come. I was pleasantly surprised to learn that CD-I was fulfilling the real-time promise. However, there is another entry in the home information appliance market that warrants mention: the CDTV by Commodore Business Machines. CDTV is an Amiga computer with a battery of infrared I/O devices, a CD-ROM drive, and a personal RAM card slot. It is capable of all the actions described in the article.

I hope Commodore will give us the opportunity to make it happen. At a street price of about $700, the CDTV doesn't quite fit Kaplan’s $200 scenario, but we all know what time does in these markets.

Gordon Cunningham
Sebago Lake, ME
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- Full keyboard—dedicated 'page up/down', 'home' and 'end' keys
- Built-in serial (2) and parallel (1) ports
- FCC Class B certification

<table>
<thead>
<tr>
<th>Notebook</th>
<th>CPU</th>
<th>RAM (MB)</th>
<th>HD (MB)</th>
<th>Battery Life (hrs)</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>386SL/25</td>
<td>386SX/25, Optional 8087SX</td>
<td>2 standard, 4 &amp; optional</td>
<td>90</td>
<td>3+</td>
<td>$1,599</td>
</tr>
<tr>
<td>386SL/25</td>
<td>Intel 80386SX/25 MHz, 64 K CPU cache, Advanced SL power mgmt, Optional 8087SX co-processor</td>
<td>as above</td>
<td>90</td>
<td>3+</td>
<td>$1,799</td>
</tr>
<tr>
<td>486DX/25</td>
<td>Intel 80486DX-25 MHz, Built-in 80786 CPU cache, Optional 8087SX co-processor</td>
<td>4 standard, 3.3 &amp; optional</td>
<td>130</td>
<td>2.5+</td>
<td>$1,999</td>
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<tr>
<td>486DX/33</td>
<td>Intel 80486DX-33 MHz, Built-in 80786 CPU cache</td>
<td>as above</td>
<td>130</td>
<td>2.5+</td>
<td>$2,899</td>
</tr>
</tbody>
</table>

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- And many more!

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### Desktops

<table>
<thead>
<tr>
<th>Desktop</th>
<th>CPU</th>
<th>RAM (Mb)</th>
<th>HD (Mb)</th>
<th>Floppy</th>
<th>Display</th>
<th>Price</th>
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<tbody>
<tr>
<td>3860x/33</td>
<td>Intel 80386DX-33 MHz</td>
<td>32 max</td>
<td>40</td>
<td>1.2 &amp; 1.44</td>
<td>16 bit SVGA card, 14&quot; M64x680 VGA</td>
<td>$849</td>
</tr>
<tr>
<td>3860x/33 or 486sx/25</td>
<td>Intel 80386DX-33 MHz or Intel 80486DX-25 MHz, w/built-in 8K CPU cache</td>
<td>32 max</td>
<td>80</td>
<td>as above</td>
<td>16 bit SVGA card, 14&quot; M64x680 VGA</td>
<td>$999</td>
</tr>
<tr>
<td>486sx/25</td>
<td>Intel 80486DX-25 MHz</td>
<td>as above</td>
<td>80</td>
<td>12 &amp; 1.44</td>
<td>16 bit SVGA card &amp; Hi-Color Support</td>
<td>$1,199</td>
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<td>380sx/33</td>
<td>Intel 80486DX-33 MHz</td>
<td>32 max</td>
<td>120</td>
<td>as above</td>
<td>14&quot; M64x680 VGA, 28 Interlaced Color Monitor</td>
<td>$1,399</td>
</tr>
<tr>
<td>486cx/33</td>
<td>Intel 80486SX-33 MHz</td>
<td>8K CPU cache</td>
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<td>120</td>
<td>as above</td>
<td>$1,499</td>
</tr>
<tr>
<td>486cx/33 CACHE</td>
<td>Intel 80486DX-33 MHz</td>
<td>128K CPU cache</td>
<td>as above</td>
<td>120</td>
<td>as above</td>
<td>$1,799</td>
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<td>Intel 80486DX-50 MHz</td>
<td>32 max</td>
<td>120</td>
<td>as above</td>
<td>18 bit SVGA card, 1MB Video RAM &amp; Hi-Color Support, 14&quot; M64x680 VGA</td>
<td>$1,999</td>
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<tr>
<td>486sz/266</td>
<td>New Double Clock CPU</td>
<td>New Build 128K CPU cache</td>
<td>32 max</td>
<td>120</td>
<td>as above</td>
<td>$2,499</td>
</tr>
</tbody>
</table>

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Circle 241 on Inquiry Card.
IBM Boca Raton Readies OS/2 Enhancements

BOCA RATON, FL—Now that IBM has passed the 1 million sales mark for OS/2 2.0, the company has its hands full keeping the bandwagon rolling at a sufficient clip to ward off the 16-bit Windows threat while attempting to preempt Microsoft's unreleased 32-bit Windows NT. By the end of the year, IBM expects to make several announcements in the areas of OS/2 multimedia, 32-bit graphics, Windows 3.1 support, and pen computing.

IBM's programmers have been improving OS/2 and fixing more than a hundred bugs found in the initial April release of version 2.0. By the end of next month, IBM expects to release a Service Pak that will fix the numerous bugs and enhance the operating system. The nominally priced Service Pak will offer faster DDE and Clipboard links between Windows and OS/2 Presentation Manager applications and between Windows applications when run from OS/2. A 32-bit graphics engine will provide developers with a flat-memory model that should cure problems encountered from the previous 16-bit engine's resource limits. Slowness attributed to 32-bit graphics calls being thumped, or converted, into 16-bit instructions should be alleviated, and seamless Super VGA and XGA support will allow for resizable windows where the original version 2.0 permitted full-screen windows only.

IBM will also provide video drivers for five major players in the video adapter market: Tseng Labs, ATI, Headland, Western Digital, and Trident. According to OS/2 senior programmer/manager Franz Walkow, the Tseng drivers will be included in the Service Pak; the others will follow early next year. A video device-driver kit for other vendors' boards should be available to developers this fall.

IBM will provide support for Microsoft's Windows 3.1 through an "installable feature." In this feature, the company will include most of Windows 3.1 but not games, the Windows macro recorder, the terminal emulator (OS/2 has its own terminal emulator), and certain applets. This feature will improve OS/2's support in several ways. DDE links will be supported across VDMs (virtual DOS machines), although OLE will work only within a single VDM. It will also add extensive online support for Windows, DOS, and OS/2. For example, instructions on creating a custom AUTOEXEC.BAT file for each VDM will be provided. (Previously, individual VDMs could not be customized beyond individual CONFIG.SYS files.) Windows applications will also run non-Windows DOS applications.

This year, IBM hopes to release OS/2 Pen Extensions for desktop pen devices (e.g., digitizing tablets) that are connected to desktop PCs. Support for pen-centric portable PCs like the original ThinkPad will arrive in the first quarter of 1993. Also slated is support for PCMCIA (Personal Computer Memory Card International Association) devices and the Intel-Microsoft Advanced Power Management specification.

Gordon Arbeitan, IBM's senior programmer for OS/2 Pen Extensions, said that the pen extensions will come bundled with an application called TeleSketch, which lets users share and collaboratively edit on a simulated blackboard across a LAN or a remote link. A second application called ImageMail, which lets you embed voice attachments in a pen program's document, began as an internal application and may or may not make it to market.

At the Fall Comdex, IBM plans to demonstrate beta versions of new UltiMotion software, a companion product to the shipping Multimedia Presentation Manager/2. UltiMotion, in combination with MMPM/2 and an IBM M-Audio or other adapters from Creative Labs and MediaVision, provides 8-bit audio, 320- by 240-pixel resolution, and full-motion color video at 24 frames per second. The program's algorithm can compress a 300-MB full-motion video file to a mere 6 MB.

—Ed Perratore

Now that LANs have become a reality in business computing, the move toward downsizing (or rightsizing) is gaining momentum, according to a recent Datapro Information Services Group (Delran, NJ) study. Of about 1000 respondents, 23 percent of MIS professionals plan to implement within the next 12 months a client-server structure in their organization, which is up from just 8 percent in 1991. One barrier to the successful implementation of a client-server solution, according to Datapro managing analyst Pam Paul, is that client-server applications and other software programs are not available yet for MS/OSes.

"There's a lot of pieces that are missing from this whole [client-server] puzzle," Paul said. One of those pieces is network system management, which is why Computer Associates is porting its CA-Unicenter for mainframes to NetWare.

Softool's president Leon Presser says that another software piece that will be crucial to the client-server puzzle is configuration maintenance and version-control. "As more companies downsize, the change-control problem is multiplying," he said. "If you're going to downsize, change and configuration management is essential where it was not as essential when you were centralized," he said. When companies move to distributed network solutions, Presser explained, someone still needs to be responsible for managing the software that goes out to a population of users.
Unleash 32-bit Power!

WATCOM C9.0/386 lets you exploit the two key 32-bit performance benefits. The 32-bit flat memory model simplifies memory management and lets applications address beyond the 640K limit. Powerful 32-bit instruction processing delivers a significant speed advantage: typically at least a 2x speedup.

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32-bit DOS support includes the DOS/4GW 32-bit DOS extender by Rational Systems with royalty-free runtime license
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32-bit Windows support enables development and debugging of true 32-bit GUI applications and DLLs.
- Includes licensed Microsoft SDK components

32-bit OS/2 2.0 support includes development for multiple target environments including OS/2 2.0, 32-bit DOS and 32-bit Windows
- Access to full OS/2 2.0 API including Presentation Manager
- Integrated with IBM Workframe/2 Environment

AutoCAD ADS and ADI Development: Everything you need to develop and debug ADS and ADI applications for AutoCAD Release 11

Novell’s Network C for NLM’s SDK includes C/386

The Industry’s Choice.

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

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

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

IBM, John Sayring, Director of OS/2 Software Developer Programs: “IBM and WATCOM are working together closely to integrate these compilers with the OS/2 2.0 Programmer’s Workbench.”

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

Novell, Nancy Woodward, V.P. and G.M., Development Products: “We searched the industry for the best 386 C compiler technology to incorporate with our developer toolkits. Our choice was WATCOM.”
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Sun Expands Alliance With Russian Computer Scientists

REDWOOD CITY, CA—Sun Microsystems (Mountain View, CA) has hired 33 top Russian computer scientists, including supercomputer designer Boris Babaiian, to write compilers and other development tools for Sun Sparcstations. Working under exclusive contracts at three locations in their home country, the Russians will apply their knowledge of multiprocessing architectures to a new generation of Pascal and FORTRAN compilers and optimization tools.

“We think this can be a precedent for other research-and-development-intensive companies,” said Scott McNealy, president, CEO, and chairman of Sun Microsystems. Babaiian, a longstanding member of the Russian Academy of Sciences, is known as the “Seymour Cray of the Russian computer industry.” He was the principal architect of the Elbrus-3 supercomputer, which was reputed to be three times faster than a Cray Y-MP, the fastest U.S. supercomputer. The 16-processor Elbrus-3 uses an architecture known as fine-grain parallelism to achieve its high performance. In the 1970s, Soviet computer designers pioneered multiprocessing architectures to overcome the limitations of their slower processors, and their long experience in writing software for those architectures is what attracted Sun’s attention.

Sun first contacted the Russians in 1990.

PCMCIA Standard Faces Incompatibilities

PCMCIA (Personal Computer Memory Card International Association), the standard for credit-card-size devices to hook up with laptop and palmtop computers, is off to a fast, and incompatible, start. At the Fall Comdex, about 50 vendors will be showing computers and peripherals that use the PCMCIA interface. The problem is that a significant number of them won’t be able to talk to each other.

PCMCIA got popular too fast. While the physical specification is well established, some critical pieces of the software standard are still missing. Socket services, which interface with the hardware, need to be reworked to meet the changing uses of PCMCIA. The card services layer, which is the layer above the socket services layer, isn’t complete yet. In their eagerness to use PCMCIA, manufacturers are working around the missing pieces by hooking into higher levels in various, mostly incompatible, ways.

PCMCIA is being stretched beyond what its designers originally envisioned. PCMCIA was supposed to be for memory cards, but it is becoming the standard for connecting any kind of peripheral to a notebook or palmtop computer. It is compact and power-efficient in a way that alternatives (e.g., the ISA bus) are not.

Because manufacturers are writing their own versions of the missing software, most of their work will probably have to be redone when the standard is made final. PCMCIA thinks the fuss is overblown. Brendan McGuire, executive director of PCMCIA, said he expects some incompatibilities. “That’s inevitable” with a new standard, he said. But he added that incompatibilities will be minor and companies have said they will release compatible versions of their software as soon as possible.

—Rick Cook
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Borland vs. Symantec: High-Level Intrigue

Is it a tempest in a teapot or a full-blown industrial espionage? And just how private is E-mail? That’s what people are wondering about one of the strangest scandals to erupt in Silicon Valley in years.

On September 1, Eugene Wang surprised his colleagues at Borland International (Scotts Valley, CA) by resigning to join Symantec (Cupertino, CA). As vice president and general manager of the Languages Business Unit, Wang was one of Borland’s top executives.

But the real surprise came after Wang resigned. Borland says it “received information” that Wang had leaked company secrets to Symantec. Borland then accessed Wang’s corporate MCI Mail account and read all the messages he had sent over the previous five days. According to Borland, at least 10 of those messages were addressed to Symantec CEO Gordon Eubanks and contained secret information about Borland’s marketing plans, recruiting prospects, business strategy, and specific strategy regarding Symantec.

Borland called the local police and the district attorney, charging that Wang had stolen trade secrets, a felony in California. Authorities obtained search warrants and raided Wang’s home and Eubanks’s office and two houses. The 12-page list of seized items included computers, disks, and files. The next day, Borland sued Wang, Eubanks, and Symantec.

How did Borland access Wang’s MCI Mail? Borland uses MCI for internal communication and pays for its employees’ accounts; therefore, Borland had Wang’s password, and the company was able to scan his MCI mailbox. Borland says that this is the first time it has read an employee’s E-mail.

Symantec won’t comment on specifics but denies any wrongdoing. Symantec also accused Borland of “harassment tactics” and dismissed the situation as a “tempest in a teapot.”

—Tom R. Halfhill

C&T Refocuses on Single-Chip Systems

Chips & Technologies (San Jose, CA) says it will no longer make new clones of discrete Intel-compatible 80x86 processors; instead, it will focus its efforts on single-chip systems for the emerging portable computer market. Spokesperson Gavin Bourne put a positive spin on the company’s fourth-quarter financial loss of about $8.8 million, saying C&T is now shipping its Super386 processors and SuperMath coprocessors in volume. C&T will continue to ship its Super386DX processor but has canceled its plans to release the Super38600SX and 05SX processors. “The [SX] parts are here, but clearly, the market has collapsed,” he said.

—David Andrews

New RISC Chip to Emulate 486 and 68040

International Meta Systems (Torrance, CA) claims it has a new RISC microprocessor that can emulate an Intel 486 or Motorola 68040 at their full native speeds and at a fraction of their cost. IMS is pitching the CPU for pen computers that need high performance for tasks such as handwriting recognition. It also says the chip could be used in a “chameleon computer” that runs PC and Mac software.

The IMS 3250, slated for mid-1993 production, is a two-chip set with a RISC CPU and an I/O controller. IMS says the 3250 will use 0.7- or 0.8-micron CMOS technology with the equivalent of 400,000 transistors. Clocked at 100 MHz, the CPU reportedly runs at 90 MIPS in native RISC mode.

What sets the 3250 apart from other RISC chips is its programmable microcode. Although many CISC processors implement their instruction sets in microcode, most RISC chips do not. Systems designers can reprogram the 3250’s microcode using assembler-like tools. IMS says it has written modules that emulate a 486 at 25 MHz and a 68040 at 30 MHz, including FPU support.

To build a computer that runs both PC and Mac applications, a designer would still have to add the appropriate system software. PC clones are easy to make, but a Mac clone would require either licensed Mac ROM chips or their legal equivalent. One possibility is a Mac “compatibility engine” such as the toolbox emulator from Quorum. IMS says the 3250 will cost just $50 to $60 in production quantities.

—Tom R. Halfhill

Home Row (Clackamas, OR, (503) 656-2995), the developer of the J-Mouse—an alternative to the traditional mouse for Microsoft Windows—has developed a smoother-functioning version of the device that the company hopes will make the J-Mouse a standard on desktop keyboards. Portable PC manufacturers have already incorporated the J-Mouse into their keyboards so that you don’t have to struggle with a klunky trackball. The J-Mouse, which appears as a blue-colored J key in the keyboard, does double duty as a regular alphabet key and as the actual pointing device. Sejin America (Sunnyvale, CA, (408) 752-8447) will include the J-Mouse in a new 101-key keyboard.

Rumors of the demise of WordPerfect have been greatly exaggerated, says Russ Dastrup, product manager for the WordPerfect database package. Responding to reports in trade papers and in BYTE’s September Microbytes claiming that WordPerfect’s new WISE (WordPerfect Information System Environment) strategy could mean the end of DataPerfect, Dastrup said the software “is not dead.” To the contrary, he says, WordPerfect’s board of directors has “made a recommitment to DataPerfect in both development and marketing.” A new release 2.3 is expected to ship at the end of October, while work is under way on “a version beyond 2.3,” Dastrup says.

California would gain as much as $5 billion in reduced fuel costs and increased productivity a year if more workers commuted electronically, a study by the California Engineering Foundation says. The biggest obstacles to telecommuting are structural (e.g., the IRS rules on workers’ home offices).

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Tandy Goes After the Interactive Home Market

Tandy has joined companies such as Commodore and Philips in the interactive home-learning, information, and education market. Tandy has announced a new CD-ROM-based digital information delivery system that uses the TV as its display. As part of the announcement, Microsoft said that it is developing a modified ROM version of Windows for Tandy's new VIS (Video Information System) multimedia player that's optimized for viewing on TV. Modular Windows titles feature large 3-D buttons and support a simple point-and-shoot remote-control operation.

Tandy will be competing with Philips's CD-I and Commodore's CDTV formats—not of which will be compatible with VIS—as well as possible future products from Sega, Nintendo, and NEC. But the alliance with Microsoft enables Tandy to attract potentially thousands of developers to Tandy's VIS format: applications developed for VIS will be easily ported from standard Windows to Modular Windows, both companies said. Mike Grubbs, senior director of Tandy's marketing department, said Windows 3.1 programs won't be able to run on Tandy's or other manufacturers' VIS players without at least some modification to the program's interface and drivers. For example, users interact with CD-ROM Windows applications via the keyboard, and VIS players won't have a keyboard. "But a lot of applications will transfer quite readily," he said. "Adaptations required in the program will be relatively minor."

Tandy envisions VIS as a technology that will be integrated into products tailored to learning, information, and family entertainment, where programs will let viewers interact with pictures, voice, music, and animation. Grubbs said that because Tandy will license the VIS format to other drive manufacturers, including Zenith Electronics, pricing of VIS players will be left to individual vendors. But Zenith's player will sell for about $700, which is about the same price as a VIS player that Radio Shack will sell.

The VIS player looks like a standard CD audio player (it will play standard audio CDs) but will be more simple to operate, Grubbs said. A typical VIS configuration will use standard TV as its display with stereo sound provided through audio connections to a TV or receiver. VIS players will also have an infrared remote handheld controller, and a Save-It cartridge for saving positions in programs and other user information. Nearly 50 software and content-publishing companies have committed to delivering over 100 VIS titles, which will range from $29.95 to $79.95.

Beginning this fall, VIS products will be sold nationwide by consumer-electronics retailers and department stores, including Tandy's own Radio Shack stores under the Memorex label. VIS products are expected to be available in stores before Christmas.

—David Andrews

PCSes Battle for Bandwidth

PCSes (personal communications services) may be in trouble before they even get off the ground. Despite recent FCC approval, the plan to use high-frequency radio to tie together pocket telephones, personal computers, and other kinds of equipment, is facing powerful opposition in the U.S. Senate because of a squabble over frequency allocations.

Recently, a group of computer industry leaders, including representatives from Apple, went to Washington to testify against a proposal that would effectively block PCSes from the wavelengths the FCC assigned. The FCC chose to assign PCSes to the relatively underused 2-GHz bandwidth. However, underused doesn't mean unused. Some corporate communications systems, notably utilities and railroads, use the frequencies. Senator Ernest Hollings (D-SC), chairman of the Senate Commerce Committee, says he will introduce legislation to protect the utilities and railroads if their concerns aren't met. PCS proponents in the communications and computer industries say that Hollings' bill would effectively kill PCSes.

—Rick Cook
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They say nothing's perfect.
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From its bright, easy-to-read LCD screen to its light-as-a-feather weight, the T3300SL may very well be the best-designed 386 notebook you can buy.
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Our engineers gave this Toshiba a rapid fire 25 MHz 386SL microprocessor, a PCMCIA slot, and your choice of an 80MB or 120MB hard drive, not to mention all the other qualities that make a Toshiba a Toshiba. Namely, standard size keys with full key travel. Compatibility with our DeskStation IV And Maxtime power management, which lets you get the most out of yet another virtuous feature: a powerful Nickel Hydride battery.
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Other companies need several packages to do what Corel does in one!

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<thead>
<tr>
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<th>Drawing/Illustration</th>
<th>Charting/Presentation</th>
<th>Photo-Editing</th>
<th>Fonts</th>
<th>Clipart</th>
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<td>Micrografx</td>
<td>Designer</td>
<td>Charisma</td>
<td>Picture Publisher</td>
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<td>Harvard Draw</td>
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<td>Aldus</td>
<td>Freeland</td>
<td>Persuasion</td>
<td>PhotoStyler</td>
<td>12</td>
<td>305</td>
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<td>Corel</td>
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REPORT FROM SÃO PAULO

SÃO PAULO—Large computer trade shows are often held in relatively small places like Las Vegas, Nevada, or Hannover, Germany, where the event dominates the city’s existence during its run. But the biggest show of all, by some measurements, is just another layer of crowding in this mammoth, blocky metropolis of over 22 million inhabitants.

Twenty minutes from São Paulo’s gridlocked downtown lies the relatively open space of Anhembi Park. This area contains an imposing trade-show building, a modern conference facility, and, between them, the mortar skeleton of an unfinished hotel. The visitor’s glance is almost unwillingly pulled to the aborted structure and its dramatic outline. This, in a few acres, is the promise and despair of Brazil: the surge toward development and, at its center, the hulk of an economy gone mad.

Inflation is Brazil’s principal, inescapable fact of life—now back to around 20 percent a month after temporary constraints imposed by the reform government of Fernando Collor de Mello in 1990. Businesses continually take the pulse of the economy in order to hedge the inflation with purchases of dollars, precious metals, or goods. It is an ongoing, counterproductive distraction.

During a single week last July, the cruzeiro, Brazil’s basic unit of currency, gained 7 percent against the dollar. It was the week of Fenasoft, a contraction of the Portuguese for “National Software Show.” Although Max Gonçalves, the 49-year-old dynamo who started the event in Rio de Janeiro a decade ago, is keeping the name, he insists that hardware has fully caught up with software, both at Fenasoft and in Brazil as a whole.

Banned in Brazil

Starting in 1964, when the country entered a 26-year period of military rule and changed from an agrarian to an industrial economy, walls of protectionism were erected around the computer industry, which the generals considered dangerous and subversive. With the resulting tariffs, software cost Brazilian consumers up to two and a half times what they would have paid in the U.S. In the 1980s, as the developed world latched onto microcomputer power, foreign hardware makers were banned in Brazil, except for a few mainframe and minicomputer producers. One of those, IBM, finally gained access to the microcomputer market in 1991.

In Brazil’s banks, law offices, and accounting firms, older generations of computers are treated with respect, even reverence. Often a single central microcomputer is shared by several executives, with lower-level bureaucrats and secretaries still pounding away at typewriters. The 8088-based XT is common in high-profile places and constitutes almost a third of new sales. Hard drives are frequently no more than 10 or 20 MB in size. Monitors are typically CGA. The most common word processor in the country is WordStar, and a significant proportion of the installed base is WordStar for CP/M.

Although XTs are prevalent here, a visiting journalist found himself the center of attention whenever he prepared to take notes on his XT-compatible palmtop. This was the Poqet PC, an 80C88-based computer, whose 9- by 4- by 1-inch dimensions caught the eye of many Brazilians, to whom such miniaturization seemed irresistibly encanto (charming) or engenhoso (ingenious).

A Hunger for Technology

Despite a diet of outmoded technology, or perhaps because of it, a hunger for sophisticated products has arisen. In a nation of 150 million citizens, an estimated 1 million computers are in place, perhaps half of them brought in against the rules. The guess is that 80 percent of individual users and 20 percent of corporate users have dealt with smugglers.

The public, deprived of the possibility of shopping, stays abreast by reading. Brazil’s major newspapers run regular computer supplements, and there are 17 monthly computer magazines and five semimonthly computer newspapers, all designed to keep readers up-to-date on the latest in cutting-edge, unavailable technology. One is reminded of the movie Modesty Blaise, in which a parched Dirk Bogarde crawls through a blazing desert, rasping, “Champagne, champagne....”

As Brazil’s protectionist economy fades away, computer vendors are anxious to show their wares

The extra excitement this year coincided with long-awaited moves by the democratically elected government, now politically beleaguered, to end trade barriers.

PHOTO: UNIPHOTO/BRUCE MCALLISTER

NOVEMBER 1992 • BYTE 45
REPORT FROM SÃO PAULO

The bureaucratic hurdle of software registration—and its compulsory and expensive translation, filing of multiple copies, and months of waiting for a ruling—is gone. As for hardware, some of the tariffs have already been reduced and are scheduled to fall to 20 percent by the end of 1994. At that level, Brazilian merchants believe, legitimate products, with their telephone support, documentation, upgrade paths, and so on, have a fighting chance against contraband.

O Estado de São Paulo, the city's leading newspaper, noting that barely 10 percent of the computers in the country are currently networked, predicts that the connectivity market will grow to eight times its present size in two years. And Marcelo Bernstein, editor in chief of BYTE/Brasil, while referring to the inflation as "our catastrophe," also calls himself "optimistic" about the computer industry here. He cites estimates that 350,000 new systems will be installed in the next three years. "It's the only way to make economic achievements," he says. "This country understands that there's no way to run any industry without computers."

"The Billion Dollar Show"

No wonder, then, that Fenasoft attracted a multitude that American showgoing veterans would find difficult to imagine. Published estimates ranged as high as 800,000, but Fenasoft president Gonçalves, anticipating incredulity at such numbers, hired a group of young, upright Mormons from Salt Lake City to handle the attendee registration process. This group, Market Lead, had firm figures of 450,000 badges sold at US$5 apiece by show's end; this doesn't count staffers, press, students (who had special badges), and those who may have circulated their cards for a price. That made Fenasoft '92 the world's largest strictly computer show, in terms of attendance. It also drew more than five times the number of the U.S.'s biggest computer show, Fall Comdex.

On the second day, a delegation from Comdex's producers, The Interface Group, including president Sheldon Adelson, arrived from Boston for a look-see. Interface is one of three sponsoring groups for Comdex/Sucesu-São Paulo, which it billed as "South America's Largest Computer Trade Show and Conference," scheduled for a mere 45 days after Fenasoft in the same hall.

What the members of the delegation saw as they made the rounds were some 800 exhibitors in a room of 485,000 square feet, in many respects similar to a large trade show in the U.S. Although the familiar logos of IBM, Compaq, Microsoft, WordPerfect, Lotus, and Borland were in evidence, some of the largest exhibitors—Itautec, Microtemp, SID—were domestic hardware manufacturers. Equally large booths represented Brazilian software distributors Compucenter Informática, Brasp, and Wild West. Most of the hardware groups would return to the Interface show in September.

But surely most impressive to the visitors were the teeming attendees, who swarmed in, eight or 10 abreast, almost uninterrupted. At times, the aisles were almost impassable. And these throngs were not what American show producers sometimes disparagingly refer to as "junk people." Since Brazil does not have U.S.-style distribution channels of computer stores, outlets, or mail-order houses, many attendees were here to buy. Fenasoft is a cash-and-carry show; hardware and software alike are for sale on the spot.

Some of the paper deals cut on the floor were large-scale. ZIM, a Canadian database management firm with a strong presence in São Paulo, appeared at Gonçalves's office with a case of champagne to toast the signing of a nearly $10 million contract with a Brazilian firm. Taking into account floor transactions, exhibitor fees, advertising revenue, and attendance charges, the business magazine Visão Econômica headlined its story "The Billion Dollar Show."

Few New Products

The missing ingredient usually associated with important trade shows was an array of new products. That is presumably because the country's restrictive trade policies have also restricted innovation. As President Collor said shortly after he took office two and a half years ago, "Protectionism leads to incompetence." Many Brazilians wondered why, with such clear-sightedness, he had not moved more quickly to stimulate the talent and energy of his country's domestic computer industry.

There were some signs, however, of what may prove to be fertile ground. A Brazilian company, Êncel Informática, showed a word processor for Windows that seemed to be competitive with Word for Windows 2.0 and even performed rapid on-the-fly formatting in preview mode. But a shipping copy is not available yet, and there is little reason to anticipate an English-language version for export. There are hopes for a database application development system, Joiner 3.0, which Tux on Software Development of São Paulo intends to introduce in the U.S. One of its claimed features is that it compiles the same code for DOS or Unix.

Deico Electronics, an established California motherboard manufacturer, is making a move both into Brazil and into the systems business. It has committed to building a factory in Florianópolis, the island capital of the southern state of Santa Catarina, to produce hardware for worldwide export. Ingrid Moos, Deico's CEO, recalls a meeting with the governor of Santa Catarina, who told her, "Go to Singapore. Go to Hong Kong. Go to Taiwan. Get the best deal you can and then come to me. I'll beat it." And, she adds, "he did."

Bridging the Computing Gap

To one viewing Brazil from the perspective of an interested and sympathetic visitor, a striking parallel suggests itself between the nation's computer users and its society as a whole. At the top is a healthy high end, familiar with mainframes, minicomputers, and networks, using Unix-based systems and coding in a variety of languages—the elite. At the bottom is that massive, uncontrollable population of XTs. And in between, there is a void—virtually no 286s, no 386s, no middle class.

When that void is filled, computers may actually make a difference to this inflation-wrecked country. Simple software can provide immediate solutions to common, time-wasting bothes. For example, restaurant workers who repeatedly copy new prices onto their menus can have a software package do the conversions and the printing for them. And businesspeople who lose hours of their weekday reacting to the crucero roller coaster can automate many of their calculations. Perhaps enough time, money, and energy will be saved by such widespread utilization of computer technology that the hotel in Anhembi Park can, before too long, be finished. ■

Stephen Banker is the Washington-based publisher of Tapes for Readers, a series of audiotape interviews with contemporary figures. You can reach him on BIX as "sbanker."

46 BYTE • NOVEMBER 1992
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<thead>
<tr>
<th>Phar Lap DOS-Extender</th>
<th>Vendor A</th>
<th>Vendor B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturity</td>
<td>Over 5 years and 1000 applications</td>
<td>Less than a year</td>
</tr>
<tr>
<td>Memory Model</td>
<td>Safe</td>
<td>Dangerous</td>
</tr>
<tr>
<td>Compatibility</td>
<td>INT 15, XMS, VCP, DPMI</td>
<td>XMS, DPMI</td>
</tr>
<tr>
<td>Library Support</td>
<td>Extensive list of 32-bit libraries</td>
<td>Limited library support</td>
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<tr>
<td>Documentation</td>
<td>Extensive and detailed</td>
<td>Limited</td>
</tr>
</tbody>
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Underdog is here, with fresh new lines of desktop and portable PCs built to oppose the dreaded price-busters and make IBM a contender once again.

“Great machines, but can’t justify the cost.” The words may have varied across corporate America, but the sentiments were consistent regarding IBM. The products were good. The technology was cutting-edge. But as the performance and quality of clones improved, pricing became increasingly important. IBM, came the cry, didn’t get it.

Now that IBM apparently gets it, you can get an IBM machine for an affordable price. Big Blue’s sweeping announcements opened the fall season with a restructuring of the company’s existing PS/2 line; the debut of a new clone buster line called PS/ValuePoint; and, at last, the introduction of a formidable notebook line. The new product announcements came roughly a month after IBM’s formal reorganization of its Personal Systems line of business into the IBM Personal Computer Co., a separate operating unit. With the new operating company in place, the new lines boost a better chance of evolving with the needs of the market place.

The first task IBM faced in developing low-cost desktops was to redefine the PS/2 line, which had ranged everywhere from the 386SX/20-based PS/2 Model 35 to the PS/2 Server 295, the multiprocessing Par- allan superserver IBM resells. The new PS/2 theme? Exclusively Micro Channel architecture, XGA-2 graphics on the motherboard, compliance with the latest ISO specifications for the work environment, SCSI, and fat three-year warranties that include on-site service worldwide. PS/2s also sell with OS/2 2.0 preinstalled.

The PS/2 Models 80 and 90 will remain in production, but IBM plans to phase out the Model 70. Now in the line are the 486-based PS/2 76 and 77 and the 486SLC2-based PS/2 56 and 57. While all PS/2s are upgradable, the 56 and 57 have an as-yet unannounced upgrade path. Rely on Intel, if not IBM, to clear up that ambiguity.

Break with the Past
As before, the IBM PS/2s will be sold through dealers and system integrators as well as directly to corporate accounts. In addition to these channels, however, Big Blue will market its new, lower-cost PS/ValuePoint line through distributors as well as by mail order. IBM experimented in the mail-order channel with its PS/2 Models 35 and 40, both of which are being phased out. The only channels through which IBM doesn’t plan to offer the ValuePoint are retail stores such as Sears and superstores; these remain the realm of the newly revamped PS/I line.

New for IBM, and expected to encompass at least the PS/ValuePoint line, is the company’s intention to advertise estimated street prices (with a footnote that dealer prices may vary) instead of its own suggested retail price. This departure is good news for consumers, provided that the figures quoted are indeed representative of the average. It also reinforces the message that IBM is meeting traditional mail-order PC makers on their own turf.
Under the hood, the three IBM-designed and manufactured systems that make up the PS/ValuePoint line are easily distinguishable from the PS/2s: industry-standard—as opposed to industry-leading—is the way IBM describes them. More specifically, the desktop systems are ISA-bus machines with Super VGA graphics, an IDE hard drive, and no external caching. The top-of-the-line model, the 433DX, is a 33-MHz 486 system with 8 MB of SIMM RAM standard (expandable to 32 MB), a 170- or 213-MB hard drive, five drive bays (three of them slim-line) with one 1.44-MB slim-line drive included, and five 16-bit slots, all available since the video and I/O circuitry are integrated on the motherboard. You can upgrade the system with an Intel 486DX6/66 processor.

What's notable about this system (and the 486SX/25-based 425SX as well) is that the rumored internal battle over whether a value-line system might sell better bundled with Windows appears to be over. Buy an OS/2-equipped system, after all, and you'll also have virtually all of Windows—perhaps version 3.1 by the time you read this. The 425SX's standard configuration is 8 MB of RAM (expandable to 32 MB), your choice of an 80-MB or 170-MB hard drive, the same expansion-slot and drive-bay setup as with the 433DX, and upgradability to a 486DX2/25 or 486DX2/66. If you do not need even this level of performance, the PS/ValuePoint 325T offers a 486SLC25 processor (with an 8-KB internal cache), 2 MB of 70-nanosecond RAM (expandable to 16 MB), and an 80- or 170-MB hard drive. It doesn't come with OS/2 2.0; DOS 5.0 alone is preinstalled. On benchmark tests that we ran on a preproduction 325T, the machine scored midway overall between the Compaq Deskpro 386/25c and the faster Tandon 486/25 on CPU, disk, and video tests.

All ValuePoint systems offer a one-year on-site warranty. IBM claims a 4-hour response time—an improvement over the standard support services that Dell Computer provides for its low-end Dimension line. IBM provides this service through its toll-free HelpWare line, which is staffed during the clock seven days a week.

Overseas, don't expect the PS/ValuePoint line to replace the Ambra clones that IBM's Individual Computer Products International subsidiary is selling on the international market. According to an IBM spokesperson, there is room for both lines, however much market share the new machines may chip away.

**TFTs and Jujubes**

Over the years, IBM has earned the Rodney Dangerfield no-respect award for its notebooks; an IBM spokesperson even denied one recent offering as "a 12-pound system with an 8-minute battery life." However, the company has finally announced an entire line of respectable machines, called ThinkPad. For the one 386SL/25-based model that so far makes up the low-end 300 series, Big Blue had to swallow its pride and have Zenith Data Systems do the building according to IBM specifications.

No such humility need accompany the three-model 700 series. The product we've known as ThinkPad, the pen-based tablet that runs Go Corp.'s PerPoint operating system, is now ThinkPad Model 700T. The star of the line, the 486SLC/25-based Model 700C, is a 7/8-pound Micro Channel-bus model (all 700-series models are considered PS/2s from design to distribution) that uses a 10'/i-inch TFT (thin-film-transistor), active-matrix color VGA display that was developed through IBM's joint venture with Toshiba. Its nickel-metal-hydride battery provides 2 hours of continuous use (with a claimed 4 hours of typical workday use). Dual display is possible for presentations—the screen will even tilt back at a full 180-degree angle to the keyboard so presenters won't have to peer over it at a podium. Both DOS 5.0 and Prodigy software come preinstalled for the price, expected at press time to be about $4000 on the street.

There's more. The standard 4 MB of RAM comes on a module that slides in and out of the PC from the outside for upgrades to the 16-MB maximum. The 120-MB hard drive eases in and out of a slot the same way, and a metal tab protrudes to let you snap on a small padlock.

Another attraction of the 700C and its monochrome equivalent, the Model 700, is IBM's ready to relinquish none of its claim of providing some of the most cutting-edge computing power you can find today. But for those who can't afford that PS/2 technology—or don't need it at every station—at last the company has hit on a formula of lower prices for industry-standard systems that maintain the reliability on which IBM made its name. And if the new, lower-cost systems take away some PS/2 profits, well, Big Blue would rather see the dollars go for a PS/ValuePoint than for a Compaq ProLinea.

**Ed Perratore is a BYTE news editor based in New York. He can be reached on BIX as “perratore.”**
As the world awaits Windows NT, Windows for Workgroups—Microsoft's newest upgrade—offers an impressive set of network services. They function equally well whether you're sharing information and printers between two PCs or working with multiple machines on existing NetWare or LAN Manager networks. WFW is easy to install and use and includes peer-to-peer file, printer, and Clipboard sharing; mail capabilities; group scheduling; chatting functions; and simple network-monitoring tools.

WFW installed smoothly on two NetWare-connected PCs, automatically detecting the NE2000 adapters in use and adding Microsoft's IPX-over-NDIS protocol alongside WFW's native NetBEUI (NetBIOS Extended User Interface); the TCP/IP alternative isn't supported yet. After rebooting, both machines reconnected to the NetWare drives and printers they'd been using. Since I assigned them the workgroup name published by my Windows NT test machine, the WFW machines could use that machine's shared drives as well as each other's. Given the NT result, it's likely that connecting to a LAN Manager server (one wasn't available) would have been equally painless. Windows lags noticeably when there is heavy access to shared resources, but that's true of all DOS-based peer-to-peer LANs.

WFW will not republish NetWare or other remote drives as shared resources. Microsoft says you can share out a local CD-ROM drive provided that you use MSCDEX 2.21 and specify the /s switch. There's no remote-access solution for pure WFW networks yet; the best you can do now is dial into a LAN Manager network, using its client software instead of WFW's, and then tap into WFW resources visible on that network.

WFW's dual-shell configuration for NetWare isn't as unwieldy as LAN Manager 2.1's. Microsoft has rewritten components that used to compete for conventional memory or UMB (upper memory block) space as Windows virtual device drivers. The redirector and the NetBEUI transport (as well as the server) run in protected mode, so the real-mode memory hit is almost nil. That's great news even in straight WFW or WFW/LAN Manager environments, since Microsoft's real-mode redirector and transport are bulky.

There's one catch. To benefit, you've got to be running Windows in 386 enhanced mode. For DOS-only and standard-mode Windows users, WFW includes a real-mode redirector and NetBEUI (although no server), but they're poor substitutes for their protected-mode cousins. If you use Windows only occasionally, you'll be better off with one of several excellent peer-to-peer networking products for DOS.

You should note, however, that WFW jumps through hoops to make Windows more attractive as a permanent habitat. File Manager and Print Manager gain toolbars that make sharing out resources, as well as attaching to others' shared resources, mostly a point-and-click affair. It's not as slick as the Macintosh's System 7.0, but it's much better than LAN Manager 2.1, and fully graphical at last. If you're sharing resources, you can use NetWatcher to monitor who's connected to your machine and WinMeter to see how much CPU power the server is stealing from your applications.

WFW packs considerable value beyond basic networking. It includes the newly redesigned Microsoft Mail 3.0 client and...
Picture This... a real-time television monitor built right into your PC... Now, picture using this monitor while running Windows™ 3 applications at the same time... And, picture taking that video image and resizing, (right down to crystal-clear icon size!) or clicking and dragging it to any position on the screen as easily as moving any other Window...

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Get the new Win/TV and open a window on some fresh, new and exciting possibilities.
The new (to Windows) Schedule+ application (see the screen). Mail uses the MDI (multiple document interface) to create its own miniature desktop for in-box, out-box, and user-created folders. It supports drag-and-drop transfer of messages among folders, and it also handles drops from File Manager by attaching the dropped file to a new message and prompting you for an address. The message editor supports the OLE Insert Object... command, so you can embed pictures or voice annotations in messages.

In a stand-alone workgroup, one machine has to own and share out the directory tree that is the "post office," and it must always be available. Alternatively, a workgroup attached to a server-based LAN can locate the post office at the file server, although I had to trick Mail into using NetWare for that purpose. Mail rolls its own directory services; it can’t acquire the user databases of NetWare or LAN Manager, nor can it synchronize with WFW’s distributed machine-name/password data. So on my NetWare-attached WFW machine, I have to log in three times: to NetWare, to WFW, and to Mail. To send mail to other workgroups or to the outside world, you’ll generally need a server edition that can route mail through gateways to foreign destinations.

WFW supplies a scaled-down version of MAPI, Microsoft’s messaging API, for Mail’s use—and for any other program that wants to exploit it. Schedule+, which integrates tightly with Mail, is the other obvious MAPI client. There’s also a File Manager extension that, if named as an add-on in WINFILE.INI, appends a send-file button to File Manager’s toolbar.

WFW’s generic support for mail-enabled software may change how you work even more than its file-sharing features do. If I send you a document via a shared directory, I still have to tell you where I put it, what it represents, and when you can retrieve it. I may also need to configure that shared directory for privacy. If I mail you the document, the meta-data (“final version, includes your changes”) and the data arrive in your private mailbox.

I can also send you a document, or part of a document, by way of WFW’s networked Clipboard. Built around the network DDE toolkit, the WFW Clipboard viewer becomes a “ClipBook viewer”—essentially a Macintosh scrapbook with Publish/Subscribe capability. If I connect to your ClipBook, I can transfer “pages” you’ve chosen to share onto my Clipboard and then into my applications.

Like MAPI, NetDDE could be an important enabling technology. The Chat program uses it, and other applications will surely follow. Would-be NetDDE developers may rightly wonder, though, how the protocol fits in with RPCs (remote procedure calls), Windows sockets, and a variety of other network IPC (interprocess communications) mechanisms lately advanced by Microsoft.

WFW’s most ambitious push into the groupware realm is Schedule+, a personal planner and meeting maker. I can invite you to a meeting by picking your name out of Mail’s address book. Schedule+ merges our schedules into my planner and picks the first slot that’s mutually available. Then it mails you an invitation form. If you confirm by return mail, the meeting is book and appears in our planners.

The only hitches are that Mail must be active to keep your schedule up to date and Windows briefly halts when Mail polls for messages. Fortunately, Schedule+ lets you delegate appointment-making to an assistant who can act as your proxy.

This is potent stuff. WFW’S pushes mail-enabled groupware into the mainstream, raising users’ expectations of what their networked software should do. It isn’t Lotus Notes for the rest of us yet, but it’s a big step in the right direction.

Jon Udell is a BYTE senior technical editor at large. He can be reached on BIX as "judell," or on the Internet at judell@byreb.byte.com.

**Facts**

**Windows for Workgroups**

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LANtastic Merges PCs and Macs

In this election year, it’s not difficult to compare Mac and PC users to the major U.S. political parties. All have their strong (often conflicting) opinions on “platforms” and applications, and getting them to work together is often virtually impossible. Still, in this Age of Connectivity, there’s a real need for Mac and PC users to share files, applications, and resources through those ubiquitous LANs.

Mac-to-PC connectivity has been available for some time, but for those who wanted to go beyond simple, low-cost solutions (e.g., Traveling Software’s LapLink Mac), the cost of truly networking these disparate platforms has been a budget buster. Until now, that is. Leave it to Artisoft to find a solution. The company’s powerful yet inexpensive LANtastic network operating system has taken the lion’s share of the PC peer-to-peer market. And now, with LANtastic for Macintosh, Artisoft has blasted its way into the Mac-to-PC connectivity market with a product that is destined to get Mac and PC users talking again.

Artisoft’s product is a unique blend of conventional and unconventional technology. To start off, you will need one or more PCs. On that side of the network, things are simplified immensely by the fact that Macs already have a built-in network; LANtastic for Mac works with all varieties, whether you use the default LocalTalk or opt for adding the faster (and more expensive) EtherTalk or TokenTalk. On the other side, you’ll need one or more PCs running LANtastic 4.0.

To tie the two sides of the network together, you’ll need a gateway server. The heart of LANtastic for Mac is a dedicated PC that sits between your Macs and PCs, acting as the translator between the two worlds. A gateway PC isn’t an unusual approach, and with the price of PCs continually falling, it’s not an unreasonable expense.

Although the gateway server can be just about any flavor of PC, it’s best to choose a system with as hefty a hard drive as you can afford. That’s because the gateway server acts as a central repository of files for the network.

A bit of explanation is in order: Because LANtastic for Mac costs orders of magnitude less than other Mac-to-PC solutions, there are, of course, a few compromises. The major one is that, while Macs on the network can read files off both the gateway server and any PC that’s set up as a LANtastic server, PCs can’t read files directly off Macs. PCs can, however, read Mac files stored on the gateway server. Therefore, if you want to do lots of file sharing, a large hard drive on the gateway server can pay dividends.

The major work of setting up LANtastic is in setting up the gateway server. I used a 386SX-based system with a 380MB hard drive. I installed a standard LANtastic AE-3 Ethernet card and software, configuring it as a server on my small LAN of four PCs. The next step was to install the Farallon LocalTalk card (included with LANtastic for Mac) into the gateway server and connect it to my Mac files stored on the gateway server. I then installed the LANtastic for Mac software on the gateway server; this is where user accounts and resources are configured. Like any network, this one requires a bit of planning. One important part of the process is file extension mapping, enabling Macs to display PC files as icons on the Desktop. Most common applications and data-file types come with default icons, but you can also set up new ones.

I also set up the printer resources. One thing to note: Although PCs can’t directly access files off Macs on the network, any Mac or PC can access any printer connected to any computer on either side of the gateway server.

Over on the Mac side, all I had to do was make sure the AppleShare icon was installed in the Extensions folder of my Mac (running System 7.0). There is LAN Mac Manager software that lets you administer the gateway server from the Mac side, but it’s optional.

Setting up LANtastic for Mac is actually less complicated than it sounds. Once up and running, it works flawlessly and transparently. It’s particularly useful in this era of Mac and PC applications with compatible file formats. I was able to work with Microsoft Word and Excel, Aldus PageMaker, and Claris FileMaker files from both the Mac and PC sides, with the compatible data file sitting on the gateway server.

With a price that can’t be beat, LANtastic for Macintosh is an easy-to-set-up and easy-to-use solution for anyone who wants Macs and PCs to communicate on equal terms. If only politicians could do the same.

—Stan Miestkowski

THE FACTS

LANtastic for Macintosh
with LocalTalk card for PC server, $799; software only, $599

System requirements:
Any Mac with System 6.0 or higher, AppleShare Phase 2 workstation software, LocalTalk network, or EtherTalk or TokenTalk network adapter. Gateway server: PC with hard drive, LANtastic 4.0 or higher, LANtastic-compatible network adapter card, and AppleTalk adapter card (LocalTalk card included). PC servers: PC running LANtastic 4.0 or higher.

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Microsoft Windows Sound System

Microsoft, which legitimized the "serious" business use of PC sound boards with its release of Windows 3.1 and the Multimedia Extensions, has now decided to carve itself a slice of the sound-board pie. The Microsoft Windows Sound System is a windy name for a small and sparsely populated board (see the photo). On the surface, compared to other sound boards, this one seems to come up short by virtue of the things it doesn't do: You'll find no CD-ROM controller, no Sound Blaster or AdLib compatibility, no external MIDI port, and no big bundle of standard software. But the Windows Sound System is a moderately priced board bundled with unique, useful software tools.

Of all the sound boards I've looked at, this one is the easiest to install. A single jumper on the board let me select a port address. When I fired up the Windows-based setup program from the installation floppy disk, a dialog box popped up to tell me that the board's interrupt had been reconfigured automatically because of a conflict. That's how I like things to work.

Once the board is in, making the back-panel connections is a breeze. In keeping with Microsoft's current icon madness, the ports on the back of the board are labeled with symbols. It has 1/8-inch stereo jacks for a microphone (included), headphones (also included), and line input (for external devices like tape recorders). The headphone jack doubles as a line or speaker output, and Microsoft adds twin RCA line-output jacks for direct connection to speakers or to some devices' line input. Once the board is installed, everything about it is software-controlled.

The flagship application bundled with the board is called Quick Recorder. The name is a little deceptive; this is actually a capable sound editor that doubles as an OLE server. Quick Recorder employs an interface trick I haven't seen from Microsoft before: normal and expanded interface views. In normal view, only the minimum required controls and feedback are presented in a compact window. You can record, play, load, and save sound files, but you can't edit them. Expanded view brings up a more complex interface, with...
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The digital audio section of the Windows Sound System records and plays digital audio files at a maximum rate of 44.1 kHz in 16-bit stereo. Unique is the availability of a 4-bit compressed format in addition to the 8- and 16-bit formats. The compressed format can be used even at the 44.1-kHz rate to reduce space requirements to the equivalent of those for 22-kHz audio. I found no significant difference between 4-bit compressed and 8-bit uncompressed audio digitized at the same rate.

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The Sound System board sounds wonderful, and in my tests it recorded and produced clean, undistorted audio at the 44.1-kHz rate in 4-, 8-, and 16-bit resolutions. The lower rates were less impressive, as you'd expect, but passable.

Even though there are no external MIDI connections, the Windows Sound System includes a Yamaha OPL3 four-operator FM synthesizer. FM is the most prevalent synthesizer in audio boards, but it's a bit of a mismatch here: With the board capable of reproducing such high-quality digital audio, I wonder why Microsoft chose such a cheap-sounding synthesizer chip (most of Microsoft's competitors made the same mistake). Don't expect great-sounding music from this board.

The Windows Sound System includes a voice-recognition module. A Windows application sits in the background and listens to the microphone, waiting for voice commands. Each command set links command words and phrases with Windows keystroke macros. The idea is that you can run your computer, to a degree, by talking to it. Want to find out how much memory you have available? Just say "about Program Manager" into the microphone, and up it pops.

Every thing is user-customizable, but a standard configuration is included that supposedly recognizes a limited number of commands without requiring training for a particular user's voice. The prerelease version I used required training before it would do anything, but after I learned to use the same inflection every time I spoke, it worked some of the time. Perhaps this will improve in the shipping version.

Overall, I give the Windows Sound System high marks. Its ease of installation, excellent software, and superb digital audio quality make it a worthwhile, though late, entry in the Windows sound-card race.

—Tom Yager

THE FACTS

Windows Sound System
(pric e unavailable at press time)

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

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- Dazzle VB 289
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- Visual Basic/Win 139
- Visual Basic & The Bundle 228
- Visual Basic for DOS Professional 325
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C/C++ Compilers
- Borland C++ 319
- C++/Appl. Frameworks 539
- High C/C++ CALL
- Microsoft C/C++ 7.0 325
- MS QuickC for Windows 139
- Turbo C++ 69
- for Windows 112

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- C++/Views 449
- Codebase 4.5 399
- Greenleaf Comm++ 189
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- Q D Database Library 279
- R&R Code Generator 179
- SilverClip/Fox SPSC 239
- WATCOM SQL/Dev. Edit. CALL 359

Editors
- Multi Edit 89
- Multi Edit Professional 139
- SlickEdit 149
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Utilities
- Utilities 368 MAX 72
- After Dark 32
- Bar Code Library 350
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- Dr. Switch-ASE 159
- DTV (Data Vis. Tool) CALL 199
- Hijuak 350
- Hold Everything 179
- Iconic/query 219
- INSTALIT 199
- Label Maker 429
- MKS Toolkit 199
- Norton Anti-Virus 99
- Norton Commander 99
- Norton Utilities 6.0 119
- Opt-Tech Sort/Merge 199
- PC Tools Deluxe 7.0 129
- GEM 286 69
- SpinRite II SPECIAL! 59
- UpShot 139

Graphics
- Baby Driver II 239
- BLACKHAWK 46T 319
- Essential Graphics GUI 139
- Essential Graphics Kernel 179
- Graf/Drive Plus Dev. 269
- graphics-MENU 229
- GX Effects 2.0 179
- GX Graphics 224
- GX Text 2.0 134
- ICON-TOOLS 129
- ImageMan 369
- Menus 319
- NAPCAD/3D 79
- PBI 173
- T1L 20, 30 CALL 173
- Victor Image Library 173

Editors
- Brief 179
- ED NEW! CALL 89
- Multi Edit 139
- Multi Edit Professional 149
- QuickEdit 149
- WRTFAR 1015
- WATCOM FORTRAN 779.0 449

Graphic Libraries
- Baby Driver II 239
- BLACKHAWK 46T 319
- Essential Graphics GUI 139
- Essential Graphics Kernel 179
- Graf/Drive Plus Dev. 269
- Graphics-MENU 229
- GX Effects 2.0 179
- GX Graphics 224
- GX Text 2.0 134
- ICON-TOOLS 129
- ImageMan 369
- Menus 319
- NAPCAD/3D 79
- PBI 173
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Infolio Offers Mobile Workers the Power of the Pen

While pen computer system vendors struggle to find a common thread in an embryonic market, PI Systems has struck out on a narrower path. One of the first things you notice when using PI's Infolio is that it doesn't look much like a traditional computer. Rather than designing a notebook-style computer, PI started from scratch and built a deceptively simple yet effective electronic-clipboard type of tablet specifically for data collection tasks for mobile users. Using the Infolio is intuitive and requires little or no knowledge of computing, and nearly everyone I showed my test model to had a tough time letting go of it.

Infolio deviates from the pen-computing norm in its use of the Motorola 32-bit 16-MHz MC68331, which is more often encountered as an embedded microcontroller. Infolio also runs on PI's own internally developed object-oriented operating system, PICOS, which the company says will link to other platforms in 1993.

One reason PI selected the 68331 was that it's a fully static part, allowing dynamic adjustment from 0 Hz (in Infolio's low-power stop mode) to 16 MHz. The 9.4- by 11.2- by 1.2-inch clipboard, which weighs 2.9 pounds (3.4 pounds with a battery pack of 8 AA nickel-cadmium or alkaline batteries), also has no floppy or hard drives; its use of solid-state storage rather than rotating media greatly contributes to low power consumption and brisk performance.

Of its three PCMCIA drive slots, Infolio uses the first for a 2-MB SRAM (static RAM) card containing its operating-system software; the other two slots are for storing additional data or programs. Infolio's microkernel uses only about 200 KB of memory; the entire system software requires 1 MB of memory. The clipboard also sports a Sharp reflective LCD with VGA-level 640- by 480-pixel resolution, and it uses an awake/sleep mode as well as an automatic shutdown mode, prolonging battery life up to a claimed 12 hours.

On powering up Infolio, I was greeted by a list of graphical menus representing forms-based vertical applications that mobile users typically would fill out in the course of their jobs. An example is PI's series of patient-care forms that hospitals would use to track patient billing records or treatment schedules.

My developer's edition of Infolio included a clipboard environment that had several extra utility programs (e.g., a calculator, address book, and memory usage monitor) organized in an electronic file-folder format. At the discretion of developers, most Infolio users will probably not see those features, but they will be able to take advantage of PI's character-recognition system, which allows users to "train" the system to recognize their own printing, and its ability to capture cursive handwriting through electronic ink. PI will also sell a software developer's kit, called the ProformaSDK, that includes a graphical object-oriented applications development tool with an integrated database for developing applications for Infolio using Microsoft Windows-based PCs.

PI hopes to avoid the pitfalls encountered by highly touted but more horizontal pen-system companies. Given the 2-year-old start-up's narrow focus, PI just may be able to capitalize on early growth in pen systems long enough to stick around until the market takes off in earnest later in the decade.

—Patrick Waurzyniak

THE FACTS

Infolio
$1895; ProformaSDK, $1095

PI Systems Corp.
10300 Southwest Greenburg Rd., Suite 500
Portland, OR 97223
(503) 293-9585
fax: (503) 293-9590
Circle 1075 on Inquiry Card.

A Move Toward the Paperless Office

Okidata has coined the term Desktop Document Processing to describe DOC.IT, a printer, fax, scanner, and copier all in one. Okidata has tied all the parts and pieces of the everyday office into a neat package that features a well-integrated Windows application for controlling the hardware.

At the heart of DOC.IT is a dedicated add-in board with an Intel 960 RISC processor and 4 MB of its own RAM. The board takes the processing needs of document processing away from your system's CPU. It also communicates with the DOC.IT external hardware through a high-speed port. Because the board uses an independent add-in board installed and running before you can use any features. The independent
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COMDEX/Fall '92 Sands Convention Center Booth #3222 Ballys MultiMedia Showcase Booth #B910
functioning of the modules answers the question: I always have about all-in-one hardware: What happens when one part or function breaks? With DOC.IT Manager, system functions operate independently. Another feature that makes this peripheral practical is a control panel that lets you make a copy or send a fax while the system is running other applications.

As for quality, it appears that Okidata hasn't cut corners here, either. The printer, copier, scanner, and fax functions operate at resolutions of 300 dots per inch and above. (DOC.IT is available in two models, with 300- or 400-dpi printer resolution.) The fax is CCITT Group 3, and the 8-page-per-minute printer has standard emulations such as PostScript-compatible TrueType and PCL 5.

You use DOC.IT by accessing pull-down menus on the DOC.IT Manager interface. When I wanted to scan an image, for example, I just selected the type of image, resolution, intensity, and page size from the menu. I also had the choice of line art, number of gray levels, and halftones. The scanned image was stored in TIFF format, and I had the choice of compressed, decompressed, and 200, 300, or 400 dpi. The scanner operates at 10 ppm and offers a 64-level gray scale.

The fax function works equally well, and I realized that the fax and scan functions would do the most toward freeing my office of multitudes of paper. Fax features include broadcast, delayed transmission, phone book with group lists, logs, and polling. The document-fed scanner can also be pulled out to be a hand scanner, for books and things that won't fit through the sheet feeder. One key feature that won't be available for a while is character recognition, which I consider essential for turning scanned paper into workable data.

I found DOC.IT a bit of a novelty, but only because it offers so many functions in a relatively small package. It measures 8.5 by 17.5 by 22.5 inches and weighs just 36 pounds. I can imagine a device like this becoming an indispensable part of a busy office environment, but the market may be a hard one to crack. After all, most offices already have a laser printer, scanner, copy machine, and fax. But for those users with individual document management needs, DOC.IT might suit them all.

—Anne Fischer Lent

**Personal Accounting: Quicken 2.0 for Windows**

One of Quicken's strengths has always been its flexibility, and the beta of Intuit's new Quicken 2.0 for Windows that I looked at continues to demonstrate that trait. For example, the icon bar along the top of the screen (which automates standard actions) now lets you display icons, text, both, or neither. You can hide any buttons that you don't use, and you can add icons to automate transactions that you do often, open accounts that you use frequently, and implement a dozen other functions.

In the checkbook register-like transaction windows, you can now choose between two- or one-line entries. When you fill in the payee and category, new drop-down boxes let you choose names from a memorized list, and you can have those boxes appear automatically or by clicking a button—or choose not to have them appear at all.

Like the previous version, Quicken 2.0 for Windows has excellent standard and customizable reports, and now you can change, memorize, or print those reports using a series of buttons right on top of the report. This is handier and more intuitive than having to traverse a bunch of menus.

New features include the ability to create customizable graphs of income and expense, budgets, net worth, and investments. Another new feature (and one that I found to be particularly useful) is QuickZoom, which lets you double-click on any data in a graph and get more details. One optional new feature is IntelliCharge, which lets you reconcile your credit card statement automatically, by modem or on disk.

If you already use Quicken, you'll love this new version. If you don't use Quicken, you may want to give this intuitive financial program a look.

—Kenneth M. Sheldon

**THE FACTS**

**Quicken 2.0 for Windows**

$69.95; upgrade for owners of previous versions, $29.95

System requirements:
Windows 3.0 or higher; 2 MB of RAM.

Intuit, Inc.
155 Linfield Ave.
Menlo Park, CA 94026
(415) 322-0573

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**DOC.IT**

DOC.IT 3000 (300 dpi), $3999;
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I’m a tough customer when it comes to evaluating 17-inch color monitors. After all, I have an NEC 5FG on my desk. Lately, though, I’ve been using the Optiquest 4000D hooked to a HiColor Turbo F/X video adapter from International Computers. And I like what I’ve been seeing.

The Optiquest 4000D has all the amenities you look for in a large-screen monitor. It’s noninterlaced and supports the new VESA (Video Electronics Standards Association) standard for refresh rates (72 Hz), resulting in a crisp, flicker-free display. The flat-screen design, coupled with an etched surface, reduces glare; the antistatic coating reduces distortions caused by stray magnetic fields. Radiation emissions fall within the Swedish MPR II standards.

The 4000D’s image quality is good: The monitor displayed sharp images and bright colors. I ran the full suite of DisplayMate video tests from Sonera Technologies, and the 4000D showed no serious image defects. But I’ve been spoiled: The Optiquest monitor is no match for the NEC 5FG when it comes to image quality. It’s hard to put a price on quality, but for my money, I’d need to save at least $300 to turn away from the 5FG.

Given the high cost of large-screen monitors, the surprisingly low cost of high-resolution video adapters is downright ironic. The Turbo F/X from International Computers delivers 1280-by-1024-pixel resolution and up to 16 million colors for only $159. The card uses the same Tseng Labs AT4000 chip that many other vendors ship with their video cards, but the Turbo F/X seems to pump some additional power out of the chip. With only 1 MB of video RAM, you can run at 1280-by-1024-pixel resolution with 16 colors, or you can enjoy 32,000 colors in 800-by-600-pixel resolution. Few cards can get those kinds of specifications from a single megabyte.

The Turbo F/X from International Computers delivers 1280-by-1024-pixel resolution and up to 16 million colors for only $159. The card uses the same Tseng Labs AT4000 chip that many other vendors ship with their video cards, but the Turbo F/X seems to pump some additional power out of the chip. With only 1 MB of video RAM, you can run at 1280-by-1024-pixel resolution with 16 colors, or you can enjoy 32,000 colors in 800-by-600-pixel resolution. Few cards can get those kinds of specifications from a single megabyte.

Virtually Universal Text-Processing Possibilities

LONDON—Ways for Windows is a powerful system for automating Windows text-processing applications. A background program that filters all keyboard input to Windows, Ways can substitute words into the input stream in many ways. Its free-form, associative database engine uses fast word-similarity and cluster-analysis algorithms invented by its author, the Swiss mathematician Hannes Keller, which lets Ways analyze each word you type in real time (typically 0.1 second after you press the space bar). This allows Ways to do on-line spelling correction, abbreviation expansion, macro recording and playback, word-for-word foreign-language translation, thesaurus lookup, and much more. I saw Ways used to do a word-for-word English-to-German translation.

Ways takes about 10 MB of disk space. When running, it displays a long, thin window from whose Files menu you can load new dictionaries and then browse through them manually. When you click on the Online box, Ways performs as-you-type spelling correction or translation using the current dictionary. Click on the Learn box, and Ways adds unfamiliar words to the dictionary as you type. Keller’s correction algorithms are adaptive, so the spelling rules improve as a dictionary grows. When you click on the AutoType box, you activate Ways’ dynamically created abbreviation dictionary. Thus, if I type the word transputer, whenever I type tr, transputer will be offered in the AutoType box.

Ways’ thesaurus is pretty remarkable, too. It contains the usual lists of synonyms, but it also lets you attach a database record, a note, or an external text file to any item, or even run another Windows program.

All these facilities are available within any Windows program that accepts text input (e.g., the Notepad or Cardfile) and even on the entry line of file dialog boxes. Keller tells me he’s scheduled to demonstrate Ways to Microsoft executives, so this elegant software might find its way into a future version of Windows.

---Stanford Diehl

---Dick Fountain

THE FACTS

Ways for Windows
about $200 (about 258 Swiss francs)
System requirements:
An IBM PC compatible with Microsoft Windows and 10 MB of free disk space.

Witch Systems AG.
Binzmuhlestrasse 45
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With a tilt-and-swivel screen that seems to float above the keyboard, the Zeos Freestyle/SL Notebook provides a range of viewing angles. The 9½-inch-diagonal digitally controlled monochrome VGA LCD has a resolution of 640 by 480 pixels. The 386SL system can support a simultaneous display on an external color VGA monitor.

The 5½-pound notebook comes with 2 MB of RAM (expandable to 20 MB), a 1.44-MB floppy drive, and a 64-KB internal processor cache. Its power management system lets you extend the battery’s normal 3 to 4 hours of operating time by several hours.

Other features are a built-in pointing key with left- and right-handed three-button mouse controls, flash ROM, and support for BIOS and video shadowing.

Price: Starts at $1895.
Contact: Zeos International, Ltd., 530 Fifth Ave. NW, St. Paul, MN 55112, (800) 423-5891 or (612) 633-4591; fax (612) 633-1325.

An Assistant for the Office

A complete integrated image- and document-preparation system, the mid-size tower Assistant is the basic model of Tangent’s Image/Document Pro Series. The 25-MHz 486SX system features 8 MB of RAM, a 64-KB cache, a 240-MB IDE hard drive, and an internal 120-MB mini-cartridge tape backup unit.

Additional features are a Tangent graphics accelerator, a 15-inch flat square color monitor with 1024-by-768-pixel resolution, a Hewlett-Packard ScanJet Ilc 24-bit color scanner, and a Logitech Mouseman. Software includes OmniPage Direct, Adobe Type Manager and Type Align, ImagePals Enhancer/Album/Capture, DOS 5.0, and Windows 3.1. The system comes with page-layout, word processing, and precision artwork software.

Price: $7995.
Contact: Tangent Computer, Inc., 197 Airport Blvd., Burlingame, CA 94010, (800) 466-3300 or (415) 342-9388; fax (415) 342-9380.

Choose Your Configuration

The ITS 486DX-2 uses Intel’s 486 processor chip running at 66 MHz and has a 256-KB write-back cache. The system includes 4 MB of RAM (expandable to 32 MB), an AMI BIOS, 1.2- and 1.44-MB floppy drives, and a 105-MB IDE hard drive with a 2-MB caching controller (expandable to 16 MB).

Interfaces on the ITS 486DX-2 include two serial ports, one parallel port, and a mouse port. The system has nine expansion slots. Graphics features include Super VGA capability and an S3 graphics accelerator with a maximum resolution of 1280 by 1024 pixels and 32,768 colors, plus a 14-inch Super VGA color monitor. The system comes with DOS 5.0 (or, optionally, OS/2) and Windows 3.1.


The Freestyle/SL Notebook’s screen is held in place by a pivoting mechanism.

Choose Your Configuration

The Aurum Goldnote S25 486SX notebook’s removable hard drive configuration provides customizable storage capacity of 80 or 130 MB. Each 6-ounce drive has a seek time of 14.52 ms.

Standard features are 4 MB of RAM (expandable to 16 MB), an 80-MB hard drive, a 1.44-MB floppy drive, two serial ports, a parallel port, and an IBM-compatible Award BIOS with advanced power management support. The nonglare backlit VGA LCD has a resolution of 640 by 480 pixels. DOS 5.0, Windows 3.1, and a carrying case are standard.

Contact: Aurum Computer Corp., 5 Pond Park Rd., Hingham, MA 02043, (617) 749-5092; fax (617) 749-5188.
A Solar Panel for PowerBooks

A lightweight panel incorporating impact-resistant solar cells, SolarPower gives PowerBook users an alternative to reliance on the notebook’s batteries. The panel attaches to the top of the PowerBook screen via a removable hinge, letting you swing the panel into position when you want to use it. Graphical software aids guide you to the correct positioning for maximum solar power. Optional cabling lets you also operate the unit at a distance.

Price: $189.
Contact: Microtech International, Inc., 158 Commerce St., East Haven, CT 06512, (800) 626-4276 or (203) 468-6223; fax (203) 467-1856.
Circle 1276 on Inquiry Card.

It’s All in the Speed of the Spin

By doubling their spinning speed, Texel America gives two half-height CD-ROM drives an average access time of 265 ms, a sustained data transfer rate of 300 Kbps, and a 64-KB buffer. The internal DM-3024 and the external DM-5024 support applications such as 3-D modeling, animation, and full-motion video.

Compliant with the SCSI-2 command set, the drives are compatible with most SCSI host adapters and support the CD-ROM XA standard, which permits interleaving of audio. The DM-3024 has a 50-pin SCSI bus connector; its DIP switches let you set SCSI ID and termination. The DM-5024 has two shielded SCSI Centronics connectors that let you daisy-chain up to seven devices to a SCSI adapter. You set SCSI ID and termination via external switches. The DM-5024 also has an auto-switching power supply. Both units feature a volume control and a stereo headphone minijack.

Price: DM-3024, $499; DM-5024, $599.
Contact: Texel America, Inc., 1080C East Duane Ave., Sunnyvale, CA 94086, (800) 886-3935 or (408) 736-1374; fax (408) 736-1378.
Circle 1277 on Inquiry Card.

Reading Tool for the Blind

A stand-alone reading machine for the blind, the An Open Book Deluxe Edition is based on a 33-MHz 386 platform with 4 MB of RAM and an 80-MB hard drive. The unit comes with a DECTalk PC synthesizer to provide voice output and includes a keyboard and monitor. Also available is a Standard Edition, as well as An Open Book software for installation in existing computer systems.

Contact: Arkenstone, Inc., 1185 Bordeaux Dr., Suite D, Sunnyvale, CA 94089, (800) 444-4443; fax (408) 745-6739.
Circle 1279 on Inquiry Card.

Portable Printer

A replaceable lead-acid battery pack provides the power for the SP-401B handheld printer. Able to print up to 7000 lines of text between battery charges, the printer features 40-column thermal printer technology, a 7-KB data buffer, and bidirectional RS-232 and RS-485 interfaces. The under-5-pound unit stamps each printout with the date and time and has an enclosed paper supply.

Price: $496.
Contact: Syntest Corp., 40 Locke Dr., Marlborough, MA 01752, (508) 481-7827; fax (508) 481-5769.
Circle 1277 on Inquiry Card.

Handwritten Input

With the Summagraphics tablet and Microsoft Windows for Pen Computing, you can enter data and edit documents in handwritten form. The tablet, which has an active area of 6 by 9 inches with a two-button penlike stylus, works with desktop, laptop, and notebook PCs. It has drivers for AutoCAD, Windows, and Windows for Pen Computing.

Price: About $568 (£299).
Contact: Summagraphics, Ltd., 140 Cromwell Rd., London SW7 4HA, U.K., 44-71-244-7733; fax 44-71-244-8584.
Circle 1281 on Inquiry Card.

Keyboard Intelligence

The MaxiPro II fully programmable keyboard for PCs and IBM PS/2s automatically senses the system it is connected to. Compatible with any software, the keyboard has its own nonvolatile internal memory. You can remap each of the 124 keys and program keys for special functions (e.g., diagonal cursor movement). The Macro Keys feature lets you program any key as a macro for complicated command lines, multilayered menus, or lengthy, often-used text; on-board memory holds up to 1800 characters.

Price: $125.
Contact: Maxi Switch, Inc., 2901 East Elvira Rd., Tucson, AZ 85706, (602) 294-5450; fax (602) 294-6890.
Circle 1278 on Inquiry Card.
Display Color from Your PowerBook

A 16-bit graphics card for the PowerBook 140 and 170, the ColorBook 16 provides over 32,000 colors on projection devices and on displays as large as 16 inches. The board delivers 8-bit color on 19- and 21-inch displays. The ColorBook 16’s pass-through memory port accepts an Apple 2-MB memory upgrade. PSRAM (pseudostatic RAM) on the board is available in 2-, 4-, and 6-MB configurations. The QuickTime-compatible board fits in the PowerBook’s expansion slot.

Price: Starts at $1295.

Circle 1282 on Inquiry Card.

Miniature Controller

The Little PLC, a low-cost, compact, C-programmable logic controller, features eight optically isolated inputs, eight relay driver outputs, a built-in switching power supply, and RS-485 serial communications. You program the 4- by 3-inch PC-compatible board using Z-World’s Dynamic C software, which can handle 20,000 C statements. As the programs are compiled, they download to the Little PLC via the serial port.

Price: $195.
Contact: Z-World Engineering, 1724 Picasso Ave., Davis, CA 95616, (916) 757-3737; fax (916) 753-5141.

Circle 1284 on Inquiry Card.

A Planet Connection

With the Planet ISDN card, you can connect your Mac to British Telecom’s ISDN 2 network. The card supports both of the digital network’s channels, providing simultaneous high-speed data and voice communications.

The Planet ISDN comes with Telephone Manager software and an Apple standard Communications ToolBox driver, which allows up to eight applications to share one Planet ISDN card. Using the subaddressing features of ISDN 2, the card automatically routes incoming calls to the correct application.

Price: About $2280 (£1200).
Contact: Mac Connect, 25 Low Friar St., Newcastle Upon Tyne NE1 SUE, U.K., 44-91-230-5596; fax 44-91-261-5746.

Circle 1283 on Inquiry Card.

Remote Graphics Display

The Video Line Driver add-in board lets you display your graphics on a monitor more than 900 feet from your computer through standard 75-ohm coaxial cable. The board amplifies the VGA signal and prevents it from breaking up prior to reaching its destination. The Video Line Driver is compatible with VGA and Super VGA adapters and Windows accelerators.

Price: $369.
Contact: STB Systems, Inc., 1651 North Glenville, Suite 210, Richardson, TX 75081, (214) 234-8750.

Circle 1285 on Inquiry Card.

True-Color Controllers

The D24 BitBlaster uses a Cirrus Logic CL-GD5422 controller with 1 MB of RAM to provide 24-bit true color. Display drivers on the board include those for Windows 3.1 and AutoCAD. A companion board, the V24 BitBlaster, uses S3’s 86C924 graphics controller with 1 MB of VRAM and an AT&T 24-bit RAMDAC.

Price: D24 BitBlaster, $99; V24 BitBlaster, $199.
Contact: Edge Technology, Inc., 915 East Karcher Rd., Nampa, ID 83687, (208) 465-3434; fax (208) 465-3424.

Circle 1286 on Inquiry Card.

Single-Slot Expansion

Windows-, multimedia-, and network-compatible, the One Slot board provides four serial and three parallel ports. The board fits in a single ISA or EISA expansion slot and supports laser and dot-matrix printers, mice, plotters, modems, and bar code readers.

The EIA-232 serial ports include full-duplex communications capability. You can disable the serial ports as well as the bidirectional Centronics ports via switch selection.

Price: $349.
Contact: Star Gate Technologies, Inc., 29300 Aurora Rd., Solon, OH 44139, (800) 782-7428 or (216) 349-1860; fax (216) 349-2056.

Circle 1287 on Inquiry Card.
Try stuffing these into a laptop.

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

- **MASSIVE EXPANSION.** Nobody gives you more expansion possibilities than Dolch. In an 18 pound package a Dolch P.A.C. has room for up to five full-size EISA/ISA add-in cards. You can add up to 32 MB RAM, 1 GB HDD, and any combination of drives, CD-ROM, removable HD, streaming tape, and more.

- **EXTREME POWER.** Dolch P.A.C. systems have been rated “the fastest portables on the market” since 1987, and have won more Editor’s Choice awards than any other product in its category. *Computer Reseller News* calls the 486-50E “a dream machine ... one of the most powerful PCs of any kind.” P.A.C. systems are based on 386SX and DX, and 486 CPUs up to 50MHz, delivering as much as 22 MIPs.

- **DAZZLING DISPLAYS.** “Breathtaking ... Dolch’s heart-stopping TFT Color Display produces vibrant colors and sharp images virtually on par with those seen on desktop VGA monitors,” reports *PC Computing.*

- **MIL RUGGEDNESS.** Every P.A.C. is as tough as it is powerful. Certified under MIL Std. 810C Dolch provides true mission critical reliability. “... it simply outclasses its competitors and it is sturdy and solid ...” says *PC Magazine.*

- **GET THE FULL STORY.** Call 1.800.995.7581. In Canada 1.800.561.4527.

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Circle 123 on Inquiry Card.
It's been a very difficult and confusing couple of years for Xbase developers. Filled with uncertainty and doubt about the future. At times, some questioned whether Xbase even had a future.

But those days are over. With the resources, experience and support of the world's leading database company behind it, and with the combined technological wealth of CA-Clipper, CA-dBFast™ and Computer Associates, the future of Xbase has never looked brighter.

CA-Clipper

Millions of Clipper, dBASE, Fox and CA-dBFast developers head for the next generation Xbase system.

To build the Xbase system of the future, we've added CA's visual tool and client-server technology to Nantucket's next generation Xbase project.

This new system will provide a fully object-oriented Xbase language, native code compiler, an IDE (Integrated Development Environment) and both DBF-style and client-server database support.

It will support Windows, Windows NT, OS/2 and UNIX. The complete product will be demonstrated at Fall Comdex and available for beta testing in the fourth quarter of 1992.

Two easy ways to get there: Go GUI today with CA-dBFast or go the DOS route with OOP via Clipper. Your choice.

There are two migration paths to this ultimate Xbase system: The OOP (Object-Oriented Programming) path of CA-Clipper and the GUI (Graphical User Interface) path of CA-dBFast with Windows support.

Both paths will provide immediate benefits and will protect and leverage the substantial investments you've made in Xbase.

Attention all dBASE IV developers: Your CA-Clipper/Compiler Kit Has Arrived.

After four years, the compiler kit you've been waiting
much more than a PC software company, CA is the world’s leading database software company. CA software is used in over 70 countries around the world by more than 10 million users including over 90% of the Fortune 500.

From mainframe to midrange to microcomputers, CA database software runs on more platforms, more operating systems, and handles more mission-critical applications than any other software in the world.

For Information On CA-Clipper, CA-dBFast And A Statement Of Direction: Call 1-800 CALL CAI.

To get the complete story on The Future of Xbase, call for this special 30-page statement of direction.

It contains an Executive Summary as well as an in-depth discussion of Xbase in the 90s, CA’s Open and Client-Server Architectures, Integrated Development Environment, Xbase migration plans and end-user tools. Call for your copy today.

And find out why the future of Xbase will lead you right to CA.
Create a New Ion Field

Now you can neutralize all positive ion radiation from your computer screen by reversing the positive ion field to a negative field of up to 100 square feet. The mouse-size Perfect-Aire 100 attaches to the top of your monitor with Velcro and plugs into a standard 110-V outlet. By eliminating electrostatic radiation, the unit not only cleans up the air around you and your computer, but also protects your monitor from static electricity discharge.

Price: $139.95.
Contact: Planmar Marketing, Inc., P.O. Box 13826, Research Triangle Park, NC 27709, (919) 383-3818; fax (919) 383-2871.
Circle 1288 on Inquiry Card.

Phone from Your Keyboard

Integrated Technology’s PC-compatible 101-key ComputPhone keyboard is integrated with a single-line phone circuit and equipped with an interface for a headset, eliminating the need for a separate phone when you’re telecommunicating. You use the numeric keypad for dialing; auto-dialing software is included.

Price: $299.
Contact: Integrated Technology, Inc., 76 South Orange Ave., South Orange, NJ 07079, (201) 907-0200; fax (201) 762-7234.
Circle 1291 on Inquiry Card.

Trackballs for Everyone

The Spaceball 2003 provides an intuitive way to rotate and move 3-D objects on IBM, Sun, Silicon Graphics, and DEC workstations. You can manipulate screen objects about the x, y, and z axes simultaneously with just a touch. Increasing pressure on the ball increases the speed of an object’s rotation.

Price: $1595.
Contact: Digitizer Products Group, Calcomp, Inc., 14555 North 82nd St., Scottsdale, AZ 85260, (602) 948-6540.
Circle 1293 on Inquiry Card.

Precise Power

The Onguard Universal Precision Regulators from Clary use a modular approach to power protection. Providing precision line regulation, the units protect your workstation via a ride-through capability based on a proprietary capacitor design. This capability protects your computer against momentary disturbances such as sags, spikes, surges, noise, and voltage/frequency deviations. You can expand protection with options such as a battery backup and a dedicated-input DC-to-AC inverter.

Price: Starts at $890.
Contact: Clary Corp., 1960 South Walker Ave., Monrovia, CA 91016, (818) 359-4486; fax (818) 305-0254.
Circle 1291 on Inquiry Card.

Trap Your Mouse

The Mousetrap enables you to use your mouse from your lap rather than just from your desktop. A fully adjustable keyboard-mounted side tray for your mouse, trackball, or other input device, the Mousetrap quickly clamps onto most keyboards for right- or left-handed use.

Price: $21.95.
Contact: Armchair General, P.O. Box 2211, Twin Falls, ID 83303, (208) 733-7538.
Circle 1292 on Inquiry Card.

PC Remote Control

A 26-button hand-held infrared transmitter, the Mind Path SR50 attaches to your computer’s serial port. The transmitter lets you control any DOS or Windows program from up to 50 feet away.

Looking much like a remote control for your TV, the Mind Path SR50 can be reconfigured for any application via a menu-driven program. Each button on the unit works as a single keyboard key or a sequence of keys, and you can encode security keys into the buttons. The unit has full CRC-16 error checking built in. The fiberglass-reinforced plastic case is water and dust resistant.

Price: $495.
Contact: Mind Path Technologies, 12700 Park Central Dr., Suite 1807, Dallas, TX 75251, (214) 233-9296; fax (214) 233-9308.
Circle 1289 on Inquiry Card.

Trackballs for Everyone

The Spaceball 2003 provides an intuitive way to rotate and move 3-D objects on IBM, Sun, Silicon Graphics, and DEC workstations. You can manipulate screen objects about the x, y, and z axes simultaneously with just a touch. Increasing pressure on the ball increases the speed of an object’s rotation.

Price: $1595.
Contact: Digitizer Products Group, Calcomp, Inc., 14555 North 82nd St., Scottsdale, AZ 85260, (602) 948-6540.
Circle 1293 on Inquiry Card.

F eaturing a swivelung two-button control for right- and left-handed use, the SuperTrak is Microsoft compatible. The unit fits in your hand or attaches to the side of your notebook or laptop. If you bump the trackball, its breakaway design prevents damage to it or your computer. Models are available for PCs and PS/2s.

Price: $99.
Contact: Z-Nix Co., Inc., 211 Erie St., Pomona, CA 91768, (714) 629-8050; fax (714) 629-4792.
Circle 1294 on Inquiry Card.
4 out of 5 Lotus 1-2-3 users prefer Quattro Pro for DOS

An independent study proves it!
When Lotus 1-2-3 users compared Quattro® Pro 4.0 and 1-2-3 side-by-side, they made a startling discovery. Four out of five found they preferred Quattro Pro from Borland over Lotus 1-2-3. They said Quattro Pro is easier to use than 1-2-3. They said it is richer in features and functionality than 1-2-3. In fact, 94 percent said they would be more productive with Quattro Pro 4.0 than 1-2-3!

The tests were conducted by Usability Sciences Corporation, a highly regarded independent testing lab used by major software publishers, including Lotus. The 1-2-3 users evaluated both products in 20 major categories, including analytical power, speed, graphics, ease of learning, printing, macros, and more. In every category, 1-2-3 users preferred Quattro Pro.

Which product would make you more productive? Quattro Pro (94%)
Which product is easier to use? Quattro Pro (78%)
Which product is richer in feature and function? Quattro Pro (83%)

Source: Usability Sciences Corporation, May–July 1992

Quattro Pro. With Quattro Pro, you simply get your work done faster.

Switching is easy
Stepping up to Quattro Pro is fast, simple, and painless. Your 1-2-3 files and publishing styles move effortlessly into Quattro Pro. You can even run your 1-2-3 macros.

The Usability Sciences study provides overwhelming proof that when 1-2-3 users just like you try Quattro Pro, they want to switch. Try Quattro Pro today and make your own comparison. If you don't prefer it, return it. We'll give you your money back.

BORLAND
Software Craftsmanship

See your dealer today or call 1-800-331-0877, ext. 5751
In Canada, call 1-800-461-3327

Guarantee

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Circle 94 on Inquiry Card (RESELLERS: 95).
IBM LaserPrinters: The Windows. And

Most laser printers slow to a walk under Windows.

Announcing a Windows™ driver designed to leave other printers in the dust: the new IBM® 4029 Print Accelerator for Windows. It's now standard equipment on IBM LaserPrinter Models 5E, 6, 6P, 10, 10P, and 10L, at no extra cost. And it delivers supercharged printing speeds with Windows—for more of the productivity and convenience that Windows is all about.

Now complex graphics and multiple fonts print with surprising speed. You can use both Type 1 and TrueType™ fonts. And you get the crisp, 300 dpi output and superb

<table>
<thead>
<tr>
<th>Application</th>
<th>HP® LaserJet® III with standard Windows driver</th>
<th>IBM LaserPrinter 10 with Print Accelerator for Windows</th>
<th>Speed Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvard Graphics®</td>
<td>1566 seconds</td>
<td>633 seconds</td>
<td>147%</td>
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<tr>
<td>CorelDRAW™</td>
<td>126 seconds</td>
<td>96 seconds</td>
<td>31%</td>
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*Free upgrade available through 10/18/92. Print Accelerator requires a PC with 386 SX processor or higher and 4MB of RAM. IBM is a registered trademark of International Business Machines Corporation in the U.S. and/or other countries and is used under license. HP and LaserJet are registered trademarks of Hewlett-Packard Company. Harvard Graphics is a registered trademark of
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IBM LaserPrinters come to you from Lexmark International, an independent worldwide company, formerly a division of IBM, that develops, manufactures, and markets IBM personal printers, IBM typewriters, related supplies, and keyboards.

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And see something truly unique: a laser printer that can fly through Windows. And look great doing it.

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**Video Stars on the LAN**

Based on a real-time Unix operating system, StarWorks software turns your 486 EISA computer into a video application server that can simultaneously support as many as 20 PCs running DOS or Windows and Macs. The software's Media Transport Protocol enables each user to access the same video file at different starting times.

Initially, StarWorks supports 10Base-2 and 10Base-T Ethernet and provides video networking services for up to a total network bandwidth of 25 Mbps. The software is compatible with digital video systems such as QuickTime and AVI. It also supports MPEG and JPEG systems.

**Price:** Starts at $9950.

**Contact:** Starlight Networks, Inc., 444 Castro St., Suite 301, Mountain View, CA 94041, (415) 967-2774; fax (415) 967-0686.

Circle 1295 on Inquiry Card.

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**Put Your Mac on the Network**

Built for Mac IIsi and SE/30 computers, the MacNet-SE-470 is a combination IIsi and SE-30 Ethernet card. With RJ-45, AUI, and BNC connectors, the card is IEEE 802.3 compliant and uses CSMA/CD packet passing with a transfer rate of 10 Mbps.

A second card, the MacNet-LC-480, is a 10Base-2/T card that works with the Mac LC. Like the MacNet-SE-470, the MacNet-LC-480 is IEEE 802.3 compliant and provides a 10-Mbps transfer rate in its CSMA/CD packet passing.

**Price:** $299 each.

**Contact:** MacNet, 2199 Zanker Rd., San Jose, CA 95131, (408) 954-8888; fax (408) 954-8866.

Circle 1298 on Inquiry Card.

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**Automatic Backup and Retrieval**

You can automatically back up and retrieve up to 50 GB of data on NetWare networks with the Fast 5000 Autoloader package from Palindrome. The hardware and software system combines robotic automation of tape loading and rotation with full management of data migrated from network to tape.

The Fast 5000 AutoLoader hardware provides unattended backups, automated server and volume restoration, and an automated disaster recovery system. The software, Palindrome’s The Network Archivist, can track files and file histories through its relational databases, facilitating totally unattended tape rotations for backups. TNA knows where every version of every file is located on tape. You can also send backup and restore commands by E-mail.

**Price:** Fast 5000 AutoLoader, about $21,850 (£11,500); TNA, starts at about $1510 (£795).

**Contact:** Palindrome (U.K.), Ltd., 2 Burlington Court, Burlington Rd., Slough, Berkshire SL1 2JS, U.K., 44-753-810751; fax 44-753-810624.

Circle 1296 on Inquiry Card.

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**Network Utility**

SoftNet Utilities lets Hewlett-Packard 9000 Series 7xx, IBM RISC System/6000, and SPARC-based workstations and servers act as nondedicated NetWare-compatible servers. The package includes terminal-emulation software that allows PC workstations to use the IPX protocol to remotely log onto Unix hosts.

**Price:** Starts at $1295 for a 16-user license.

**Contact:** Puzzle Systems Corp., 16360 Monterey Rd., Suite 250, Morgan Hill, CA 95037, (408) 779-9909.

Circle 1297 on Inquiry Card.
What's the difference between a presentation created with the Amiga® and every other presentation?

In a word, results. Because the Amiga turns a ho-hum presentation into a persuasive multimedia show.

You can deliver your presentation on a TV monitor, output onto slides or video, or press a CD-ROM and present your message on CDTV® (Commodore Dynamic Television), the lowest cost high performance multimedia presentation system available. You can also import and export files to both PC-compatible computers* and Macintosh®*, or easily connect to an existing Novell® network.*

Presentation professionals can also take advantage of special software programs.

SCALA® 2.0 features a simple point-and-click menu for integrating text, animation, drawings, slides, photos and music so you can create striking, attention-getting screen presentations.

Presentation Master™ offers a paint program, business graphics module, and color postscript output all in one package, so you can design, display and output powerful multimedia presentations.

With the Amiga, even those last minute changes are a snap.

In fact, the Amiga does so many things, it pays for itself. And every Amiga 2000 and 3000 series computer comes with Commodore Express Gold service options** and convenient leasing terms.

For more information, call 1-800-66-AMIGA.  
(In Canada, call 1-800-661-AMIGA.)

The Amiga. The presentation system more people are sold on.

The Amiga does so many things, it virtually pays for itself.
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Launch your favorite applications, with a
click of your mouse.

Click for immediate access to applications in
the Windows Program Groups.

Instantly change the default printer, reconfig-
figure existing ones, and
drag and drop documents
to print.

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resources with the Resource Gauge.

Instantly switch between complete screen setups in
up to 9 full-screen views in just one step.
Mention the word “fast,” and Windows users get a wild look in their eyes. Why? Because they have a need. A need for speed. Well, here’s a little something that satisfies those cravings: Introducing Dashboard.” The fastest way to work in Windows.”

Dashboard is the convenient push-button utility panel that makes quick work of complicated operations in Microsoft Windows. Zip into your favorite applications with a click. Switch between different full-screen views of applications in one step. Instantly change the printer default, or drag and drop documents to print... never has so much speed and convenience been packed into so little screen and disk space. Everything, even a clock with alarms, and a “fuel” gauge to monitor your memory usage, is instantly accessible. Whenever you feel the urge.

So the next time you get that uncontrollable craving, you’ll know what to do. Grab hold of the world’s fastest push-button utility panel, Dashboard For Windows. And get all the speed you need.

See your dealer or call 1-800-554-1305 Ext. 801B.
A Fax Modem to Travel With

The Traveler 9600-/4800-bps portable send/receive fax modem works in the background on your notebook computer, letting you continue to work in your application. With the Traveler, you can view, rotate, or print the faxes you want and delete the faxes you don't want without printing them.

The Traveler includes a 2400-bps data modem with V.42bis and MNP 5 data compression and V.42 and MNP 2 through 4 error correction. The unit operates via battery or AC power and is available in a standard DOS version, a Windows version, and as the MacTraveler for use with Macs.

Price: $199.
Contact: Best Data Products, Inc., 9304 Deering Ave., Chatsworth, CA 91311, (818) 773-9600; fax (818) 773-9619.
Circle 1300 on Inquiry Card.

Two Mac FDDI Adapters

The F6069 Desktop Network Interface card from Cabletron Systems provides a direct connection of Mac II and Quadra computers to 100-Mbps FDDI (Fiber Distributed Data Interface) networks. The processing for on-board protocol and management is via a Motorola 68ee020 processor. The adapter uses Motorola's FDDI chip set as well as EEPROM chips. The company's LanView Diagnostic System provides link and activity information. The adapter supports FDDI Station Management 6.2 and is compatible with System 6.x and 7.x and Unix 3.x operating systems.

Price: $2995.

Circle 1301 on Inquiry Card.

A Windows Network Manager

A SNMP network manager for Windows, SNMPc 3.0 uses AI techniques to simplify manipulating MIB objects. You can perform any function with a single button click after you've selected a structured data object. You can also define custom menu options that execute any command sequence.

Additional features of SNMPc include multilevel graphical map representation, automatic node discovery and map creation, real-time statistical graphs or lists, and event action filters. SNMPc exports data to a printer or disk files or through DDE and supports Windows TCP/IP products.

Price: $495.
Contact: Castelle, 3255-3 Scott Blvd., Santa Clara, CA 95054, (408) 496-0474; fax (408) 496-0502.
Circle 1304 on Inquiry Card.

Fax Server Upgrade

The self-contained FaxServer 3.0 LAN fax server lets you do your faxing from your desktop while on the network. Fully integrated with NetWare, FaxPress gives you the choice of getting your faxes on a network printer, on a FaxPress-connected printer, or in your mailbox.

New capabilities in the software include auto-routing, support for Printer Control Language 5, and support for translation to languages other than English. A link to Novell Bindery lets you become a fax server user while on the LAN. Customized user preferences let you define a personal set of defaults. A dual-line version lets you send and receive faxes simultaneously.

Price: Single-line, $3495; dual-line, $4395.
Contact: Castelle, 3255-3 Scott Blvd., Santa Clara, CA 95054, (408) 496-0474; fax (408) 496-0502.
Circle 1345 on Inquiry Card.
1. True Client/Server for reliability and performance Your databases are protected from corruption by features such as referential and entity integrity, as well as true transaction processing. Client/server architecture and our 32-bit database server software help deliver increased performance for applications running on your PC LANs.

2. Royalty-free run-time For just $99 you get royalty-free run-time support. It lets you distribute applications for standalone PCs and include our single-user run-time database server. It also lets you distribute your applications on an unlimited number of client machines in network environments.

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

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

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

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

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Developer's Edition

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

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

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

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

Special offers available to registered users: (details inside package)
- Royalty-free run-time support: $99
- 6-user Network Server Edition: $99 (Suggested retail price: $795)

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Network Server Edition

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

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

**Client System Requirements:**
Hardware: IBM PC compatible, 640K minimum memory
Software: DOS, Windows DOS box, or OS/2 DOS box

**Database Server System Requirements:**
Hardware: IBM PC compatible with hard disk, 640K minimum memory
Software: DOS

**Network Requirements:** NetBIOS or Novell Netware (IPX)

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

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

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Circle 220 on Inquiry Card.
We at Intergraph believe in Windows™. It's a great tool for integration. That's why we're a bit skeptical about the Windows products some CAD companies are offering.

You see, we know it's a Windows world. We don't see why we should make you pay for the ability to run CAD with Windows. Or ask you to accept a major lag in performance as the price of running Windows.

So we bring you MicroStation Nexus. It offers our Windows Connection and other new links to freedom in how you use CAD — right within MicroStation. And it's free.

No hassles. No limitations.

Nexus is your best choice for running CAD with Windows. What do we mean by best? For one thing, it's fast. And if you've used AutoCAD's extension for Windows, you know the hassles of waiting.

MicroStation Nexus is more than just dialog boxes tacked on top of a DOS interface — it's a complete graphical environment under Windows. And it brings a world of possibilities: cut and paste rendered 3D images into proposals ... graphics into technical illustrations ... a scanned logo into your drawing.

Take advantage of powerful object linking. Link text in a drawing and keep it always up to date. Link audio and place a message for your colleagues. Better yet, really tap MicroStation's power, and drive graphics from a spreadsheet.

With Nexus, MicroStation also gives you freedom that other Windows CAD software simply cannot. Like running in dual-screen mode. Enjoy the real estate of a full screen for design and another for running your other Windows applications.

Have a look at the Windows solution that brings true integration. MicroStation for Windows. You can open a world of possibilities ... without opening your checkbook.
Move up to greater productivity!

MicroStation’s list price is $3,450. But now through December 31, you can get MicroStation and MicroStation Nexus — with full Windows capabilities — for only $500!

All you do is pay the cost of a typical upgrade and trade a copy of AutoCAD Release 9 or higher, and you can make the move to the CAD drafting engine that has what you need today.

MicroStation Nexus lets you take your AutoCAD drawing files directly into MicroStation. It also gives you a flythrough animator and tools to configure the desktop. To help you get up to speed fast, with this offer you’ll also receive the book, MicroStation for AutoCAD Users, by Frank Conforti and Ralph Grabowski.

MicroStation runs on PCs, Apple Macintoshes, Sun SPARCstations, HP Apollo Series 700 workstations, and Intergraph workstations.

To trade up or learn more about MicroStation, call 800-345-4856 for the name of an Intergraph Solution Center reseller in your area. *Offer good in U.S. only.
Design Large Industrial Projects

Interactive Software Engineering designed ISE Eiffel 3, its object-oriented programming environment, for large industrial projects. The Unix-based software is available in components, so you purchase only the tools and libraries you need. The components are EiffelBench, EiffelVision, EiffelBuild, EiffelStore, and EiffelBase.

EiffelBench consists of the Eiffel compiler and object-oriented tools that let you debug, browse, edit, and cross-develop self-contained C packages and external language interfaces for languages like C. EiffelVision, a high-level GUI library with standard interface toolkits (Motif and OpenLook), lets you write applications in Eiffel for windowing environments without having to learn the details of the GUI toolkits and their C interfaces.

The EiffelBuild application builder generates the GUI and the links to the semantic actions and produces clear, bug-free, and maintainable Eiffel code. EiffelStore is the class library for interfacing with relational and object-oriented DBMSes. The module deals with high-level persistency and the storage and retrieval of networks of objects into and from databases using SQL (Structured Query Language). EiffelBase contains Eiffel libraries, which provide hundreds of reusable components.

Price: EiffelBench, $995; additional tool sets and libraries, $295 to $1995.


Circle 1305 on Inquiry Card.

Generate C++ Code

If you are a Windows developer who uses Knowledge-Pro for Windows, now you can generate C++ code with the KPWin+ Windows Development Tool. The C++ code-generation facility lets you prototype applications using KPWin's (or Revelation Technologies' OpenInsight's) interactive design tools and underlying language. KPWin++ works with all the expert systems, hyper-text, multimedia, list-handling, and file-handling capabilities of the KPWin language.

The package can read code written in the KPWin or OpenInsight environment and generate ANSI-standard compilable C++ code. Using the Microsoft C/C++ 7.0 compiler, you can amend the generated C++ code, link to third-party libraries, and then compile to create a high-performance executable file.

Price: $895.

Contact: Knowledge Garden, Inc., 12-8 Technology Dr., Setauket, NY 11733, (516) 246-5400; fax (516) 246-5452.

Circle 1306 on Inquiry Card.

Build Your Own Pen Applications

Personal Pen Pal, a development environment for pen computers, helps you quickly build pen-centric applications or modify the provided applications templates for your own use. Using menu- and graphics-driven selections, you can design forms, define records and databases, program actions, specify communications and print operations, and test and run applications within a single environment. A syntax builder in the menu system virtually eliminates syntax errors and the need to remember names and symbols.

Personal Pen Pal runs under DOS or Windows on PCs with a 286 or higher CPU, a VGA monitor, and a Microsoft-compatible mouse.

Price: $395.


Circle 1308 on Inquiry Card.

3-D Graphics Toolkit with PHIGS+ and PEX

Liant Software says that its FIGt package is the first 3-D graphics toolkit to combine object-oriented programming with PHIGS+ and PEX (PHIGS Extension to the X Window System). The package lets you write 2-D and 3-D graphics applications with standard PHIGS+ APIs and run the software unchanged across systems from PCs to supercomputers.

FIGt provides a library of preprogrammed objects that contain information on generating and manipulating a given graphics object. It also provides features such as color management, viewing, lighting, shading, and structure ID management. The library can use PHIGS APIs to drive the PEX protocol, and it supports PEXlib, so you can develop distributed graphics applications with a higher-level programming interface than PEXlib alone can provide.

FIGt works with most PHIGS APIs (e.g., those from Sun Microsystems, DEC, Hewlett-Packard, and IBM), as well as with the company's Figaro+

Price: $1245 to $2245.

Contact: Liant Software Corp., 959 Concord St., Framingham, MA 01701, (508) 872-8700; fax (508) 626-2221.

Circle 1307 on Inquiry Card.
Since when is Raima first in Corporate Database Development?

Since April 7, 1992

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

For professional developers like yourself, Raima products offer:

- High performance: unmatched application speed.
- Portability: runs on DOS, Windows, OS/2, UNIX, VAX, QNX.
- Royalty-free distribution: increase your profits.
- Source code availability: total programming flexibility.
- Affordable pricing: starting at just $95.

Listen to what some of our customers say about our products:

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

"Raima provided us with speed, flexibility, and royalty-free distribution which allowed us to meet and exceed our customer's needs." Dave Cooper, developer, Atlantic Research Corp.

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

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

Raima Database Manager The high-performance DBMS
Raima Object Manager The object storage class library

Call 1-800-DB-RAIMA Also available for DOS, OS/2, and UNIX

Circle 180 on Inquiry Card
Attention dBASE Users:
Can you run on UNIX* for only $99.95??

Yes! Now you can with dBMAN V. An exceptional offer. An exceptional program.

dBMAN V is the most cost effective, portable dBASE compatible relational database management system on the market.

Now Available for COHERENT 4.0
dBMAN now runs under the world's best selling UNIX clone, COHERENT. With dBMAN and COHERENT, you can create powerful, multiuser XBASE solutions at a fraction of what you pay now.

Portability
dBMAN V lets you take your dBASE application and data, developed and created on one platform, and run them on another, in color, and without modification. Port to over 100 plus platforms and run right away. Platforms include: MS DOS, LAN, UNIX, Xenix, AIX, Sun, HP, COHERENT, mainframe and more.

For end users, the time and money invested in applications is not lost when new platforms are added. For developers, software investments are protected and development efforts are leveraged to market your applications on other UNIX platforms.

Complete with Report Writer
dBMAN V includes a built-in, fully relational "band" style report writer with an easy-to-use "visual" interface. Create simple columnar reports or elaborate multi-line reports quickly without programming.

Cost Effective
Pay less for dBMAN V, less than other dBASE products and much less than major RDBMS. Unlike other dBASE products, dBMAN V is licensed for an unlimited number of users. This all adds up to a significant savings for users, and a cost effective edge for developers.

An Exceptional Price for an Unlimited Number of Users**:

<table>
<thead>
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<th>Platform</th>
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<tr>
<td>dBMAN V Coherent</td>
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Save Thousands of Dollars
Purchase dBMAN V and COHERENT for under $200. Save thousands of dollars on a complete development system for an UNLIMITED NUMBER OF USERS!

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The VersaSoft Commitment
VersaSoft has been producing high quality xBASE tools since 1983. We stand behind dBMAN V with a full 30 day money back guarantee and great product support. Order dBMAN today at 408-723-9044.

Act Now! Call VersaSoft today at 408-723-9044 to order your copy of dBMAN V. Offer expires February 1, 1993.

* dBMAN V is available for most popular UNIX platforms and COHERENT (UNIX clone).
** Price includes a license for unlimited number of users on a single system.

VersaSoft Corporation
4340 Almaden Expwy, Ste. 110
San Jose, CA 95118
Tel: 408-723-9044
Fax: 408-723-9046
The World's Best Selling UNIX Clone Just Got Better.

Now with full 32-bit implementation!

If you want to ignite your 32-bit hardware with the multi-user, multi-tasking power of UNIX, Coherent 4.0 has arrived. And if you're operating or selling small business network systems with dozens of users, that's really good news. Because Coherent 4.0 is what you want in UNIX at a price that's hard to believe.

Run UNIX applications today!

Coherent is now binary compatible with UNIX. Most UNIX PC applications port with a simple recompile and many now run right out of the box. The list is growing everyday, so call for details.

Yes, It's For Real!

How can it be? First of all, Coherent was independently developed by the Mark Williams Company, so you don't pay for UNIX licensing fees. You don't pay any mark-up or reseller costs either. Coherent is only sold directly to you.

Coherent: small, but so complete.

Make no mistake, Coherent is a wholly professional development system. You get a complete "Coherent comes so fully qualified as a UNIX clone, you find yourself thinking, 'I can't believe it's not UNIX'"—Sean Fulton, UNIX Today!

In fact, over 40,000 copies of Coherent have already been sold. And, like the ones we quote here, virtually every critic who's reviewed Coherent has raved about it.

So Much Less, Yet So Much More.

As a virtual clone of UNIX, Coherent embraces the original UNIX philosophy: Small is beautiful. Small price, yes. But there's more, much more, to Coherent than its amazing price.

Requiring only 10 megabytes of disk space, Coherent can reside with DOS. So you can keep all your DOS applications and move up to Coherent. And it runs with as little as 1 MB of memory versus 4 MB for other UNIX versions.

The World's Only Plug And Play UNIX Clone.

You'll have Coherent up and running with a fraction of the time and effort it takes for other UNIX versions. Our six disk installation is a breeze compared to their 25. You'll also learn it faster and increase overall performance. All because Coherent is smaller, faster... and better.

Small, But So Complete.

Make no mistake, Coherent is a wholly professional development system. You get a complete C compiler, assembler and over 200 UNIX commands including full sets of functions for development, administration, maintenance and text processing.

Coherent also comes with UUCP capabilities that connect you to a world-wide network of free software, news and millions of UNIX users. And it's all clearly documented in Coherent's highly praised 1200 page manual.

Coherent: Still $99.95.

In fact, over 40,000 copies of Coherent have already been sold. And, like the ones we quote here, virtually every critic who's reviewed Coherent has raved about it.

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As a virtual clone of UNIX, Coherent embraces the original UNIX philosophy: Small is beautiful. Small price, yes. But there's more, much more, to Coherent than its amazing price.

Requiring only 10 megabytes of disk space, Coherent can reside with DOS. So you can keep all your DOS applications and move up to Coherent. And it runs with as little as 1 MB of memory versus 4 MB for other UNIX versions.

The World's Only Plug And Play UNIX Clone.

You'll have Coherent up and running with a fraction of the time and effort it takes for other UNIX versions. Our six disk installation is a breeze compared to their 25. You'll also learn it faster and increase overall performance. All because Coherent is smaller, faster... and better.

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Coherent also comes with UUCP capabilities that connect you to a world-wide network of free software, news and millions of UNIX users. And it's all clearly documented in Coherent's highly praised 1200 page manual.

Experienced, Supported, Guaranteed.

Mark Williams Company has been developing professional programming tools since 1976. Our commitment to our products and users is unsurpassed. Users applaud our popular BBS and the widely acclaimed telephone support they get free from Coherent developers.

Still, we're not asking you to take a chance on Coherent. We've made it fool-proof to see for yourself—with a 60-day money-back, no hassles guarantee. So pick up that phone and order Coherent now. And the best way to UNIX will be on its way to you!

800-Mark WMS
(800-627-5967 or 708-291-6700, FAX: 708-291-6750)
60-DAY MONEY BACK GUARANTEE!

Coherent is a trademark of Mark Williams Company. UNIX is a trademark of USL.
Staff Scheduling on the PC

Designed to automate the staff-scheduling process on a PC, the Universal Staff Scheduler takes into account employee availability, shift lengths, staff task abilities, and the employee’s desired hours to help you figure out the right worker for the right job at the right time. You can determine employee availability by the quarter-hour, as well as schedule part-time employees.

The Universal Staff Scheduler provides a Employee Maintenance File where you store historical data (e.g., availability, birthdays, and vacations) and an Employee Exceptions File where you store unusual scheduling requests (e.g., National Guard duty). The package can handle up to 150 user-definable jobs and tasks and provides on-screen calculations of the actual labor cost and its percent of sales. In addition, the Universal Staff Scheduler can generate scheduling and analysis reports, monitor potential child labor law conflicts, and build a business history as a database.

Price: $495.
Contact: Atlas Business Solutions, 3330 Fiechtnner Dr. SW, Fargo, ND 58106, (701) 235-5226; fax (701) 280-0842.

Use Your Sales Force Efficiently

Market-Base helps you build, maintain, and use databases of sales leads and customers to keep your sales force efficient. The package offers flexible look-up fields, a multilevel security system, an alarm system, call planning and reporting, quotation management, lead tracking, analysis of sales-area performance, a built-in word processor, and analysis of promotional campaign effectiveness, market segmentation, and competitors.

For sales project planning, the Multiple Future Actions feature lets you attach to each contact an unlimited number of actions to be taken to alert you to each stage of the customer’s purchasing decision process. With the Field Label Tailor feature, you can modify data fields and determine which customer information to keep. The Action View option lets you access contact records in date order of action required. You work directly from a To Do list, noting the results of each event and setting the next action date.

Market-Base also lets you separate prospective and actual customers, moving companies from one data area to another.

Market-Base is available for single-user PCs, for a multiuser network, or in distributed mode for field sales staff on portable PCs.

Price: Entry-level system starts at about $1130 (£595).

Data 2.0 Helps You Make Decisions

TreeAge Software has added financial and mathematical functions, annotation, TrueType font control, and exporting of graph data to spreadsheets and trees to Data 2.0, the System 7.0 version of its graphical decision-analysis software for the Mac. Version 2.0 also includes Apple events, Publish/Subscribe for spreadsheets and word processors, print preview, and improved tree display, manipulation, calculation, and printing.

You can use Data 2.0 for strategic and tactical decision making, risk assessment, determining settlement values in complex litigation, and medical triage. The package provides two mechanisms for drawing the decision tree: You can generate a tree, including branch names and numeric probabilities, by converting a hierarchical outline that you type in Data or import from a word processing or outline program, or you can construct a tree on-screen by adding branches or by copying a subtree at decision or chance nodes that you have selected.

Price: $495.
Contact: TreeAge Software, Inc., 1 Post Office Sq., 23rd Floor, Boston, MA 02109, (617) 426-5819; fax (617) 338-2880.
"Sure, I remember my first one..."
"Now I Know Better."

The DataPort™
14.4/Fax Modem

Introducing the powerful, robust V.32bis DataPort 14.4/Fax Modem. It pays for itself by significantly reducing your phone costs—and features fax capability, too! Designed by AT&T Bell Laboratories and AT&T Paradyne, it’s tested and proven to be compatible with virtually all modems, all speeds, and all standards. Solidly-built, solidly-backed by AT&T with a lifetime warranty, plus toll-free support. The all-in-one DataPort 14.4/Fax Modem satisfies your needs for both fax and modem. It:

- Sends/receives text, data, and images
- Links PCs to PCs, fax machines, and mainframes
- Connects remote offices and homes to corporate headquarters, and
- Transfers data files; exchanges images with fax machines; accesses E-mail, bulletin boards, information services.

For PCs and Macintosh®. Five models to meet your exact price/performance and feature/function needs:

the DataPort 14.4/Fax Modem and DataPort 9.6/Fax Modem, in standalone and PC-internal card models; and the DataPort 14.4 Modem standalone.

AMAZINGLY FAST
You’ll love its performance. The V.32bis DataPort 14.4/Fax Modem can deliver an effective throughput of up to 57,600 bps. That’s 4 times faster than lesser 14,400 bps modems and 24 times faster than 2,400 bps modems.

It’s all in the technique. Its exclusive Optical phone Line Interface (OLI), pat. pending, enables the DataPort 14.4/Fax Modem to accurately isolate usable data, even on extremely weak “real world” phone lines!

THRILLING, AND PAYS FOR ITSELF
The high-speed DataPort 14.4/Fax Modem dramatically reduces your phone line costs. In fact, if you currently use a 2,400 bps modem for just 2 hours a week on long distance calls, the DataPort 14.4/Fax Modem can save you enough in long distance bills to pay for itself in less than 5 months. After that, the cost-savings become money in your pocket!

The DataPort 14.4/Fax Modem is a good value in other ways, too. It comes with FREE, powerful yet friendly QuickLink II™ communications/fax software.

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“It’s essential to talk to everyone. I tried connecting my first modem to old lines and new ports of call. It couldn’t talk to them. It was embarrassing.”

And you only use—and pay for—one phone line for both fax and modem functions. Plus your productivity improves—so figure in your time-savings, too! For example, there’s no more waiting for your screen to refresh. And the DataPort 14.4/Fax Modem:
- Comes ready to use, easy to operate
- Saves time waiting in line to send faxes
- Allows you to send presentation-quality faxes, and
- Receives faxes even if you’ve been working on your PC!

SHAKES HANDS ALL AROUND
Compatible with the industry’s widest range of modems, the DataPort 14.4/Fax Modem automatically senses and adjusts to the line speed of other modems. It connects to older, slower modems—even 300 bps die-hards. Plus, it’s compatible to standard Group 3 (2,400-9,600 bps) fax machines and Class 1 fax/modems.

No one surpasses the DataPort 14.4/Fax Modem for compatibility.

PROVEN RELIABLE
AT&T agrees: lifetime commitment is not too much to expect. The DataPort 14.4/Fax Modem is so reliable, we back it with a lifetime warranty. Moreover, AT&T is on call, toll-free, to help you with superior service and support. We’ll always be here for you.

READY TO GET SERIOUS?
It’s a terrific value that pays for itself. Highly-compatible. And its performance is breath-taking! For a lasting relationship, connect with the DataPort 14.4/Fax Modem.

Proudly made by AT&T Paradyne in the U.S.A.

For more information on the DataPort 14.4/Fax Modem, DataPort 9.6/Fax Modem, and DataPort 14.4 Modem—or the name of the dealer nearest you—call us at 1 800 554-4996 ext. 25.

SOLIDLY-BUILT, SOLIDLY-BACKED BY AT&T.
Automate Data-Analysis Tasks

The latest version of Axum, a technical graphics and data analysis package for the PC, provides batch-processing features that you use to automate repetitive graphical and data-analysis tasks. Axum 2.0 also offers automatic axis scaling and intelligent tick-placement methods that help you create publication-quality graphs.

With version 2.0's advances in 2-D, 3-D, and contour plotting, you can plot 3-D mesh-surface plots of any size, draw 3-D grids on any plane at any position, draw reference lines anywhere on a graph, and use color shading for 3-D surfaces and splines. You also get additional curve-fitting plot types; labeled scatter plots; PostScript fonts; support for TIFF, Color PostScript, and HPGL2; and the ability to use matrix data for grouped bar charts, grouped box plots, and 3-D.

Axum 2.0's data editor lets you sort multiple columns of data of any size, perform block operations, evaluate arbitrary functions, and sort on unlimited-size data sets. Axum 2.0 automatically uses EMS, XMS, and the high-memory area.

Price: $495.
Contact: TriMetrix, Inc., 444 Northeast Ravenna Blvd., Suite 210, Seattle, WA 98115; (206) 527-1801; fax (206) 522-9159.

Circle 1318 on Inquiry Card.

Scientific Data Analysis and Visualization

IDL for Windows provides a single distributed environment that lets scientists and engineers share programs, data, and computing resources transparently. You can use the package for applications such as physics, astronomy, image and signal processing, remote-sensing medical imaging, and financial analysis.

The Windows version includes all the capabilities of the workstation versions. Features include IDL/Windows, which lets scientists and engineers perform high-powered scientific computing on low-cost machines.

Ported from workstation-based hardware to the PC environment, IDL for Windows gets a GUI toolkit for building custom applications interfaces; 2-D plotting; 3-D visualization; IDL/maps, which lets you create sophisticated mapping and remote-sensing applications; IDL/gridding, which lets you fit irregularly gridded data to a regular grid for use with IDL's plotting and visualization capabilities; and IDL/statistics, a library of statistical routines for data analysis.

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Contact: Research Systems, Inc., 777 29th St., Suite 302, Boulder, CO 80303; fax (303) 786-9900.

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Statistics and Graphics for the Mac

Systat has added statistical analyses, graphics features, and data-handling features to Fastat 2.0 for the Mac. The software lets you view data, analysis results, and graphics simultaneously in several windows, and it dynamically links data and graphics, so you can select points in a chart or graph and immediately view corresponding cases in Fastat's spreadsheet-like data editor.

Fastat 2.0 can analyze up to 150 variables with an unlimited number of cases. Statistical analyses include basic descriptive statistics, correlations, factor analysis, regression, analysis of variance, nonparametric statistics, and time-series analyses. Graphing options include 3-D and 2-D scatter plots, bar charts, pie charts, category plots, box-and-whisker plots, stem-and-leaf plots, scatter-plot matrices, and probability and function plots. Fastat 2.0 is 32-bit QuickDraw-compatible, so you can select a broad range of colors for your graphics, and it supports the QuickTime system software extension, which lets you view a series of Fastat plots or graphs as an animated movie and watch how data changes over time.

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Contact: Systat, Inc., 1800 Sherman Ave., Evanston, IL 60201; (708) 864-5670; fax (708) 492-3567.

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<table>
<thead>
<tr>
<th>Button Type</th>
<th>Unique Serial #</th>
<th>Read/Write Memory</th>
<th>Password Protection</th>
<th>Expiration Timer</th>
<th>Decay Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS1420 ID Button</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DS1427 Timer Button</td>
<td>X</td>
<td>4K bits</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>DS1425 Multi Button</td>
<td>X</td>
<td>2K bits</td>
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Evergreen Technologies offers two groups of software modules, called the Ciné Loop Module Set and the Nuclear Option Pak, for medical professionals to use with MedVision, the medical visualization environment for the Mac, and QuickTime to animate medical images.

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Both packages include QuickTime extensions that let you create and view MedVision movies in the MedVision environment. You can also import other QuickTime movies into MedVision with full support for copy and paste functions and sound.

**Price:** Ciné Loop Module Set, $395; Nuclear Option Pak, $595.

**Contact:** Evergreen Technologies, Inc., Diamond Farm Office Park, 849-M Quince Orchard Blvd., Gaithersburg, MD 20878, (301) 948-1800; fax (301) 990-6844.

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The package also includes charting, table-editing, and painting modules. With the charting features, you can create more than 16 types of data-driven color business graphics with multiple data sets, including bar, pie, and line charts, as well as symbol and X,Y charts. You can import data from Lotus 1-2-3 or ASCII data files and generate single or multiple charts automatically from any portion of the data.

IslandPresents offers conversion utilities for graphics in Sun Raster, MacPaint, Group 3 fax, X Window System 11 bit-map, X Dump, and GIF formats.

**Price:** Single-user network license, $995.

**Contact:** Island Graphics Corp., 4000 Civic Center Dr., San Rafael, CA 94903, (415) 491-1000; fax (415) 491-0402.

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**Price:** Under $14,000.

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Pondering OS/2

I wonder if the people who mind our business for us think things through. That is: I'm making popcorn in the small microwave I just bought for my upstairs office. The microwave is perched precariously on a stack of cables, because the cord is too short to reach the wall socket from the sturdy bench I put in to hold the microwave. Tomorrow I'll get an extension, which of course will make the cord longer than it would have been if they'd made it a reasonable length in the first place.

Our cappuccino machine has the same problem: this very hot metal object has to be moved close to the edge of the counter if we want to plug it in. Meanwhile, my lawn mower has an enormous sticker that warns me not to put my feet under it when it's running; I wonder how many people (1) can read, (2) don't already know that putting your hands and feet under a running lawn mower isn't too bright, and (3) having read that warning will see the light. I suppose next some genius will make us put labels on our cats warning us not to carry them by the tail.

OS/2 at Last

We've installed OS/2. I wanted it to be a fair test, so we put it on the Gateway 2000 486/50, easily the fastest computer in the house just now. When we began the OS/2 setup, the Gateway had 8 MB of RAM, a Sound Blaster Pro card, and a Corel SCSI card supporting a Toshiba CD-ROM drive running off Corel software. The video card is a special edition of ATI Technologies' Graphics Ultra (with no mouse port) that comes with the Gateway. The ATI card is a good one for OS/2 because it has 8514/A emulation, and IBM software is fond of that.

The Gateway computer is a beautiful little machine, and I have no hesitation in recommending it. It comes with a good monitor, but I've been running it with a better one: NEC Technologies' MultiSync 4FG, which is an awfully good monitor for its price. One caution: if you're going to use the 4FG where there's glare, such as a bright window, you'll want the optional filter screen that slides into slots on the 4FG's case. That works wonders on glare and doesn't detract from the color and screen brightness. Unless you'll always be using the 4FG in an interior room, I'd recommend getting the filter.

On the other hand, the Nanao Flexscan F550i works wonderfully in any room under any light conditions. Of course, it costs more than the 4FG. The monitor that Gateway ships with their computer is good enough, but I recommend that serious users buy it without a monitor and get one from NEC or Nanao. The difference will be worth the price.

Prior to installing OS/2, we had the Gateway running Windows 3.1 and Norton Desktop for Windows under Quarterdeck's QEMM memory manager. The CD-ROM was available as drive D in both Windows and DOS. One CD-ROM program we had running was Sherlock Holmes, a game that has quite a bit of motion video with Sound Blaster Pro music and speech. It's a very impressive multimedia display and a rigorous test of the system, if a bit limited as a game (not enough cases).

OS/2 installs from 18 primary disks and half a dozen disks holding specialty printer drivers and the like. The installation takes about an hour if everything goes right. If things don't go right, it can take considerably longer.

Preparing for OS/2

First, you can leave in the Sound Blaster Pro card, but take out your SCSI card. Don't just disconnect the SCSI devices; take the card out entirely. Our first installation of OS/2 failed because we had that card in there.

Second, if you have Windows 3.1, remove it. If you have Windows 3.0, you can leave that installed. If you don't get rid of 3.1, you can get some screwy results when you start trying to run Windows applications in OS/2. Moreover, most of the Windows 3.1 applications, such as card file and calendar, won't work anyway. If you try to run them, you'll get a long delay, a screen of trademark information about as useful as a "no handle" tag on a cat's tail, and finally a message that this Windows session can't run that application. Better not to have them around in the first place.

Third, be sure you have 8 MB of RAM. I'm told that OS/2 will work with 6 MB, but people I trust say 8 MB is pretty much a practical minimum. Running OS/2 with

OS/2 2.0 gets a real workout—and receives high marks—at Chaos Manor

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NOVEMBER 1992 • BYTE 109
USER'S COLUMN

There's no Program Manager in OS/2. Instead, there's a folder full of "prompts."

4 MB is painful: the system will be accessing the disk a lot, and you'll wonder why you ever bothered.

I can't emphasize that enough. OS/2 is a robust operating system with a number of desirable features—we may even adopt it here at Chaos Manor if they get more peripheral drivers written and Windows 3.1 support as promised; but you must have proper hardware. That doesn't mean you need a superfast 486. A good 386/25 will run OS/2 nicely, provided you have a large hard drive, 8 MB of RAM, and a good, fast video card. Note that Windows needs a large hard drive and a fast video card, too, but it will run in 4 MB. I don't recommend either Windows or OS/2 unless you have the right hardware for the job.

Given the right hardware, OS/2 installs as OS/2 decompresses some files and begins to tidy things up. If you interrupt that process, you'll have to start the installation all over again.

Now What?
When you install Windows, the Setup program searches through your disk, looking for both Windows and DOS applications. If it finds any, it makes icons for them. In theory OS/2 does the same, but the only DOS program it found for me was Norton Utilities, Norton Commander, Procomm Plus, various text editors, and a number of games were ignored. I found I had to do most of that installation myself: and when I did, I got it very wrong. I tried it without reading the manuals. I don't advise doing that. Read your OS/2 manuals or a good third-party book on OS/2. It will save you time in the long run.

Understand, unlike Windows, which is a program that runs under DOS, OS/2 2.0 is a relatively new operating system. It is not a DOS program, nor is it merely "super DOS." It really is different, and it has its own philosophy that will have to be learned. That philosophy is self-consistent and has many features I wish had been incorporated into Windows; but it must be learned, and that is going to take some time and effort.

Installing DOS Programs
There's no Program Manager in OS/2. Instead, there's a folder full of "prompts." Open it by double-clicking. One of those is a full OS/2 window; another is a full-screen DOS prompt. There's also a windowed DOS prompt that—unsurprisingly—brings up DOS in a small window. Either of the windows that you get by double-clicking on one of the DOS prompts will work to let you run your DOS software's installation program or to copy the software from a floppy disk to the hard disk.

There's also a folder marked Drives, which has an icon for each drive and sort of functions the way the Windows File Manager works. That will also let you copy programs from floppy disks or run installation programs.

I didn't like any of these, so the first thing I did was to install Norton Commander. I use Commander in Windows, for that matter. It works just fine in Windows or OS/2, but, alas, I installed it incorrectly.

The proper way to do it (given that Commander was already on the hard disk, so I merely needed to tell OS/2 to create an icon for it) would be to open yet another folder, called Templates, and select the icon called Program. Use the right-
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The WIN-OS/2 Full Screen icon launches a bare-bones instance of Windows: no applets, no wallpaper, and no File Manager.

hand mouse button—OS/2 uses the right-hand mouse button a lot—to drag that template out onto the desktop. This creates a copy of the template icon; the old template is still back in the Templates folder. Right-click on the copy, and a little notebook shows up; use that to name the program, specify the path, name the Icon, start a startup directory, and so forth.

There are other pages to this “book,” and in them you can tell OS/2 how much expanded memory to allocate, play about with video-system options, and do a bunch of other optimization stuff. Learning what to do with that is not easy. It’s not well documented in the manuals, and the help files are from that peculiar school that teaches how to write text that is clear and informative only to people who already knew the information in the first place.

The best way to learn many of the features of OS/2 is from an OS/2 enthusiast. You can find them on BIX, GEnie, and other electronic information services; I strongly advise anyone trying to learn OS/2 to get on one of those services. An awful lot of essential knowledge about OS/2 is passed along only as folklore. That’s also true of Windows and the Amiga. All powerful systems seem to have lots of badly documented, or undocumented, features.

Fortunately, for most DOS programs you will install on OS/2, the default settings will work just fine; you won’t need to do any fine-tuning to get started, and later on you can learn the tips and tricks needed to optimize. The fact is, just about all DOS programs run better under OS/2 with the default setup than they do under Windows optimized or, for that matter, under DOS itself.

When you finish telling OS/2 about your
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new program, drag the icon to whatever group folder you like and drop it in. You can also create new empty group folders.

However, if you right-click on the Program icon while it is still in the Templates folder, the little notebook pops right up; and if you then give it a program name and path—I gave it the specs for Norton Commander—you're doomed. Thereafter, when you drag that icon out to the desktop, it starts the program you entered. You cannot install any other DOS programs. I had about 10 copies of Commander going before I got wise. The remedy is to go back to that Program icon in the Templates folder, right-click, and erase everything so that all the program specs are blank again. Enter program specs only on a copy of the program folder that you've dragged out onto the desktop.

There are several other gotchas, and as I said, the help files were largely written by people from the "clear only if previously known" school. Eventually, though, you will get your DOS programs installed and organized.

Alas, they will all have the same boring icons. OS/2 comes with an icon editor, which lets you draw your own icons; but OS/2 does not recognize icons done for DOS programs, and the OS/2 icon editor will not read those third-party icons. The good news is that there's a freeware program that will convert Windows icons to OS/2 format, so you can have the Commander's hat and gloves, or Civilization's city and pharaoh, if you take the trouble to download it from BIX or GEnie. What I really wish is that IBM would add the ability to read Windows icons into the OS/2 icon editor. Then they could be saved, modified or not, in OS/2 format.

Running DOS in OS/2

DOS programs run just great in OS/2. The memory management is invisible and nifty: extended memory, expanded memory, virtual memory up to 32 MB per program,
How do you move volumes of data from your SCSI device fast and efficiently? With the Fast Disk EISA SCSI Caching Host Adapter from American Megatrends.

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POWERFUL SOFTWARE

Since it's practically impossible to crack or duplicate a key having all the features mentioned above, a pirate will usually go for the software linking the protected program to the key. Therefore, check that your protection software has all of the following:

- A Linkable Protection Module with which calls can be made to the key from any point in the protected program.

An "Envelope" installation program. Such programs enhance security while making it possible to protect a software even without its source code.

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Circle 78 on Inquiry Card.
kind of video and sound card you have; and it will go find the Sound Blaster Pro, and oui will come the music.

On the other hand, Warlords, as an example, tries to find your sound card. If you have the proper environment settings, it will be able to under DOS or OS/2 (but almost never under Windows; I don’t know why). If you don’t have the right settings, it won’t find the card and there will be no sound. In other words, when it comes to sound cards, OS/2 sometimes works the way Windows does: it requires evil and potent magic to enable the sound.

Windows Under OS/2

There are two ways to run Windows applications under OS/2. One is to open the folder called Windows Programs, find your program in there, and open it. The system will trundle for a while and then display some stupid trademark notices. If you had a bunch of Windows 3.1 applications on your hard disk, this is probably one of them and you’ll get a message that the applications can’t be run. Considerable time is wasted to no purpose.

If it does work that way, it will be slow. I mean really slow, and it won’t matter much whether you have other processes going at the same time. It’s just going to be slow. Video objects will drag across the screen—this on a 486/50 with a fast video card. It’s worse on slower hardware.

The other way to run Windows applications under OS/2 is to open the WIN-OS/2 Full Screen icon. That will bring up an instance of Windows.

It’s not a complete Windows. There are no applets and no wallpaper. (The applets are back on the OS/2 desktop; press Alt-Escape to change to that and run the OS/2 calendar and clock. There’s no card file.)

There aren’t any programs located and grouped as applications the way Windows does when installed. You’ll have to figure out where your Windows programs are and install them one by one, building up your Windows desktop from scratch. Since there is no possibility of running a DOS window, you cannot save your new setup unless you exit WIN-OS/2, having checked the Save Setup box. Warning: if you merely close the WIN-OS/2 window from the OS/2 desktop, all the arrangement work you have done will be lost.

There is no File Manager; you’re on your own in finding your Windows applications and their paths. If it will show you a directory tree, I wasn’t able to find it. You can pop back to OS/2 and use the disk drives “object,” but that’s a bit of a pain. I tend to use Norton Commander, but that too requires changing from the WIN-OS/2 window to a DOS application Window.

that wasn’t on your WIN-OS/2 desktop. A better solution is to run Norton Desktop for Windows. That works. It has its own file manager and some of its own applets and utilities, and it lets you save your configuration without exiting the window.

WIN-OS/2 does recognize your familiar Windows icons, so you can build your desktop with those.

Within this WIN-OS/2 window, your applications will run faster than they do if opened one at a time directly from the OS/2 desktop; but they will be considerably slower than if you were running Windows 3.1 under DOS. So it goes.

Conclusion: it’s not a better Windows than Windows. At least not yet.

Tricks and Limits

If there are any OS/2 CD-ROM drivers, I can’t find them. I have some Corel drivers that purport to work with OS/2 but don’t. Corel says they have CD-ROM working with OS/2, but no one else I have talked to knows how to do that.

Nor will drivers run in WIN-OS/2. Moreover, this limitation applies to all SCSI devices: tape drives, WORM drives, optical disks; as I write this, none work in OS/2 windows. A number of outfits are said to be writing OS/2 SCSI drivers—given Corel’s usual success in systems integration, it’s surprising theirs don’t work yet—and by the time you read this, there should be good SCSI OS/2 drivers, so ask around.

There is a way to create a window in which you can run CD-ROM drives. It’s called double booting, and it’s an interesting trick.

What you must do is dump OS/2 and turn your machine back into a DOS system. This is surprisingly easy to do. An OS/2 command in the Prompts folder does it simply and painlessly. The system exits OS/2 and reboots itself as DOS (and will boot as DOS from then on until you enter the OS/2 subdirectory and issue the command BOOT/OS2, which will convert it back).

Once you are running DOS, format a floppy disk with the /s (i.e., system) option to make a bootable disk. Now transfer your old CONFIG.SYS and AUTOEXEC.BAT to that floppy disk and edit them so that they have all the drivers and commands (e.g., MCDLED) required to access your CD-ROM. Keep that disk, open
the A drive door, and do the BOOT /OS2 command. Your system will trundle for a while and come up in OS/2. Since OS/2 remembers everything you were doing when you shut down, you will first have to say “no” to the question “Do you want to exit OS/2 and reboot in DOS?”

Now open the Prompts folder, and you will see a Boot from A option. Put your new system disk in the A drive and click away. OS/2 will create a window containing a virtual machine with that floppy disk’s CONFIG.SYS and AUTOEXEC.BAT. If you’ve done everything right, you may be able to use your CD-ROM.

I say may because I never did get the Corel CD-ROM system to work. We did get the slower CD-ROM drive that plays off the Sound Blaster Pro card to work. I am told that Future Domain SCSI boards can be made to work, but I don’t know. Telephone calls to OS/2-using friends like Rich Heimlich get the information that they can use CD-ROM in one of those floppy-disk-booted windows under OS/2, but they do it only because they have to. They think this is a kludge and advise waiting for the OS/2 CD-ROM and other SCSI device-driver software. Everyone is sure that the drivers will be out by the time you read this. I sure hope so.

Incidentally, you can boot up a window running any bootable DOS-type operating system with that boot-from-floppy-disk trick. You can bring up DOS 3.3 or DR DOS 6.0. The one thing you cannot do is run QEMM in there. Being a memory manager, it conflicts with OS/2. On the other hand, you can run HIMEM.SYS and some of the Microsoft DOS memory manager stuff. The boot-from-floppy-disk deal is a neat trick; some may find it useful.

Bottom Line on OS/2
I’ve used more space on OS/2 than I intended. My conclusion is that if you run mostly DOS programs and you don’t need a CD-ROM drive right away, OS/2 has a lot of advantages. It’s fast, installation of DOS programs is harder to describe than to do, and memory management is smooth and effortless. DOS programs run just fine full-screen or windowed, and transfer of stuff between DOS windows under OS/2 is easier than doing those transfers in Windows.

If you want to run mostly Windows programs, get Windows 3.1. That will run DOS programs well enough and Windows programs far better than OS/2 will. That may change with new versions of OS/2, but right now it is not a better Windows than Windows. If you do get OS/2, Norton Desktop for Windows will make WIN-OS/2 considerably more convenient.

If you want to play with OS/2 and you can’t live without CD-ROM and multimedia, it’s all right to install OS/2 and begin getting used to it, but wait until you know those peripherals operate in OS/2 before making the change permanent.

The learning curve is steep and long. A better DOS than DOS, yes. A better Windows than Windows, no.

A Windows Problem
You can tell a Windows aficionado by the big monitor running at high resolution—1024 or 1280—and the cluttered desktop. However, if you run Windows at high resolutions, you have a problem: Windows games generally won’t run full-screen. It’s odd. DOS applications run full-screen: the resolution changes to accommodate Windows applications can’t do that. Solitaire, for example: on a high-resolution screen, the cards are tiny.

The result is that many games applications are not written for Windows at all because Windows can’t scale from regular VGA when it encounters high resolution. Maybe this will be fixed in Windows NT.

Near Disaster
I was talking on the telephone. Windows was up and running. I’d be stuck on the phone for a while, so it seemed a good time to send Commander Mail out to collect my MCI Mail. The only problem was that I had the phone resting on my shoulder, and I needed my right hand to take notes. I couldn’t reach the mouse with my left hand.

I remembered there is a way to control Windows from the keyboard. I tried Alt-W. That would actually have worked, had I then used the arrow keys to highlight the list of window names, but I was distracted by the phone and pressed Return. That rearranges your desktop windows to cascade format, which means that all the windows are the same size and arranged one behind the other. I think it’s a lousy way to organize your desktop.

There isn’t much you can do to get rid of that cascade arrangement and go back to what you started with. You can individually resize each window and move it to where you want it, or you can turn the machine off. Nothing else will work. Unfortunately, I was still distracted by the phone, and I exited Windows. That did it: now Windows had saved that horrible cascade
image as my normal desktop, and my carefully arranged desktop was gone. At this point I must have taken leave of my senses. I was out of Windows, and it was going to take some work to restore my desktop; so for reasons I never will understand, I entered Palindrome’s Network Archivist and told it to make a backup onto DAT (digital audiotape). It did, but now—now I had made a backup copy of that miserable excuse for a desktop arrangement. Absolutely stupid.

Fortunately, Network Archivist is smarter than I am. It keeps copies of old versions of files. By going into it and restoring PROGMAN.INI and all the .GRP files to one version previous to the current ones, in 10 minutes I had my desktop back. One more reason to cheer for Network Archivist; it’s better than WORM drives. Incidentally, by the time you read this, Palindrome will have a new version that will copy to read/write optical disks. I like DAT: the medium holds a lot, and it’s cheap—one-half cent per megabyte.

**Intel Does It Again**

Pournelle’s Law states, “One user, at least one CPU.” In fact, I believe in real multiprocessing: why time-share one CPU when you can have one CPU per task? Intel’s Satisfaction system implements that philosophy.

This fax/modem board comes with its own CPU and half a megabyte of memory. That means it can truly run in the background. It can answer the phone, detect an incoming fax, and record that. Meanwhile, you are still working on whatever foreground tasks you’ve set yourself. You will not have heard the phone ring.

If there’s another incoming call, the Satisfaction hears a voice request and rings the phone.

Later on you can give the Satisfaction a list of messages to send out by fax. You can specify a time for it to do that or have it start right in. All this works in DOS or Windows. I haven’t been able to try it with OS/2 yet, and Intel didn’t know if it would work.

The new Satisfaction 400E is a high-quality 14,400-bps modem with MNP, V.42bis, and all the trimmings, and it sells at a competitive price for such; but you also get the fax capability. Intel likes to say that the fax is free.

If that’s not enough, if you get their software package, you get an OCR (optical character recognition) program that really works. We sent ourselves a newspaper article from the regular fax machine to the Satisfaction. Then we aimed their OCR program at it: it read the whole newspaper article and put it into Word for Windows. There were only three mistakes.

I have been a fan of the Intel communications coprocessing system since they first came out with it. Now this product is better and cheaper than ever. Recommended.

**Visual Basic and Crescent**

I’ve used up so much space and time on OS/2 that I won’t be able to do a full report. Microsoft has Visual Basic for DOS. It’s pretty much compatible with Microsoft QuickBasic and the BASIC compiler; the advantage is that it writes object-oriented code and makes creation of great user interfaces simplicity itself.

Best of all, it works with Crescent Software’s library of BASIC tools, QuickPak Professional for Windows, including their communications library. You can do good BASIC programming without Crescent tools, including their PDQ library (link it...
Now we're the shot

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instead of the standard BASIC library at compile time; it saves time and space). You can, but you’re needlessly handicapping yourself.

If you do much BASIC programming, get Visual Basic for DOS; it will be a good transition path to Visual Basic for Windows and a painless way to learn about OOP (object-oriented programming). While you’re at it, get QuickPak. Between them, you’ll find you can write and debug astonishingly complex programs in a very short time; they’re the best programming productivity tools I know of.

**Word for Word**

I’ll make this quick. Word for Word translates data files from one format to another, preserving as much information about formatting and fonts and suchlike as can be preserved. I use it. There’s a new version of Word for Word. It has more formats, including Word for Windows, and some new spreadsheets as well as word processor formats. You can also use it to view files, even if you want to look at a file but don’t have the particular word processor or spreadsheet that created the file. Recommended.

**WinSleuth Gold 3.0**

This is another product that deserves better than short shrift, but I’m out of room. This is about as complete a program for investigating your hardware and software as I know. It beats Quarterdeck’s Manifest. It tells you all about everything, including which interrupts and ports are in use. You won’t use this a lot, except when you have to install something new; then you’ll want it bad. Recommended.

**Procomm for Windows**

I have used Procomm Plus for a long time. When I changed to Windows, I installed it with a PIF (program information file), giving it 2000 ticks in both foreground and background, and I’ve had no trouble with background downloads.

I was eager to get the Windows version. When I installed it, however, I found that the terminal window occupies only part of the screen, the default font is smaller and not as pretty as my DOS font, and it’s actually harder to mouse around than it is to use commands and arrow keys. I used it a couple of times, and it works. There are some neat features here and there, but I find that Procomm Plus for DOS (running under Windows) works better.

**Books About CD-ROMs**

Meckler has been doing an amazing number of computer books on many subjects, but particularly CD-ROM books. I don’t often see them in stores, which is a pity, because most of them are excellent. They tend to be specialized, the kind of thing that if you need them, you need them a lot. Descriptions of databases, the massive CD-ROMs in Print (available as both a book and a CD-ROM version for $95 each), and technical books on how optical drives work. They’re uniformly good, and libraries in particular should be sure to get the Meckler catalogs (Meckler Corp., 11 Ferry Lane W, Westport, CT 06880, (203) 226-6967).

**Winding Down**

I’ve just seen the cover art for the book jacket to The Gripping Hand by Niven and Pournelle. It’s gorgeous. The book’s scheduled for February release.

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

**The PKWARE Data Compression Library**
by PKWARE

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

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FastFacts 3043-011

**Genus GX Developer's Pak**
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Incorporate graphics images into your programs quickly and easily with the GX Developer's Pak. Includes the PCX Toolkit which allows you to manipulate PCX graphics images; GX Graphics which is a complete graphics library supporting all graphics primitives; GX Effects which lets you add special effects to programs, and GX Text which allows you to display bitmapped text in any graphics mode.

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LIST:  PS Price
ANSI C  $325  $315
Pascal  $325  $315
FORTRAN  $375  $375
FastFacts 1958-048 (C), 1958-050: (Pascal), 1958-049: (FORTRAN)

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

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

LIST: $795  PS Price: $749
FastFacts 89-063

**F77L EM/32 Version 5.0**
by Lahely Computer Systems

Industry leading 32-bit Fortran Language System includes Phar Lap's 386/ DOS Extender. This VCL, VMS, and DPMI compliant extender enables users to access up to 4GB and operate in the MS Windows DOS box. The extender is royalty free and includes virtual memory support. New with Version 5.0: 32-bit debugger, arrays beyond 16MB, compression linker, and 466 optimizations. Support for popular VXL, IBM VS, and 90 features.

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FastFacts 334-052

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PRO
LIST $495 PS Price: $415

Standard $199 $159

FastFacts 501-048: (PRO), 501-047: (Stand.)

Distinct TCP/IP for Windows
by Distinct Corporation

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(SDK) LIST $495 PS Price: $439

(Application) LIST $395 PS Price: $379

FastFacts 1951-003: (SDK), 1951-007: (App.)

Easy Boot v1.0
by Clear Software Inc.

Easy Boot allows you to maintain 15 different system configuration sets, so that you can reboot your machine with the optimal configuration every time. Maintain 15 different AUTOEXEC.BAT and CONFIG.SYS files that can easily be copied, edited, and printed. It's the perfect solution to lots of accessories.

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FastFacts 873-011

SLATE with Graphics
by Symmetry Group

SLATE with Graphics is a universal printer driver library. It supports dot matrix, laser, and PostScript printers. It includes over 250 text and graphic printing functions to select fonts, print text, print images from the screen, PCX, and TIFF files, and much more. It allows royalty-free distribution of your application, the 750 printer database, and the setup and testing programs.

LIST: $448 PS Price: $419

FastFacts 891-005

Q+E DataLink/OV
by Pioneer Software

Q+E DataLink/OV is a set of self registering ObjectVision @functions that enables you to link your ObjectVision application to the following databases: Btrieve, dBASE, DB2, Excel files, INGRES, NetWare SQL, Oracle, OS/2 DBM, Paradox, SQL/400, SQLBase, SQL/DS, SQL Server, Sybase, Tandem NonStop SQL, Text files, and XDB. Build complete database applications, generate reports, create customized data entry forms, execute batch updates, or perform any other database operation. ROYALTY FREE!

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LIST: $399 PS Price: $379

FastFacts 2137-013

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Fastest dynamic overlay linker for C, C++, ASM, BASIC, Clipper, QuickBASIC, Fortran, etc., with new integrated memory swap function designed to save time and memory. Automatically creates fast, stable overlaid .EXEs to reduce memory requirements. Uses XMS/EMS to save currently executing program and run a second within the first. Features CodeView support and overlay caching to XMS/EMS for optimum runtime performance.

LIST: $299 PS Price: $269

FastFacts 2061-002

WindowPhone" Software Developer's Kit
by AG Communication Systems

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

LIST: $495 PS Price: $439

FastFacts 4061-002

Q+E Database Library
by Pioneer Software

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LIST: $399 PS Price: $379

FastFacts 2137-013

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FastFacts 3674-001 (C-Dbug), 3674-003 (C-Verify)

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by Micrografx

Micrografx Designer 3.1 plus OLE is the only precision illustration program for Windows. Compatible with Windows 3.0 and 3.1, Designer includes Adobe Type Manager, Adobe TypeAlign, and more than 175 Type 1 fonts. Users get 15 drawing tools, object snap, 64 layers, automatic dimensioning, OLE and TrueType font support, 2,200 clip art images, more than 30 import and export filters, and 24-hour technical support.

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RELATE
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RELATE is a personal information manager which is tightly interfaced with Word for Windows, Ami Pro, Excel and other Windows products. It allows you, within minutes, to organize your files to provide "information at your fingertips." You automatically link your documents well to incoming and outgoing correspondence, voice notes and multimedia to a quick and easy-to-use electronic rolodex.

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military, with a good approach to integrating the lessons of the Gulf War into military theory.

The computer book of the month is *Waite Group's Visual Basic How-To* by Robert Arnsen et al. (Waite Group Press, 1992). This is an intermediate programming book. Beginners will want something simpler for an introduction, but this gives oodles of examples and shows how to do some pretty tricky stuff. It was written when Visual Basic was for Windows only, but much of it is applicable to Visual Basic for DOS.

Two games of the month. First, *Hardball III* from Accolade. If you like computer baseball, you'll like this a lot; at least Richard, the baseball enthusiast in the family, does. Real play-by-play comments through Sound Blaster Pro. Second, *Gunship 2000* from MicroProse. I don't get to keep this one: my son Phillip is a Navy officer on a helicopter carrier, and the only thing those guys like better than flying choppers for real is flying them with a good flight simulator, and this way Marines can fly an Apache.

Finally, you can get the *Lost Treasures of Infocom*: 15 disks, 20 text adventures (including Zork, Planetfall, and Bureaucracy), and all the clue books and maps. There's no fancy graphics, but those old text games had something the modern computer games lack.

Next month: another look at palmtops, some math programs, and short shrift to a bunch of stuff that's too good to ignore but I never have room for.

And now we're off to the beach house, where with any luck I will turn out the final draft of *Janissaries IV, Hour Of Treason* and simultaneously run off 10 pounds.

Wish me luck.

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

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<td>fax: (613) 728-8200</td>
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<tr>
<td>Intel Corp., 5200 Northeast Elm Young Pkwy., Hilsboro, OR 97124</td>
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<td>(800) 438-3373</td>
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<td>(503) 629-7444</td>
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<td>fax: (800) 525-3019</td>
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<td>Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052</td>
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<td>(800) 426-9400</td>
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<tr>
<td>Word for Word</td>
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<tr>
<td>MasterSoft, 6991 East Camelback Rd., Suite A-320, Scottsdale, AZ 85251</td>
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<tr>
<td>(602) 277-0900</td>
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Penny-Pinching PCs: How They Did It

Before buying a budget PC, know which corners the vendor has cut

ANDREW REINHARDT

The dramatic plunge of PC prices in the last nine months has touched off a fundamental restructuring that will leave the PC industry forever changed. PCs will be made, marketed, and sold differently. Only the strongest, smartest vendors will survive. For the consumer, the benefits are great, but so are the risks.

On the upside, you will pay less for computers now and in the future, as they have become commodity items. As vendors’ profit margins erode, they will be forced to find new, innovative ways to add value. Base systems will be configured more tightly to specific types of user needs.

However, buyers must be more careful than ever when choosing which PC to buy. Cutting prices usually means cutting corners, as vendors use less durable parts and eliminate features. Today’s bargain PC might become tomorrow’s orphan as weaker clone vendors fail, leaving their customers without support. By reducing R&D funds, companies could sacrifice their future to gain market share today.

Ironically, the catalyst for the PC price plunge was the move of vendors of traditionally high-priced products into the low-cost world. Compaq, AST Research, DEC, and IBM, among others, have introduced new PC lines that compete directly with those of the bottom-feeding clone vendors. Risking their reputations as providers of superior-quality systems in an effort to survive, these vendors have brought prices down using both innovation and good old-fashioned cost cutting.

The BYTE Lab tore apart six low-cost systems from Compaq, Dell, AST, IBM, DEC, and Apple to see exactly what you get for your money (see the text box “Less Expensive, or Cheap?” on page 132). Although all six companies made some trade-offs with these systems, they have maintained a high level of quality: A Compaq is still a Compaq, even at $1000.

A Folding Umbrella

In the past, as long as giants such as IBM, Compaq, and Apple kept prices high, clone makers had a fertile ground for selling less expensive systems to a hungry market. But when the giants dropped their prices to clone levels, the so-called price umbrella collapsed.

“Everybody suddenly realized that you didn’t have to buy IBM and Compaq; brands like Gateway were acceptable,” says David Blitzer, vice president and chief economist for Standard & Poor’s in New York. The result was a steadily decreasing market share for vendors of high-priced products; according to Benny
PENNY-PINCHING PCS

PC SYSTEM PRICES

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Features</th>
<th>Price</th>
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<tbody>
<tr>
<td>AST</td>
<td>Bravo 4/25s</td>
<td>386SX/33, 120-MB hard drive, one floppy drive, Super VGA, Windows 3.1, mouse</td>
<td>$1745</td>
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<td>Compaq</td>
<td>ProLinea 3/25zs</td>
<td>386SX/25, 84-MB hard drive, two floppy drives, Super VGA</td>
<td>$1617</td>
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<td>DECpc</td>
<td>333sx LP</td>
<td>386SX/33, 122-MB hard drive, one floppy drive, Super VGA</td>
<td>$1549</td>
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<tr>
<td>Dell</td>
<td>Dimension 386SX/25</td>
<td>386SX/25, 80-MB hard drive, two floppy drives, VGA, Windows 3.1, mouse</td>
<td>$1359</td>
</tr>
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</table>

Figure 1: Standard equipment for each of the systems compared here varies, but each listing represents the respective company's entry-level system. All come with 4 MB of RAM, MS-DOS 5.0, and a monitor. The Compaq and AST prices are retail, while the DEC and Dell prices are direct. Dealers generally discount retail prices, although the percentage varies. AST estimates the street price of the Bravo to be approximately $1500. IBM had not yet released pricing on its ValuePoint line at press time.

Lorenzo, an analyst for the investment firm Dillon, Read, 50 percent of the market now belongs to off-brand clones.

Competition heated up in 1991, as a soft economy led to an overall 25 percent price decline in systems. Then, last February, Dell cut its prices by up to 38 percent; Tandy, DEC, Everex, CompuAdd, AST, Zenith, and Apple followed suit. In Europe, Siemens Nixdorf introduced a line of low-cost PCs. In May, IBM trimmed prices on its PS/2s, in some cases offering direct-order models below dealers' wholesale prices.

The turning point in the price war was Compaq's June introduction of its low-cost ProLinea line, which launched a new torrent of price cuts throughout the industry. IBM has since followed with its PS/ValuePoint line, and DEC recently introduced a low-cost line of PCs made in Taiwan (see figure 1).

Compaq's new ProLinea line is intended to complement its Deskpro series. Compaq wasn't the first to implement a dual-product-line strategy; AST and Advanced Logic Research, for example, have long offered different families targeted toward corporate and individual buyers. But with its clout, Compaq has accelerated the move toward a price-driven market. "This is happening a lot faster than anybody anticipated," says Sheridan Tat-

suno, president of NeoConcepts, a consulting firm in Aptos, California, specializing in the Asian market.

Early reports indicate that, at least for Compaq, sales of low-cost, name-brand PCs are doing very well. Harry Henry, director of research at market research firm Computer Intelligence/Storeboard, says that Compaq moved about 10,000 ProLineas of all models through the retail channel in July, from essentially zero the month before. "Talk about a rebound," he says. In fact, Compaq is backlogged on ProLinea orders, although the company expected production to meet demand sometime last month.

Despite signs of success, not everyone believes the dual-line strategy is good for the long term. Chris Buckham, marketing director for U.K. computer maker Apricot, calls IBM and Compaq's decision to enter the low-price market "a panic decision to a passing trend that peaked some six months ago." He believes that as buyers sour on lower-quality machines and direct sales, "there will be a backlash against cheap machines; not everybody wants to drive a Lada." Noting that only 20 percent of systems in the U.K. are sold direct, he asserts that the other 70 percent are sold to people who are interested in more than price.

Cutting Costs or Corners?

Vendors are coping with a mix of lower profit margins and reduced spending on everything from salaries to advertising to customer support. But much of the effort is focused on reducing the cost of systems themselves, through an interrelated combination of design changes and revised manufacturing processes.

The costliest parts of most systems are the hard drive and the motherboard (see figure 2). Other than renegotiating supplier contracts, manufacturers can do little to reduce these expenses. Many companies have turned to AMD and Cyrix for CPUs, which has prompted Intel to slash its own prices.

This leaves the rest of the motherboard as a prime target for cost reduction, says Roger Alford, a system designer with Programmable Designs and a BYTE consulting editor. Companies are designing "universal" motherboards that can accept a wide range of processors, from a 386SX up to a 486DX2. Many companies are reducing the number of PCB (printed circuit board) layers from six to four, for a savings of 20 percent to 40 percent per board. And all companies are seeking to reduce part counts wherever possible by using highly integrated chip sets.

Vendors also contend that some lower-rated parts can be used without affecting quality. "Everything was specified very robustly when the industry was young," says Daniel Sheppard, director of product marketing for AST Research. By using a less expensive SIMM socket, for example, AST is saving tens of thousands of dollars per year. The company most notorious for overengineering was Compaq, says Gerald Purdy, director of corporate marketing for Sundisk and former director of portable computer systems at BIOS vendor Phoenix Technologies. "Compaq was religious about this," he says. "They way over-specified their systems." Many of those high specs, such as an external cache on the 386SX and extra RFI shielding, were the first to go when Compaq designed the ProLinea.

AST Redesigns Its Systems

Sheppard says AST has reduced costs by 35 percent while improving serviceability in its new Bravo systems. The reductions came from changes that saved anywhere from a few pennies to tens of dollars.

The most noticeable change is a new L-shaped universal motherboard that has only four layers instead of six. The unusual shape allows AST to punch out two motherboards from each sheet of PCB material, a raw savings of 50 percent. A new chip that AST codeveloped with VLSI Designs integrates all core
logic into a single device. A “personality slot” on the motherboard permits users to add in features formerly on the motherboard, such as a network interface, without using up an ISA bus slot.

Some of the modifications implemented with the Bravo systems are minor. AST uses a less expensive speaker than before. The SIMM sockets, formerly rated for 1000 insertions, are now rated for 30. “How many times do you change your memory configuration?” asks Sheppard. “We save 2 cents on each socket, and that adds up because we buy millions.” Likewise, serial and parallel connectors rated for 10,000 insertions were replaced with less expensive parts that will still outlast most users.

Some changes reflect different usage patterns. Because floppy drives see less use than in years past, Sheppard says AST can specify lighter-duty units. The same holds true for the floppy media shipped with systems. AST also cut 6 inches from the length of the keyboard cable. “Once upon a time, somebody decided 3½ feet was the right cable length,” Sheppard says. AST now saves 200,000 feet of cable a year.

Some areas were off limits. “When you mess with the keyboard, you get into trouble because of ergonomics,” Sheppard says. AST also kept the reset button on the front panel despite potential savings in moving it. The power supply, too, must meet exacting standards, but AST is saving money by using a unit in U.S. systems that meets FCC and UL ratings but not the tougher Nordic standards.

Cutting corners can lead to problems. Dave Kirkey, vice president of sales and marketing at ALR, warns that discount motherboards can delaminate. Programmable Designs’ Alford is wary of inexpensive connectors, which can be unreliable. He is especially disturbed by the practice of substituting 8-bit RAM for parity-checking 9-bit RAM. “This saves RAM chips and the parity-generation and checking circuitry,” he says. “But without parity checking, the system cannot detect RAM failure while it is running.”

Hewlett-Packard, long known for quality, is seeking ways to trim costs from its Vectra line, built in Grenoble, France. Like the Compaq ProLinea, HP’s new Vectra 486N uses an 85-watt power supply; since the system has limited expansion capability, the company claims a more powerful unit isn’t needed. Product manager Alison McCallum-Varey says the 486N and the earlier 386N contain a total of about 450 parts, a 40 percent reduction from the approximately 840 parts used in the older Vectra QS16S. The lower part count saves HP money in raw materials, inventory management, assembly, testing, and service (see table 1). Another design focus was to reduce the number of screws on the motherboard, which saves on both manufacturing and service costs. “If you look at a Dell motherboard, it has about 25 screws,” McCallum-Varey says. “Ours has just one screw, which we are working to get rid of.”

Compaq Streamlines Manufacturing
For Compaq, designing a low-cost PC involved as many changes to process as to product. The company initiated a continuous-flow assembly line, where products go straight from board assembly to systems assembly, eliminating work-in-process queues. The company also added redundant testing of subassemblies; only a statistical sample of boards are evaluated before being installed in systems, and then all completed units are fully tested and burned in. Keith Maxwell, manager of new-products manufacturing for Compaq, says these process changes reduce inventory-carrying costs and the more substantial expense of rework.

Compaq has also implemented a flux-free soldering process that saves a washing step for PCB assemblies and conveniently eliminates the use of ozone-depleting chlorofluorocarbons. In the realm of innovative accounting tricks, the company now stores completed systems inside rented trucks, which reduces its inventory tax liability. In the cutthroat world of low-cost PCs, you take your savings where you can find them.

AST’s manufacturing is also tuned for low-cost systems, says Darius C. Power, managing director of the company’s U.S. manufacturing. Power touts AST’s commitment to concurrent engineering—the simultaneous development of product and process—which he says cuts both cost and time to market. AST uses an integrated materials-handling system and an automated shop-floor control system that manages everything from statistical quality control to system configuration to the downloading of test routines appropriate for each system. The company is constantly looking for ways to reduce cycle times: updating sales projections more often, propagating projections faster through the production scheduling system, and placing parts orders more quickly. “Any manufacturing technique can be successful,” says Power. “It’s the culture and efficiency that dictate whether or not it works.”

Whether through design or manufacturing, argues NeoConcepts’ Tatsuno, the ultimate goal for manufacturers must be simplification. “A danger for U.S. designers is that they love to get involved in complex technology,” he says. To survive in the “ruthless” world of consumer electronics, he says, “the only way to cut costs is to eliminate complexity. The companies that survive will be the ones that reduce costs by 30 percent to 40 percent per year.”

Although Apple has remained largely neutral during the recent
Less Expensive, or Cheap?

STEVE APIKI AND TOM THOMPSON

You can’t make a personal computer for less money without cutting at least one or two corners. With this in mind, the BYTE Lab examined the design trade-offs of six low-cost systems from brand leaders: Compaq’s ProLinea 3/25zs, Dell’s Dimension 386SX/25, IBM’s PS/ValuePoint 325T, AST’s Bravo 4/25s, the Digital DECpc 333sx LP, and Apple’s Mac Performa 600. The question we wanted to answer was, are these indeed high-quality systems at a lower cost, or are they simply cheap?

Compaq ProLinea 3/25zs

The ProLinea 3/25zs is Compaq’s least expensive system. What it most obviously sacrifices is expansion capability: Missing are a high-capacity power supply, an EISA bus, and lots of slots. While more slots and more drive bays are available in other ProLinea models, expansion and serviceability remain the areas where the ProLinea shows the most change from Compaqs of old.

Still, Compaq has built a high-quality, cost-effective machine. The motherboard and support ASICs (application-specific ICs) are all designed and manufactured by Compaq. The ProLinea’s main board shows the same commitment to surface-mount components as does the system board of a Deskpro 386/33L (see photo A). The ProLinea is a more highly integrated system than the Deskpro. High integration and heavy emphasis on surface-mount components have made the ProLinea much smaller and less subject to faulty mechanical connections. These qualities have also let Compaq switch from the eight-layer, double-sided board of its older Deskpro to a less expensive, four-layer, single-sided PC board.

Shrinking the size and the expansion capability of the ProLinea shaved a lot of expense. Fewer expansion slots means a lower power-supply capacity, less demanding cooling requirements, and a smaller case with less need for reinforcement and shielding. Since expansion is so deemphasized, the ProLinea’s case is not designed for ease of access. Screws, rather than thumbscrews, attach the cover, and the hard drive is inaccessible without removing the power supply.

Important components in the ProLinea remain top-notch: The 40-MB hard drive in the 3/25zs comes from well-regarded Quantum. The integrated video system is based on a Western Digital WDC-90C11, a solid—if not outstanding—VGA platform.

But Compaq did compromise on a few features. The old, heavy, mechanical Compaq keyboard is replaced on the ProLinea by a lighter, membrane-switch device that lacks the solid feel of the older keyboard. Gone, too, is the large proprietary power supply of the Deskpro, replaced by a standard 70-watt unit. Some traditional Compaq “overengineering” items—external cache on a 386SX, several layers of drop-in RFI shields, proprietary memory modules populated with RAM from only a few select sources—have also fallen by the wayside in the ProLinea. On the positive side, Compaq’s use of standard components means you have third-party sources for ProLinea replacement parts.

The ProLinea still has what it takes in the important areas. Performance is good, and its high level of integration should make it a reliable system.

Dell Dimension 386SX/25

Dell has earned respect by manufacturing solid systems at a reduced cost to the buyer. In this sense, Dell had less to cut than Compaq in delivering its low-cost Dimension line.

The most obvious change between the Dimension and Dell’s standard P series is that the Dimension’s system board is made by SMC, not Dell, and the system is assembled by another contractor. While the 333P (a 386DX system) uses a six-layer board, the Dimension’s board is a sim-

In the Performa 600, Apple dispenses with the relatively costly aluminum coating that is sprayed inside the cases of other Macs to meet the FCC Class B standard for RF emissions. Instead, the Performa 600 has a sheet-metal casing that costs less to manufacture and easily exceeds the Class B rating.

On the Performa 600’s motherboard is a new custom ASIC (application-specific IC) Combo chip that combines the SCSI-controller and serial-controller chips. Marc Auerbach, a Macintosh product manager, says Apple is developing even more integrated ASICs to reduce the size of motherboards, make the boards easier to manufacture, and improve reliability.

Another method that Apple is using to cut costs is reduced
pler four-layer design. It lacks the modular CPU and cache-upgrade features of Dell's P series, which allows you to add cache memory or upgrade to a 486 with an option card. The Dimension also includes standard 30-pin SIMMs, versus the 333P's larger SIMM boards.

The Dimension still has good components, like a Conner IDE drive and 90C11-based VGA on-board. However, some of the nice touches of the P series have been cut. The Dimension's keyboard is much lighter than and lacks the feel of Dell's standard design. Although the drive controller, video, and I/O ports are integrated on the motherboard in both series, the Dimension board uses less-sold plug-in connectors for I/O and video in places where the P series has ports soldered to the board. Also, the Dimension's motherboard fits poorly in its case; the board has six ISA slots, but only four are accessible externally, and the chassis has room for only four cards. However, the Dimension also scores a few points over the slim-line P series: It has more slots (the 333P has only three) and a larger power supply (150 W versus 84 W).

**IBM PS/ValuePoint 325T**

The PS/ValuePoint may be IBM's idea of a low-end, low-cost system, but cost compromises are few and far between on this very solid design. High integration, standard rather than custom solutions, and existing IBM technology put to good use are the keys to the ValuePoint 325T's low price.

IBM's 386SLC processor, with its built-in 8-KB cache, gives the ValuePoint a slight performance edge over other 386SX-based systems. It also saves IBM from having to dedicate board space and additional external logic to maintaining an external processor cache.

The ValuePoint's four-layer, single-sided board is larger than that of the ProLinea, but it has about 20 percent fewer ICs. The high-integration support chips are from VLSI Designs and Oki/IBM. The system board has a built-in video and IDE controller, 2 MB of DRAM, and two plastic sockets for large SIMM boards. You can put in two more SIMM modules for a total of 18 MB, but the memory-support hardware supports only 16 MB.

The ValuePoint's on-board video is Super VGA, not XGA. The Super VGA is provided by a Cirrus 5422, a high-speed video controller that includes a 24-bit RAMDAC. There's also 1 MB of VRAM (video RAM) on-board, in just two memory ICs.

There are a few cheap points: a 145-W power supply to drive four drive bays and five ISA slots, a small piezoelectric speaker that doesn't deliver much of a beep, and a 3-volt coin battery for CMOS backup. But the big components are excellent: an IBM 80-MB IDE hard drive and a nice, heavy IBM keyboard.

The case has a plastic front bezel that snaps on with a plastic clip. The rest of the case contains a lot of metal, with a reinforcing bar across the middle of the chassis. The drive bays pop out easily with a few screws.

**AST Bravo 4/25s**

AST reduced cost long before it was cool; the company introduced its low-end, cost-cut Bravo series in 1988. In September, AST rolled out its most inexpensive Bravo line to date, which cuts cost even further, primarily in packaging, which has environmental benefits, too. For instance, most Macs come in boxes that are 20 percent to 25 percent plastic foam, while the Performa 600's packaging is only about 17 percent foam.

Still another approach is to recycle proven designs. The Mac LCII, introduced last spring, uses the same motherboard as the older LC. The LC's 68020 chip has been replaced in the LCII with a 68030, and the system includes 4 MB of RAM soldered to the motherboard instead of 2 MB. This money-saving shortcut entailed a trade-off, however. When you add two 4-MB SIMMs, the LCII has a total of 12 MB, but it can address only 10 MB, because Apple saved months of development time by not redesigning the LC's memory controller.

**Survival of the Fittest**

Sometimes, says Ronald Chwang, president and CEO of Acer America, "you have to reengineer the whole company." With labor representing a fairly small portion of total system cost—
PENNY-PINCHING PCS

The new Bravos are built around a redesigned system board, like the ProLinea’s system board. All 486-class Bravo systems use the same motherboard, which can provide clock frequencies of between 16 and 40 MHz. Thus, you can plug any 486 CPU into it. The board also includes a soldered-on 486SX chip and space for an optional daughter card. The daughter card supports an Intel OverDrive processor and cache module; other Bravo models are built around the same system board with different CPU and cache combinations on the add-in card. The onboard 486SX is populated on factory-configured DX and DX2 systems.

The common 486 board is an L-shaped, four-layer, double-sided PCB (printed circuit board). The motherboards of older Bravos were six-layer designs and about twice as big. AST claims that the L shape and reduced size of the new boards enable the company to print two boards at a time instead of just one. Despite its small size, the new board is only moderately populated. The heart of the system is a highly integrated VLSI Designs chip set that accounts for most of the system logic. The largest consumer of board real estate is the on-board VGA, which includes a Cirrus 5422 VGA controller (including a 24-bit RAMDAC) and 1 MB of VRAM. Serial and parallel I/O and an IDE controller are included on the system board. Finally, there is a proprietary connector designed to accept a network interface daughter card.

Except for the system board, very little has changed from the last Bravo. The chassis is the same—a relatively cheap, mostly plastic case that disassembles easily and has room for four half-height drives. The unit the BYTE Lab looked at included a reliable Western Digital IDE drive. The power supply is also similar to that used on older models, although AST now ships different ones according to the standards of the country of destination.

AST also saved small costs by using a cheaper, clip-on coin battery and a cheaper speaker. But surprisingly, the new Bravo looks like a better machine than its more expensive predecessor; it’s more highly integrated, and it packs more features into the same case.

DECpc 333sx LP

Unlike DEC’s Tandy-built mainstream desktops, the LP series is assembled entirely in DEC’s Taiwan facilities. The shift to lower labor costs undoubtedly contributes to DEC’s aggressive pricing. But the LP series also shaves cost through its design—with high integration and limited expandability.

The main system board on the DECpc 333sx LP is a well-made, four-layer, double-sided PCB. Like the other manufacturers, DEC cut price while improving reliability by using highly integrated parts. The heart of the 333sx is an Eteq Panda chip set (an 82C390SX), a single chip that incorporates most of the support logic required for a 386SX design. As a result, the board has plenty of free space; the only other significant support chip is a Chips & Technologies 82C206 CMOS/ clock device. There is room for eight SIMM modules on the system board, and each socket accepts 4-MB SIMMs. However, the Panda supports only 14 MB of total system RAM. The SIMM sockets use metal, not plastic, clips.

The Eteq chip includes 64 KB of cache memory and a cache controller. The 333sx LP runs on an AMD 33-

| Table A: Although vendors cut a few performance features in these low-cost designs (e.g., scrapping the processor cache), system speeds remain respectable. All indexes are relative to a Compaq Deskpro 386/33L, which has an index of 1. |
|---|---|---|---|---|---|
| CPU Index | Disk Index | Video Index |
| AST Bravo 4/25s | 0.95 | 1.07 | 1.11 |
| Compaq ProLinea 3/25zs | 0.45 | 1.04 | 0.57 |
| DECpc 333sx LP | 0.87 | 1.15 | 1.08 |
| Dell Dimension 386SX/25 | 0.39 | 0.97 | 0.53 |
| IBM PS/ValuePoint 325T | 0.49 | 1.04 | 0.90 |

Acer used to manufacture systems in Taiwan, where it is based. Now, says Chwang, “it doesn’t matter where you manufacture; the key is how you manage inventory.” Product life cycles have shrunk from as long as one to two years to as short as three to six months. Better-informed customers demand freedom to configure systems. The solution is to assemble PCs at the last possible minute, minimizing inventory on hand and maximizing flexibility. “When product spends six weeks on a boat, you lose money,
MHz 386SX, and the combination of 33-MHz operation and cached memory provides good performance.

Other components of the 333sx are outstanding. DEC's integrated VGA is a Cirrus 5422, the same 24-bit device used in the ValuePoint and Bravo. The 52-MB hard drive is from Quantum. The power supply is a 145-W unit manufactured by Delta with a variable-speed fan for noise reduction. It’s not a cheap supply, and 145 W is not bad for the three slots and four drive bays that the 333sx LP needs to support.

The case is not rugged, but it’s very well thought out. Drive cages pop out with just a few screws. A single connector runs from all front-panel switches and indicators to the system board. The only obvious cost reductions are in the flimsy case lock and clips.

The 333sx is somewhat of an anomaly in the LP line, which is designed to share as many components as possible among systems—a major source of savings. All the LP systems share the same case, power supply, and drives. The 32-bit members of the LP line share a common motherboard, with a daughter card for processor-specific features. However, the 333sx has a system board all its own. According to DEC, adding 16-bit data paths to the general-purpose board would add more cost than designing and stockin a dedicated 386SX motherboard.

Mac Performa 600

The Performa 600 closely resembles the 25-MHz Mac IIci and has all the features you’d expect from a Macintosh: three NuBus slots, virtual memory, built-in color video, and sound I/O.

Apple offers this 32-MHz, 68030-based Mac with extra features and a built-in CD-ROM for around $2500.

The Performa 600 has plenty of expansion capability. At the front is a half-height bay. A smaller internal bay holds a 3'/4-inch drive. Both bays support SCSI peripherals. The 112-W power supply is a universal type.

The Performa’s built-in video supports 8-bit-deep displays of 640 by 480 pixels on 13-inch and VGA monitors. However, the Performa’s video frame buffer resides in 512 KB of VRAM, while the IIci’s frame buffer consumes a portion of main memory. Furthermore, this VRAM buffer can be expanded to 1 MB, so the Performa 600 can display 16-bit pixels (32,768 colors)—a feat the IIci is incapable of achieving.

A glance at the Performa 600’s main logic board shows a high level of integration. The 68882 FPU is gone, but there is a socket for one for those who need it. The board has only four SIMM RAM sockets and two SIMM VRAM sockets. You can expand memory by replacing the existing SIMMs with higher-density ones.

A Combo chip on the main logic board combines the functions of a 53C80 SCSI controller chip and an 85C30 serial controller chip. Borrowed from the IIci is a 68HC05 microcontroller that eliminates several custom chips by integrating the Apple Desktop Bus logic, real-time clock, power control, and parameter RAM.

A custom ASIC, called the Vasp, consolidates the clock-signal, video-generation, and memory-mapping functions that required several chips in the Mac IIci design. The Vasp also incorporates the sound circuitry found in another ASIC on the Mac LC and LCII.

Although the Performa 600's CPU is clocked at 31.334 MHz, the bus operates at only 15.667 MHz. This allows the use of inexpensive 80-nanosecond RAM, but it also exacts a performance penalty: The CPU and FPU often wait for memory reads and writes to complete.

Steven Apiki is a technical editor for the BYTE Lab. You can reach him on BIX as “apiki” or on the Internet at apiki @bytepb.byte.com. Tom Thompson is a BYTE senior technical editor at large.

You can contact him on BIX as “tom_thompson.”
PENNY-PINCHING PCS

Table 1: Hewlett-Packard reduced the number of parts in the Vectra 386N Model 50 to 452 from a total of 844 in the Vectra QS16S Model 40 a year ago.

<table>
<thead>
<tr>
<th></th>
<th>QS16S</th>
<th>386N</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU complex</td>
<td>503</td>
<td>228</td>
</tr>
<tr>
<td>Video system</td>
<td>160</td>
<td>119</td>
</tr>
<tr>
<td>Multifunction card*</td>
<td>110</td>
<td>76</td>
</tr>
<tr>
<td>Mechanical parts</td>
<td>67</td>
<td>27</td>
</tr>
<tr>
<td>Number of cards</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Total parts</td>
<td>844</td>
<td>452</td>
</tr>
</tbody>
</table>

*includes one serial and one parallel port and a hard floppy drive controller.

But not everyone agrees with this view. Compaq reduced costs of its ProLinea line in part by moving away from its normal (and expensive) habit of designing custom components. And Dell, which already did less in-house design than Compaq, turned to outside suppliers for major subsystems in its Dimension computer line. Argues Ming Hsu, president of OEM supplier Asima Computer Systems, “The notion of vertical integration in the U.S. is not an advantage when functionally identical, reliable components can be obtained at significant cost savings from outside sources.”

Another approach is to seek horizontal integration. Tatsuno predicts that even companies the size of Dell won’t be able to go it alone and will need to seek technology, marketing, or manufacturing partners. “We’ll see acquisitions by the majors of smaller companies that own market niches,” he says. “This will produce economies of scale and a kind of horizontal integration more like that of GM and Ford than that of the vertically integrated Toyota.”

New PC Order

The result of this price restructuring will be a dramatically different market. Tatsuno believes there will be a lot of failures and mergers. Paul Saffo, a research fellow at the Institute for the Future in Palo Alto, California, has a bleaker view. “This is the fire sale before the storm. The clone makers are doomed. They had to better take the money and run,” he says.

The change is permanent. “This is not a six-month correction, where prices plummet and then go back up,” says Todd Bakar, an analyst with investment-banking firm Hambrecht & Quist in San Francisco. He sees the restructuring as a sign that the PC industry is maturing.

In a mature market, a company can sell different products to different buyers. Lorenzo says that profit margins on high-end systems and servers can range up to 40 percent or 50 percent, whereas low-end PCs run from a loss of up to 22 percent. By selling a range of systems, companies can achieve both high unit volume and high profits: For example, according to analysts’ estimates, Apple earned overall profit margins of 44 percent last year due to the success of its higher-priced Quadras, Mac IIs, and PowerBooks.

Jeff McNaught, a PC product manager for Wyse Technology, says his company summarizes differentiation as “slots, watts, and bays.” High-end systems offer a lot of all three, but “to build a truly low-cost system, you have to cut some out.” But Blitzer argues that the job goes beyond just products; he says differentiation is “more in the marketing and perceptions than in manufacturing.” Assuming that all systems offer a similar baseline (i.e., an Intel-compatible CPU, a hard drive, and VGA graphics), he predicts that service, support, and distribution channels will determine who buys what.

This view is echoed by Apricot’s Buckham, who divides the market into three classes of users: price-dependent, brand-dependent, and value-dependent. Price-dependent customers will buy any PC at the lowest price; the brand-dependent are swayed by brand names; and the value-dependent balance the price, feature set, and vendor reputation. To satisfy value-dependent customers, he says, you have to invest heavily in R&D to add extra features.

R&D Cutbacks

Too much focus on rock-bottom pricing could dampen innovation and delay the wide adoption of newer technologies such as higher-capacity floppy drives and multimedia. “[When you focus too much on pricing,] you tend to eliminate some of the high-risk R&D efforts,” says Acer’s Chwang. Features that might make PCs more enticing to buyers—stereo sound, faster graphics, CD-ROM, on-board DSPs (digital signal processors)—are left out to cut costs. Unfortunately, this will beget a vicious cycle: Because these add-ons will remain nonstandard, they won’t sell at the volumes necessary to drive down their cost. And with profits squeezed, vendors will see opportunities for high profit margins in options, thus keeping prices up and further reducing their volumes.

But most observers don’t believe creativity is in jeopardy. “In the future, you’ll have to innovate to make any money,” says Esther Dyson, editor of the RELEASE 1.0 newsletter. “We’ll see a lot of price cutting and then a wave of innovation as a means of differentiation.” Indeed, some argue that by aggressively stripping cost out of the basic PC unit, manufacturers will actually find it easier to sell advanced features.

Innovation, not cost cutting, will ultimately win the market. “Companies need to continue to develop new technologies and invest in R&D,” says Hambrecht & Quist’s Bakar. “It would be a big mistake to sacrifice the future.”

Maintaining high R&D spending is a formidable challenge in an industry with tight profit margins. Compaq has already cut its spending levels: In the first half of 1992, it spent $89 million on R&D, compared to $101 million for the same period in 1991. On average, PC vendors spend about 1 percent of the cost of a PC on R&D, says Krish Shetty, managing director of Nascam Computer in North Andover, Massachusetts. Companies such as AST and Compaq spend approximately 3 percent. IBM might spend as much as 5 percent.

Tatsuno argues that the computer industry will have to follow the model of consumer electronics firms. “The Japanese learned that the only way [to succeed in consumer electronics] is with huge volumes,” he says. “In five years, we’ll have hundreds of millions of machines; companies will be making 2 percent to 3 percent margins, and they’ll reinvest 40 percent to 45 percent of that back into R&D. That’s the name of the game.”

Companies will have to balance their immediate need to remain in business with a long-term view that allows them to pioneer new markets and invest in new technology. Says Bakar, “It’s obvious that Apple, Compaq, Dell, and AST will prosper. But beyond them, it becomes less clear.”

Editor’s note: BYTE’s U.K./Europe bureau chief Andy Redfern and BYTE news editors Patrick Waurzyniak, Tom Halfhill, and Ed Perratore also contributed to this story.

Andrew Reinhardt is BYTE’s West Coast bureau chief. You can contact him on BIX as “areinhardt.”
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A camera is a camera. Right? Wrong. With the rapidly approaching acceptance and implementation of digital photography, a camera isn’t just a camera anymore. Used in combination with computers, digital photography has become a hybrid environment that makes the best use of both technologies.

You can use many methods to convert a real-life image into its digital counterpart. You can create digital bit-map images by using video digitizer frame-grabber boards that accept composite video signals and by using hand-held, flatbed, and slide scanners.

Of course, you can still produce superior-quality images using conventional silver-halide film rather than digital methods. For many applications, however, digital images resemble film images so closely that differences aren’t noticeable.

**Practical Applications and Advantages**

Digital cameras can produce and transmit pictures quickly. News services can use digital cameras to take photos in the field and transmit the data by modem to central locations for immediate distribution to their customers. With a digital camera, the speed of distributing still photos is close to the speed of a live TV broadcast, but the quality is much better—as good or better than that of conventional film photos transmitted over news wires.

For computer users, probably the most important advantage to using digital images is being able to put images into desktop publishing documents. I’ve used digital images to good effect in various ways; for example, I’ve inserted photographs of company executives into newsletters, diagrams into technical manuals, product photographs into sales brochures, and documentation photography into viewgraph presentations. If you want to add an image to your document, you can do so quickly.

Digital images are also well suited for developing an image library. You can use large hard drives, WORM optical drives, and other mass-storage devices to store huge quantities of high-quality images. If you properly index the images, you can access a digital library quicker than you can a collection of photographs. Digital imaging is also better for the environment than conventional photography in that the technology eliminates the need for developer chemicals.

Kodak (Rochester, NY) offers its PhotoCD service to develop your slide film and, for an additional fee, scan the slides and save them onto a CD-ROM. Presently, PhotoCDs are not compatible with current CD drives.

Digital photographs can be distributed less expensively and more quickly than film or photographs. You can transmit...
digital photographs by modem to individual locations or mass-distribute them via broadcast techniques. You can upload pictures to electronic BBSes and time-sharing systems, or even use a satellite broadcast to transmit high-quality images around the world. Also, the disks that you mail require less in-transit protection (and less postage) than photographs.

I used a digital camera, the Kodak DCS (Digital Camera System), to take pictures of a space-shuttle launch (see photo 1). I transmitted the picture by modem to a friend with a ham radio setup, who uplinked it to UoSAT-F, an amateur radio satellite in a polar orbit. Within hours, the satellite’s flight path took it around the earth, and anyone with the proper hardware could download the picture.

Some people are concerned that digital cameras will eliminate the existence of photographic evidence, fearing that edited digital photographs could be passed off as original photographs. You can edit digital photographs to produce supermarket tabloid-style photos. But you can always determine that a photo was taken with a digital camera by magnifying the photo enough to show its square-pixel patterns. Conventional photos, as well as electronic text, have always been subject to “post-editing,” and digital images aren’t any different.

Collecting Images Digitally
Two types of cameras that use CCDs (charge-coupled devices) to collect images are still-video and true digital. Each has its own advantages and disadvantages.

True digital cameras are hybrids combining a film camera’s optics with a computer’s microprocessors. A digital camera’s lens focuses the image on a CCD instead of on a roll of film. CCDs used in image applications are semiconductors arranged as a grid of microscopic light-sensitive detectors. Photo 2 shows CCDs that are extremely popular for aerospace applications. (See the text box “Digital Images from Space” on page 144.)

The CCD is the input for a fairly simple computer consisting of a microprocessor, memory, multiplexing circuits, and a power source. The images can be stored in the camera’s memory or onto a more permanent storage device, such as a floppy or hard disk (see the figure).

Shutters are optional for digital cameras. A high-quality, accurate shutter is usually one of the most expensive parts of a good camera. For some applications, you can build a digital camera less expensively simply by eliminating the mechanical shutter. In cameras without shutters, the software acts as the shutter, accepting only the light falls on the CCD within a designated time. CCDs don’t react to light as quickly as film, and for certain high-speed applications, a shutter may be necessary.

Once the image is stored in the camera’s memory, you can use several methods to transfer it to a computer. You can connect a cable from the camera to the computer’s serial, parallel, or SCSI port; transfer a removable hard drive from the camera to the computer; or outfit the camera with a standard floppy drive.

Still-Video Cameras
The first commercial cameras to use CCDs were still-video cameras, two examples of which are the Canon Xapshot and the Sony Pro Mavica. These cameras use nonstandard 2-inch floppy disks that store data in analog format; for this reason, these disks don’t actually qualify as digital media.

Still-video cameras aren’t true digital cameras. You can view images from still-video cameras on video monitors or output them on hard copy by using specialized video printers. To convert still-video images into true digital format, you need an additional video digitizer board to convert the video image into actual computer data. Digital Vision (Dedham, MA) sells a still-video camera as an option for its ComputerEyes boards.

Still-video cameras are limited to TV resolution—less than 500 scan lines. A
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A digital camera uses a CCD to convert images into electronic pulses. In this example, a standard 1.44-MB drive is used to store the images. Alternatively, you could use a serial cable to transfer the pictures from your camera to the computer.

The least expensive and most practical method of creating still digital images is to take high-quality photographs and use a good flatbed scanner to digitize them. However, as true digital cameras become less expensive and the technology matures, you will find that the cameras provide several advantages.

I have experimented with two drastically different digital cameras—the $799 10-ounce Logitech Fotoman and the $20,000 19-pound Kodak DCS. The Logitech is the “Instantamatic” of digital cameras. It is fairly lightweight but has very low resolution. The Kodak DCS produces excellent-quality images, but it’s extremely complicated to use. (Kodak recently introduced a newer model—the Kodak DCS 200ci—that sells for less than $10,000.)

Right now, true digital cameras appear to be as unsophisticated as the earliest mid-1970s microcomputers: They have plenty of potential for future applications, but they are impractical for most uses. The table shows the qualitative differences between film, still-video, and true digital cameras.

Selecting a Digital Camera
Your most important criterion for choosing a digital camera is whether you need color. Monochrome cameras are capable of producing finer resolutions, and they work better in less light. If your primary application is using black-and-white images, you can use a typical office laser printer to create excellent-quality outputs. Color CCD cameras can produce fairly accurate color images on well-tuned RGB monitors, but only very high-end color printers can reproduce accurate colors.

Using a digital camera, you have the dual advantages of portability and immediate results. Unlike with film cameras, with a digital camera you can see exactly how your image will come out and make adjustments for composition and exposure on the spot. Advertisements for digital and still-video cameras suggest they can be effectively used in applications such as those performed by...
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Digital Images from Space

Most digital images are created with CCDs (charge-coupled devices), tiny detectors in a grid pattern residing on a silicon chip. In 1969, Bell Labs (Holmdell, NJ) developed CCDs, but they did not become popular until engineers found they could be used in various aerospace applications. CCDs are lighter, use less power, and are more efficient than photographic film or video tubes—all important features for spacecraft components.

An early CCD application was the Hubble Space Telescope's Wide Field/Planetary Camera, or WF/PC (pronounced "wiff-pic"). Each thumbnail-size CCD has an 800-by-800-pixel matrix capable of distinguishing 4096 gray levels (i.e., 12 bits). The four images can be electronically combined to create a 1600-by-1600-pixel picture. WF/PC operates like a zoom lens: In its wide-field mode, it can take images of relatively large areas, and in its planetary-camera mode, it can zoom in on close-up views of planets. Some of its results include incredible images of planets, galaxies, globular clusters, and nebulas (see photo A).

Other scientific satellites that use CCDs include the European Giotto, which returned the first close-up pictures of Halley's comet, and the U.S./German Galileo spacecraft, which is en route to Jupiter. Closer to Earth, thousands of home and professional video cameras use CCDs. In an interesting reverse-technology transfer, dozens of space-shuttle missions have carried along home camcorders. A handful of missions have carried a modified 35mm camera with a CCD.

The Electronic Still Camera

The Electronic Still Camera, built by NASA, uses the optics from a Nikon F4. Engineers at the Johnson Space Center (Houston, TX) installed a 1024-by-1024-pixel, 8-bit (256-light-level) CCD at the film plane. Other modifications included a microprocessor controller and a 42-MB removable hard drive "film cartridge." Since the ESC uses a standard F4 body, it can use normal Nikon accessories (i.e., lenses and a flash).

The ESC setup includes an MS-DOS laptop computer with two expansion slots: an adapter to transfer the data from the hard drive film cartridges, and a video board to display images on the shuttle's onboard video monitors. On some missions, the astronauts have the capability to downlink images to the control center through the shuttle's high-bandwidth (Ku-Band) data channel.

The data is received on a workstation where it is displayed and archived. On Spacelab missions, where the experiments have the highest priority for data transmissions, the ESC stores its pictures on the hard drive film cartridges for analysis after the space shuttle returns.

The ESC was carried on the STS-48 mission, which deployed an Earth observation satellite; the STS-42 IML-1 (International Microgravity Laboratory) mission; the STS-45 ATLAS-1 (Atmospheric Laboratory for Applied Sciences) mission; and the STS-49 mission, which rescued a stranded Intelsat satellite. Engineers and astronauts who have used the ESC are extremely happy with the results, and upcoming flight crews have requested that the camera be added to their missions.

ESC's downlink capabilities would be extremely useful on future long flights. Other versions under development include enhanced features such as higher resolution, color, and low-light capabilities. instant cameras (e.g., real estate sales, medicine, R&D, and insurance claims). Besides current applications where digital cameras have marginal advantages, post-processing digital techniques will offer new benefits.

Even though true digital cameras have some inherent limitations, once you get used to using them, you'll discover the added flexibility of being able to store images on magnetic media. Being able to see a preview image on the camera's built-in monitor assured me that I would obtain the results I wanted. I discovered that I was much more comfortable taking several images at different exposures and settings, because I could easily delete pictures that didn't come out well.

Desktop publishing has allowed people to become their own publishers and printers. Digital image processing will extend conventional printing technologies and offers the potential to improve the quality and feel of images even further.

Philip Chien is an aerospace and microcomputer consultant. He started in the microcomputer field working with the original 1977 Apple II, and, since 1983, he has covered and written about computers and the U.S. space program. You can reach him on BIX c/o "editors."
A Technical Perspective For the '90s
# A Technical Perspective For the '90s

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>QD-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>DESQview and PC Fundamentals</td>
<td>QD-5</td>
</tr>
<tr>
<td>2.1</td>
<td>Introduction</td>
<td>QD-5</td>
</tr>
<tr>
<td>2.2</td>
<td>The PC Memory Map</td>
<td>QD-5</td>
</tr>
<tr>
<td>2.2.1</td>
<td>Conventional Memory</td>
<td>QD-5</td>
</tr>
<tr>
<td>2.2.2</td>
<td>Extended Memory</td>
<td>QD-5</td>
</tr>
<tr>
<td>2.2.3</td>
<td>Expanded Memory</td>
<td>QD-5</td>
</tr>
<tr>
<td>2.3</td>
<td>EMS 3.2</td>
<td>QD-5</td>
</tr>
<tr>
<td>2.4</td>
<td>EEMS and EMS 4.0</td>
<td>QD-5</td>
</tr>
<tr>
<td>2.5</td>
<td>Software Emulation of EMS memory</td>
<td>QD-6</td>
</tr>
<tr>
<td>2.6</td>
<td>Multitasking more than 640K</td>
<td>QD-6</td>
</tr>
<tr>
<td>2.7</td>
<td>LOADH! capability</td>
<td>QD-6</td>
</tr>
<tr>
<td>2.8</td>
<td>Program Swapping</td>
<td>QD-6</td>
</tr>
<tr>
<td>2.9</td>
<td>Switching and Windowing</td>
<td>QD-6</td>
</tr>
<tr>
<td>2.10</td>
<td>Application Video Behavior</td>
<td>QD-6</td>
</tr>
<tr>
<td>2.10.1</td>
<td>Well-Behaved Applications</td>
<td>QD-6</td>
</tr>
<tr>
<td>2.10.2</td>
<td>Ill-Behaved Applications</td>
<td>QD-6</td>
</tr>
<tr>
<td>2.10.3</td>
<td>Virtualization</td>
<td>QD-7</td>
</tr>
<tr>
<td>2.10.4</td>
<td>Loaders</td>
<td>QD-7</td>
</tr>
<tr>
<td>2.11</td>
<td>Microsoft Windows</td>
<td>QD-7</td>
</tr>
<tr>
<td>2.12</td>
<td>Application Types</td>
<td>QD-7</td>
</tr>
<tr>
<td>2.13</td>
<td>DESQview API</td>
<td>QD-7</td>
</tr>
<tr>
<td>2.13.1</td>
<td>The SHADOW Call</td>
<td>QD-7</td>
</tr>
<tr>
<td>2.14</td>
<td>Processor Types and Modes</td>
<td>QD-8</td>
</tr>
<tr>
<td>2.14.1</td>
<td>The 8088/8086 and Real Mode</td>
<td>QD-8</td>
</tr>
<tr>
<td>2.14.2</td>
<td>The 286 and Protected Mode</td>
<td>QD-8</td>
</tr>
<tr>
<td>2.14.3</td>
<td>The 386 and V8086 Mode</td>
<td>QD-9</td>
</tr>
<tr>
<td>2.14.4</td>
<td>The 486</td>
<td>QD-9</td>
</tr>
<tr>
<td>2.15</td>
<td>DOS Extenders</td>
<td>QD-9</td>
</tr>
<tr>
<td>2.16</td>
<td>VCPi Specification</td>
<td>QD-10</td>
</tr>
<tr>
<td>2.17</td>
<td>DESQview Capabilities</td>
<td>QD-10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>An Introduction to X</th>
<th>QD-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Traditional Graphics Output</td>
<td>QD-11</td>
</tr>
<tr>
<td>3.2</td>
<td>X Servers, Clients and Protocol</td>
<td>QD-11</td>
</tr>
<tr>
<td>3.3</td>
<td>An Event-Driven System</td>
<td>QD-11</td>
</tr>
<tr>
<td>3.4</td>
<td>A Distributed System</td>
<td>QD-12</td>
</tr>
<tr>
<td>3.5</td>
<td>Operating System and Architecture Independence</td>
<td>QD-12</td>
</tr>
<tr>
<td>3.6</td>
<td>X Terminals</td>
<td>QD-12</td>
</tr>
<tr>
<td>3.7</td>
<td>A Stand-Alone System</td>
<td>QD-12</td>
</tr>
<tr>
<td>3.8</td>
<td>The Window Manager</td>
<td>QD-12</td>
</tr>
<tr>
<td>3.9</td>
<td>X Development Layers</td>
<td>QD-13</td>
</tr>
<tr>
<td>3.9.1</td>
<td>Xlib</td>
<td>QD-13</td>
</tr>
<tr>
<td>3.9.2</td>
<td>Toolkits</td>
<td>QD-13</td>
</tr>
<tr>
<td>3.9.3</td>
<td>Intrinsics and Widgets</td>
<td>QD-15</td>
</tr>
<tr>
<td>3.9.4</td>
<td>Xt Intrinsics</td>
<td>QD-15</td>
</tr>
<tr>
<td>3.10</td>
<td>X11</td>
<td>QD-15</td>
</tr>
<tr>
<td>3.11</td>
<td>Toolkit Summary</td>
<td>QD-15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>DESQview/X</th>
<th>QD-17</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Minimum Requirements</td>
<td>QD-17</td>
</tr>
<tr>
<td>4.2</td>
<td>General Structure</td>
<td>QD-17</td>
</tr>
<tr>
<td>4.2.1</td>
<td>The X Server</td>
<td>QD-17</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Socket Driver</td>
<td>QD-17</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Regular DOS Applications</td>
<td>QD-17</td>
</tr>
<tr>
<td>4.2.4</td>
<td>DESQview API Applications</td>
<td>QD-17</td>
</tr>
<tr>
<td>4.2.5</td>
<td>Microsoft Windows and Windows Applications</td>
<td>QD-18</td>
</tr>
<tr>
<td>4.2.6</td>
<td>Regular DOS Graphical Applications</td>
<td>QD-18</td>
</tr>
<tr>
<td>4.2.7</td>
<td>X Clients</td>
<td>QD-18</td>
</tr>
<tr>
<td>4.3</td>
<td>Direct Windows</td>
<td>QD-18</td>
</tr>
<tr>
<td>4.4</td>
<td>Available Memory</td>
<td>QD-18</td>
</tr>
<tr>
<td>4.5</td>
<td>The Window Manager</td>
<td>QD-18</td>
</tr>
<tr>
<td>4.6</td>
<td>Fonts</td>
<td>QD-18</td>
</tr>
<tr>
<td>4.6.1</td>
<td>Scalable Fonts</td>
<td>QD-18</td>
</tr>
<tr>
<td>4.6.2</td>
<td>Using Scalable Fonts</td>
<td>QD-19</td>
</tr>
<tr>
<td>4.6.3</td>
<td>Scalable DOS Windows</td>
<td>QD-19</td>
</tr>
<tr>
<td>4.7</td>
<td>Advanced Memory Management</td>
<td>QD-20</td>
</tr>
<tr>
<td>4.7.1</td>
<td>Virtual Memory</td>
<td>QD-20</td>
</tr>
<tr>
<td>4.7.2</td>
<td>Dynamic Link Libraries</td>
<td>QD-20</td>
</tr>
<tr>
<td>4.8</td>
<td>Print Server</td>
<td>QD-21</td>
</tr>
<tr>
<td>4.8.1</td>
<td>DOS Application Printing</td>
<td>QD-21</td>
</tr>
<tr>
<td>4.8.2</td>
<td>X Client Printing</td>
<td>QD-21</td>
</tr>
<tr>
<td>4.8.3</td>
<td>Print Manager</td>
<td>QD-22</td>
</tr>
<tr>
<td>4.9</td>
<td>The Network Connection</td>
<td>QD-22</td>
</tr>
<tr>
<td>4.9.1</td>
<td>The Network Manager</td>
<td>QD-22</td>
</tr>
<tr>
<td>4.9.2</td>
<td>Operation over a Network</td>
<td>QD-22</td>
</tr>
<tr>
<td>4.9.3</td>
<td>Communication Ports</td>
<td>QD-23</td>
</tr>
<tr>
<td>4.9.4</td>
<td>Remote Shell</td>
<td>QD-23</td>
</tr>
<tr>
<td>4.9.5</td>
<td>Remote Exec</td>
<td>QD-23</td>
</tr>
<tr>
<td>4.9.6</td>
<td>File Transfer Protocol</td>
<td>QD-24</td>
</tr>
<tr>
<td>4.9.7</td>
<td>Telnet</td>
<td>QD-24</td>
</tr>
<tr>
<td>4.9.8</td>
<td>Remote Clients</td>
<td>QD-24</td>
</tr>
<tr>
<td>4.9.9</td>
<td>Interprocess Communications</td>
<td>QD-24</td>
</tr>
<tr>
<td>4.10</td>
<td>Stand-Alone or Networked?</td>
<td>QD-24</td>
</tr>
<tr>
<td>4.10.1</td>
<td>Unix Machines and DOS/Microsoft Windows programs</td>
<td>QD-24</td>
</tr>
<tr>
<td>4.10.2</td>
<td>DOS Machines and Unix Programs</td>
<td>QD-25</td>
</tr>
<tr>
<td>4.11</td>
<td>A User’s View</td>
<td>QD-25</td>
</tr>
<tr>
<td>4.12</td>
<td>A Consistent Growth Path</td>
<td>QD-25</td>
</tr>
<tr>
<td>4.13</td>
<td>DESQview/X System Capabilities</td>
<td>QD-25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5</th>
<th>Development Issues</th>
<th>QD-27</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Real Mode Applications Development</td>
<td>QD-27</td>
</tr>
<tr>
<td>5.2</td>
<td>Protected Mode Applications Development</td>
<td>QD-27</td>
</tr>
<tr>
<td>5.2.1</td>
<td>Using a Protected Mode Compiler and Linker</td>
<td>QD-27</td>
</tr>
<tr>
<td>5.2.2</td>
<td>Using a Regular DOS Compiler</td>
<td>QD-27</td>
</tr>
<tr>
<td>5.2.3</td>
<td>DOS Extenders</td>
<td>QD-28</td>
</tr>
<tr>
<td>5.3</td>
<td>X Client Development for DESQview/X</td>
<td>QD-28</td>
</tr>
<tr>
<td>5.3.1</td>
<td>DESQview/X Development Kits</td>
<td>QD-28</td>
</tr>
<tr>
<td>5.3.2</td>
<td>DOS/4GX Support</td>
<td>QD-28</td>
</tr>
</tbody>
</table>

| 6 | DESQview/X Products | QD-29 |
1 Introduction

This document is intended to provide end users and developers with an understanding of the capabilities and implementation of the DESQview/X product, along with the DESQview DOS multitasker and the X Window System.

### Definitions

**X Window System**
The X Window System is a hardware-independent and operating system-independent graphics standard designed to operate over a network or within a stand-alone machine. Developed at the Massachusetts Institute of Technology in 1984, it has subsequently become an industry standard employed by companies such as AT&T, DEC, Hewlett-Packard, IBM, Sun Microsystems and others.

**X Server**
An X Server is a special X Window System graphics application that controls a computer’s display screen, drawing windows, text, lines, pictures, circles, polygons and the like according to the requests (messages) from an application. An X Server may handle the screen drawing for multiple applications concurrently — each application typically displaying information with one or more windows on the screen.

**X Client**
An X Window System application program (such as a spreadsheet or drawing program) that communicates with an X Server is called an X Client. A well-defined messaging system links the two participants. This messaging system may occur over a network or within a single machine.

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**DESQview/X:**
- Is a third DESQview (DESQview, DESQview 386 and now DESQview/X), adding distributed graphics and remote computing capabilities to Quarterdeck’s multitasking DOS environment.
- Brings the X Window System to DOS — thereby enabling DOS users to participate in the many graphical and multimedia advances available today only on workstation platforms.
- Allows DOS PCs to participate in industry standard, multivendor, multi-operating system, distributed processing (cross-platform computing).
- Supports the latest advancements in font technologies and advanced memory management.
- Provides printer spooling for DOS PCs as well as remote printing capabilities for Unix X Window workstations and other DOS PCs.
- Gives users of Unix X Window workstations access to many off-the-shelf DOS and Microsoft Windows software packages.
- Gives DOS users access to Unix X Window workstations or mainframe programs (Clients).
- Gives DOS users access to Unix text-based applications (using xterm).
- Gives DOS users access to more powerful DOS and Microsoft Windows programs that are not capable of being run on their own machine.
- Promotes DOS to that of a multiuser system through its remote execution and security features.
- Provides file transfer capabilities between DOS and Unix or other DOS machines on a network.
- Provides developers with an industry standard “open”, graphical development environment and choice of user interface.
- Supports industry standard methods for application programs to communicate across a network (Inter Process Communications), regardless of the network type.
- Provides X Client developers and manufacturers access to the huge installed base of DOS machines.
Specifically, it:

- Runs either stand-alone or as a networked system.
- Adds a graphical 3D look and feel to DESQview.
- Provides a growth path from character mode DOS to industry standard graphical user interfaces.
- Gives users a choice of interfaces (window managers) - the DESQview/X, OSF/Motif or OPEN LOOK interfaces are prime examples.
- Dynamically scales the windows of DOS text applications to any size (scalable DOS windows), from just a few pixels to full screen, using scalable font technology.
- Can run applications up to 16MB (16-bit protected mode) or 4GB (32-bit protected mode) by supporting the use of 16-bit and 32-bit DOS Extenders.
- Supports the use of virtual memory and dynamic link library technology to drastically reduce the amount of memory needed to run large application programs.
- Incorporates the Adobe Type Manager and scalable font technology giving X Clients access to the vast array of Adobe Type 1 fonts.
- Allows users to run many off-the-shelf DOS and Microsoft Windows applications in windows side-by-side with local or remote X Window Clients.
- Incorporates a Print Server that can handle print requests from remote machines (both DOS and Unix) connected on a network, while spooling to a printer.
- Allows local users to display and use many off-the-shelf DOS and Microsoft Windows applications that are running on another machine on a network.
- Allows local users to display and use Unix graphical applications (X Clients) that are running on another machine on a network.
- Allows local users to display and use Unix text-based applications that are running on another machine on a network (using xterm program).
- Allows local users to display and use DOS Clients written for X (graphical applications) that are running on another machine on a network.
- Allows X Window Unix users to display and use many off-the-shelf DOS and Microsoft Windows applications that are running on another DOS machine on a network.
- Provides a multiple level security feature to restrict access to a machine by other remote machines.
- Implements the File Transfer Protocol (FTP) for the peer-to-peer transferring of files to remote machines (DOS or Unix).
- Gives developers a choice of application styles - OSF/Motif, OPEN LOOK and others - or the freedom to design their own.
- Implements a printer imaging model that mimics X Window System display output so that X Clients need only support a single imaging model for both display and printer output, greatly simplifying the coding of X Clients.
- Implements the Berkeley Socket interface, providing Inter Process Communications between separate applications (on the same machine or even across a network) that is independent of the underlying network type.
- Provides developers a platform to port X Clients from Unix to DOS.
- Allows developers to create X Clients in a DOS environment for later porting to other operating systems using the X Window System.

The purpose of this document is to explain how the features of DESQview/X are possible. It provides coverage of the DESQview DOS multitasker, the X Window System and the integration of both of these technologies. This document also describes the development processes necessary to create X Client graphical applications for DOS.
This section describes the fundamentals of the DESQview multitasking software and basic PC concepts. Readers familiar with these topics are still encouraged to read the information presented here.

2.1 Introduction

DESQview is a program that extends DOS (either PC-DOS, MS-DOS or DR DOS) into a fully pre-emptive multitasking system. Contrary to popular belief, DESQview can perform multitasking on all classes of processor - 8088, 8086 (PC-XT), 286 (PC-AT), 386 and 486. However, the technical advances of the later processors empower DESQview with greater capabilities.

DESQview is compatible with most current PC software - and can even run Microsoft Windows 3.0, 3.1 along with Windows programs, GEM-based, as well as other graphic programs simultaneously.

A program in the DESQview environment may run occupying the whole display screen, or can appear in a small window, framed by a border. Multiple applications may appear on the screen simultaneously, each in its own window.

Certain applications may run in a small window and in "background", depending on how the program has been written and the type of processor being used - a table later in this section summarizes specific capabilities.

2.2 The PC Memory Map

A brief explanation of the architecture of a PC's memory map is beneficial to the understanding of this document. A PC's memory is laid out as follows:

![Memory Map Diagram]

2.2.1 Conventional Memory

Conventional Memory is memory that resides from 0K to 1024K (1MB). DOS, TSRs (Terminate and Stay Resident programs) and device drivers are loaded at the bottom of this memory with video RAM being located between 640K and 768K. Between the top of DOS and the bottom of video memory is the Application Area. Above the video area and below the top of conventional memory (1024K) is the System Area or what Quarterdeck refers to as High Memory. The System Area contains, for example, special system code such as the machine's BIOS (Basic Input/Output System) or RAM for a hardware card. Typically, this area is not contiguous, but contains portions of unused address space, sometimes more than 128K in size. See Quarterdeck's Manifest User Manual for a detailed description of High Memory (System Area).

2.2.2 Extended Memory

Extended Memory is memory that resides from 1MB and upwards (up to 16MB on a 286, 4 Gigabytes on a 386/486). It is available on machines that use a 286 processor or better and hence is not available on 8088/8086 machines. To be able to directly access this memory the processor must be in a special mode called protected mode. This mode is incompatible with DOS and DOS applications which run in real mode.
2.2.3 Expanded Memory

Expanded Memory is memory that acts as a "pool" of memory which, under the control of a special program (the Expanded Memory Manager), can be "mapped" into one or more conventional memory areas. Mapping is a process whereby a portion of expanded memory "appears" at a specific memory location through the use of special hardware (or in certain circumstances via software control - see the section titled "Software Emulation of EMS Memory"). Note that no transfer of data is actually performed - EMS memory is a bank-switch type of system (and hence very fast).

Unlike extended memory, expanded memory is available for all processor types. There are 3 different types of expanded memory, EMS 3.2, EEMS and EMS 4.0.

2.3 EMS 3.2

EMS 3.2 can only map four 16K pages of memory (64K) into conventional memory at a time, typically into a 64K area within the System Area called the EMS Page Frame. EMS 3.2 memory is essentially limited to enhancing the data handling capabilities of a program and has been superseded by the other two types of expanded memory.

2.4 EEMS and EMS 4.0

EEMS and EMS 4.0 memory can map multiple pages of varying size into conventional memory enhancing both data access and program execution capabilities - a far more flexible scheme than EMS 3.2. Note, however, that some EMS 3.2 memory boards were packaged with a 4.0 Expanded Memory Manager. Unfortunately, this gives the user an impression that EMS 4.0 memory is available with these boards, when only 3.2 capabilities are.

Note that for the remainder of this document, all references to EMS 4.0 memory are also applicable to EEMS memory.

2.5 Software Emulation of EMS memory

Due to the capabilities of the 386 and 486 processors, an Expanded memory manager like Quarterdeck’s QEEM-386 can “convert” extended memory into EMS 4.0 memory. In the case of programs like QEEM-386, it is the Expanded memory manager that provides the mapping function through software control.

2.6 Multitasking more than 640K

Despite DOS normally being limited to 640K for its programs, DESQview can run more than 640K concurrently by using expanded memory. Programs are loaded first into the Application Area and when this is exhausted, DESQview will load programs into EMS 4.0 memory. As DESQview task switches from one application to another, it first maps the application from EMS memory into the Application Area and then runs it.

Note that EMS 3.2 memory is not used in this way due to the limitations of the specification; EMS 3.2 memory can only map a maximum of 64K and hence the available partition size is too small to contain the majority of programs.

On 8088/86 and 286 based systems, it is essential to disable motherboard memory to as low a value as possible (typically 256K) when using EMS 4.0 memory and DESQview. Due to hardware limitations of these processors, EMS 4.0 memory cannot be mapped on top of other memory (RAM or ROM) that is present in the system. If motherboard memory cannot be disabled, DESQview cannot multtask applications in EMS 4.0 memory. In the worst case, EMS 4.0 memory can act like EMS 3.2 memory to store “swapped” programs (see the “Program Swapping” section for details), but may still have the LOADHI capability outlined next.

2.7 LOADHI capability

Since DESQview uses the Application Area below 640K to perform its multitasking “magic”, it can be seen that the larger this area is, the larger applications can be that run under DESQview (unless an application is a DOS Extended application - see the “DOS Extender” section for details).

Any TSRs (Terminate and Stay Resident programs) or drivers (such as mouse or network drivers) that are loaded before DESQview occupy space in conventional memory on top of DOS and reduce the amount of memory available to the Application Area. It is therefore advisable to keep the number of TSRs and device drivers using conventional memory to a minimum to ensure a maximum amount of space for applications.

One solution is available with the Quarterdeck QRAM, QEEM-50/60 and QEEM-386 products - the LOADHI capability. With this utility, TSRs and device drivers can be loaded into the unused regions of the System Area, thus freeing up more space below 640K and enabling larger applications to be run inside of DESQview.

2.8 Program Swapping

When all of the Application Area and EMS 4.0 memory has been used to store programs, any further loading of applications will cause DESQview to swap applications already running onto either a hard disk, a network drive, a RAM drive or expanded memory (even EMS 3.2 can support this type of operation). Any programs "swapped out" in this way will be suspended from running. Despite being suspended, any swapped applications can be swapped back in at the request of the user with only a
short delay. Doing this will force one of the currently running programs to be swapped out in order to make room if there is not enough memory for the incoming program.

Note: DESQview/X version 1.0 does not support DOS program swapping.

2.9 Switching and Windowing

Since DESQview can multitask multiple DOS applications, a user can switch from one application to another using two or three keystrokes or mouse clicks. Because of this, there is a concept in DESQview of one foreground application and multiple background applications.

Some applications may be running in windows smaller than the screen size and others may occupy the whole screen. In addition, some applications may be running in background, while others are suspended. These capabilities are dependent on the video behavior of the program and the machine's processor type.

2.10 Application Video Behavior

DOS applications may be written to produce display output in either of two ways. They may call DOS and BIOS routines to perform the output, or alternatively may write directly into the video area. The latter method is usually employed for speed reasons. Applications that use the DOS and BIOS routines are termed well-behaved and others that write directly to the video area are ill-behaved. Typically, graphical applications are ill-behaved; text-based applications may be either.

2.10.1 Well-Behaved Applications

Since DESQview can easily intercept DOS and BIOS calls, well-behaved applications may run in a small window or in background on any machine regardless of processor type. When a well-behaved application makes a video BIOS or DOS call, DESQview intercepts and executes the call, but places the relevant information in a special save area called the logical window buffer as well as clipping and shifting the information to appear within a small window on the screen.

2.10.2 Ill-Behaved Applications

Since ill-behaved applications write directly to the video RAM, DESQview cannot run them in a small window or in background unless the processor is a 386 or a 486 (see the “Virtualization” section for details). These applications, when run on a 8088/86 or 286 PC, can only run full screen in the foreground. Application developers should note that in many cases it is very easy to make an ill-behaved text application well-behaved, simply by adding a single subroutine call - see “The SHADOW Call” section for details.

2.10.3 Virtualization

Due to the sophisticated memory handling capabilities of the 386 and 486 processors, DESQview can redirect an application that writes directly to video RAM to a portion of memory that DESQview calls the logical window buffer. DESQview copies the information from this buffer to the actual video RAM, clipping and shifting it as necessary to appear within a small window. In this way, DESQview coupled with QEMM-386 and a 386 or 486 processor can virtualize ill-behaved applications (including graphics ones) in small windows and run them in background.

The only exception to this process are graphical DOS Extended applications - see the “DOS Extenders” section for more information. This is because the virtualization process uses a special processor mode that is incompatible with the DOS Extender.

Note: Version 1.0 of DESQview/X does not support the virtualization of DOS graphics programs.

2.10.4 Loaders

For machines that do not have a minimum of a 386 processor, a loader may be available to run an ill-behaved text program in a small window and in background. Loaders are utilities that alter a program’s operation while it is running and coerce it into being well-behaved. Quarterdeck supplies several loaders with DESQview for use with programs such as Lotus 123.

2.11 Microsoft Windows

Microsoft Windows (and any Windows applications running within it) appears to DESQview simply as a graphical application and is handled as such. Consequently, Windows 3.0 real mode can be virtualized in a small window on machines with 386/486 processors whereas Windows 3.0 and 3.1 standard mode runs full screen (Windows standard mode acts like a DOS Extended graphical application).

Presently, Windows 3.0 and 3.1 386 enhanced mode does not function under DESQview. Note, however, that some of the extra capabilities of 386 enhanced mode (such as the virtualization of DOS windows) are duplicated in DESQview and are best handled by DESQview.

Note: DESQview/X includes special Windows drivers that enables Windows 3.0 in real mode and Windows 3.0, 3.1 in standard mode to run in small windows and remotely.
2.12 Application Types

There are three types of applications that exist in the DESQview multitasking environment: DESQview-oblivious, DESQview-aware and DESQview-specific.

DESQview-oblivious

DESQview-oblivious programs are ones that know nothing about DESQview - this includes programs like Lotus 123, Microsoft Word or AutoCAD.

DESQview-aware

A DESQview-aware program is one that has been modified slightly to make it run more efficiently in DESQview. Paradox, dBASE and WordPerfect are examples of DESQview-aware programs.

DESQview-specific

A DESQview-specific program has been written to take advantage of the DESQview API (Application Program Interface). Consequently, these programs can only run when DESQview is present.

2.13 DESQview API

Present in every copy of DESQview is the DESQview API (Application Program Interface). This interface allows programs to call the DESQview subroutines and functions in order to start and close down other applications; move, resize and scroll their windows; perform intertask communication and many other functions. The DESQview API is callable by Assembler, C, BASIC, Pascal, Clipper and dBASE programs.

2.13.1 The SHADOW Call

One API call of particular significance is the SHADOW call. This call may be made whether DESQview is present or not.

An ill-behaved text application will typically determine the kind of system present (monochrome or color) and load a variable with the corresponding video RAM value for the system (either B000H or B800H). From then on, the application will use the variable in order to access video RAM.

If during initialization, a program performs the SHADOW call using the desired video RAM value before storing it, the program will then become well-behaved when running under DESQview. This is because DESQview returns the logical window buffer for that application, whereas under DOS, the SHADOW call returns the value unchanged.

Since the application stores the returned value and uses it whenever video RAM access is required, the application is writing directly into the DESQview logical window buffer instead of to the screen. DESQview shadows from the logical window buffer to the screen, clipping and shifting as necessary, so the otherwise ill-behaved text application can run in a small window and in background on all processor types. This process is fast enough to be rarely noticeable by the user. WordPerfect, dBASE and Paradox are examples of commercially available programs that do this.

2.14 Processor Types and Modes

Since the original PC was introduced in 1981, various processors have been used, each one superseding the previous version and providing greater functionality. This functionality was always gained with the advantage of backward compatibility with all the previous processors.

2.14.1 The 8088/8086 and Real Mode

When the PC was first introduced, it used an Intel 8088 microprocessor. This is a 16-bit architecture processor with a segmented memory scheme capable of addressing 1MB. The 8088 used an 8 bit external data path unlike its otherwise functionally equivalent bigger brother, the 8086 which used an external data path of 16 bits. The mode of operation of these two processors is termed real mode.

2.14.2 The 286 and Protected Mode

The 286 processor supplies a real mode capability, but improved upon the 8088 / 86 by providing a new mode called protected mode. In protected mode, the 286 can access up to 16MB of memory (again by using a segmented addressing scheme), however certain operations available in real mode (such as segment arithmetic) are prohibited in protected mode. In addition, protected mode also has the hardware necessary for an operating system to “protect” an application from crashing the system or overwriting another application.

Unfortunately, protected mode is sufficiently different from real mode that DOS and regular DOS applications cannot operate in protected mode. For a long time this limited applications to running in real mode and hence constrained them to the 1MB limit. Thankfully, a solution has become available that addresses this called the DOS Extender - see the “DOS Extenders” section for details.
2.14.3 The 386 and V8086 Mode

Next to be introduced was the 386. Providing backward compatibility means that the 386 has both a real mode and protected mode capability. But in addition to this, Intel added a third mode called Virtual 8086 Mode that can operate under the auspices of protected mode. This mode supplies a virtual 1MB 8086 style environment while running in protected mode. This elegant solution enables regular DOS and real mode applications to run under protected mode without modification. The 386 also has an effective addressing range of 4 Gigabytes. It supports a flat memory model as well as a segmented addressing mechanism.

Also included in the 386 were memory mapping capabilities, a 32-bit architecture and hooks for a paged virtual memory system as opposed to a somewhat meager segmented virtual memory system that became available in the 286.

Note that 386 technology has been realized in several processors including the 386SX, 386SL and 386DX. The 386SX processor uses the 386 32-bit architecture internally, yet has a 16-bit external data path. The 386SL chip is a low power version of the 386SX with built-in power management features and is primarily designed for battery-powered computers. The 386DX processor (essentially a renamed version of the original 386) uses an internal 32-bit architecture and a 32-bit external data path.

All 386 processors are functionally equivalent and are referred by the 386 moniker for the rest of this document.

2.14.4 The 486

The latest member of the 80x86 family to be introduced was the 486 processor. Basically this is similar to a 386 processor with an internal memory cache and is faster due to improved instruction execution. The 486 appears in several variants including a basic 486SX, a low power 486SL and a 486DX version that sports an internal math coprocessor (an optional external component with the 486SX, SL and all the other previous processors). Another variant is the 486DX2 processor which appears to a computer system much like a regular 486DX chip, but executes instructions internally at twice the speed of a 486DX.

All 486 processors are functionally equivalent (save for math functions) and are referred by the 486 moniker for the rest of this document.

2.15 DOS Extenders

Since DOS cannot run in protected mode, a way was devised for protected mode applications to run under DOS and use other real mode services. Protected mode applications are desirable since they have access to up to 16MB of memory on a 286 and 4 Gigabytes on a 386/486.

A DOS Extender is a special utility that is linked in to a protected mode application. Whenever the application makes a DOS call or any other request that requires real mode, the DOS Extender copies down any necessary data into the 1MB conventional memory area and switches into real mode. It then calls the requested function and on return switches back into protected mode, returning any results to the protected mode application.

There are usually two types of DOS Extenders - 286 DOS Extenders and 386 DOS Extenders.

286 DOS Extenders These run 16-bit protected mode applications on a machine with a minimum of a 286 processor. They have access to a 16MB address space.

386 DOS Extenders These run 32-bit protected mode applications on a machine with a minimum of a 386 processor. They have access to a 4GB address space.

Note that some DOS Extenders combine the capabilities of the two different types and can handle both 16-bit (286) protected mode applications as well as 32-bit (386) protected mode applications.

Most DOS Extenders also have a virtual memory option. That is, a DOS Extended application may run in less memory than normally is required by using virtual memory techniques.

In essence, the DOS Extender becomes the system's control program. This normally would have posed a problem to DESQview as protected mode allows only one control program in a system. Since DESQview multitasks applications, multiple DOS Extended applications would conflict with each other as each expects to be the control program. This is compounded with the fact that DESQview 386 (DESQview plus QEMM-386) is also a control program.

To obviate this problem, Quarterdeck and Phar Lap (one of the companies that produce a DOS Extender) developed the VCPI (Virtual Control Program Interface) specification which has been adopted by all major 386 DOS Extender manufacturers - see the “VCPI Specification" section for details.

It should be noted that VCPI is a specification for 386 and 486 processors, yet 16-bit protected mode applications may be run on 286 machines. In order for DESQview to multitask multiple 16-bit protected mode programs on a 286 so that they do not assume control of the same blocks of extended memory, their individual 286 DOS Extenders must use the XMS (Extended Memory Specification) interface specification. A utility program called QEXT.SYS supplies the necessary XMS...
services for 286 DOS Extenders running under DESQview on a 286 machine whereas QEMM-386 supplies the services for DESQview 386.

Note that a DOS Extended application consists of two parts. A real mode portion of the DOS Extender resides in conventional memory and interfaces with the protected mode portion that resides with the protected mode application in extended memory. When DESQview performs a task switch to a DOS Extended application, it ensures that the real mode portion of the application is mapped into the conventional memory Application Area and that the protected mode portion is "visible" in extended memory. Since the majority of the application resides in extended memory and only a small portion (the real mode part) need occupy the Application Area, DOS Extended applications tend not to be constrained by the size of the Application Area as regular real mode applications are.

Note: DESQview/X includes a built-in DOS Extender supporting 16- and 32-bit virtual memory and dynamic link libraries.

2.16 VCPI Specification

The VCPI specification was developed so that multiple protected mode control programs can coexist and interact within a single 386 (or 486) system. The specification consists of two parts - a VCPI server and several VCPI clients. The VCPI clients request memory and mode switching services from the VCPI server.

In a DESQview 386 system, the VCPI server is implemented within QEMM-386 and the DOS Extended applications become VCPI clients. Whenever a DOS Extended application requires memory services it calls upon the VCPI server to perform them. When QEMM-386 is not present, the DOS Extender performs all services for itself. The end result is that DESQview is able to run a mix of real mode and DOS Extended (protected mode) applications concurrently on a 386/486.

As mentioned earlier, 286 machines may run multiple 286 DOS Extended applications only if the DOS Extenders utilize XMS services.

2.17 DESQview Capabilities

DESQview's ability to window an application and run it in the background is a function of the machine's processor and the type of application. Here is a table that summarizes the possible combinations:

<table>
<thead>
<tr>
<th>DESQview Capabilities</th>
<th>8088</th>
<th>8086</th>
<th>286</th>
<th>386</th>
<th>486</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well-behaved Text Application</td>
<td>Real Mode</td>
<td>W</td>
<td>W</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>or Ill-behave Text Application with Loader</td>
<td>16-bit Protected</td>
<td>-</td>
<td>W</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>32-bit Protected</td>
<td>-</td>
<td>-</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Ill-behaved Text Application</td>
<td>Real Mode</td>
<td>D</td>
<td>D</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16-bit Protected</td>
<td>-</td>
<td>D</td>
<td>WD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>32-bit Protected</td>
<td>-</td>
<td>-</td>
<td>WD</td>
<td></td>
</tr>
<tr>
<td>Graphics Application</td>
<td>Real Mode</td>
<td>D</td>
<td>D</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16-bit Protected</td>
<td>-</td>
<td>D</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>32-bit Protected</td>
<td>-</td>
<td>-</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Microsoft Windows 3.0, 3.1 and Windows Application</td>
<td>Real Mode*</td>
<td>D</td>
<td>D</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard Mode</td>
<td>-</td>
<td>D</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

W Application can run in a window and in background.
D Application can only run direct (full screen) and not in background.
WD Dependent on individual application - most run as W, some may run as D.
* Processor cannot support this type of application.
- Available only with Microsoft Windows version 3.0.

Note: The above table presents the capabilities of the DESQview multitasker. For information on DESQview/X capabilities please see page QD-26.
3 An Introduction to X

The basic concepts of the X Window System are described in this section. Readers familiar with X may elect to skip this section.

The X Window System is a powerful concept that utilizes machine and device independence as well as providing a graphical interface to users with both keyboard and mouse support.

3.1 Traditional Graphics Output

In traditional systems, if an application wishes to produce graphical output on a computer’s display device, it will typically call a library or system software graphic subroutine. This subroutine performs the task requested (in the example shown, draw a line) and once the task has completed, control returns to the application.

3.2 X Servers, Clients and Protocol

In an X Window System, the system software is replaced by an application called the X Server - it is this application that has complete control of the display screen. An application that wishes to produce graphical output instructs the X Server to perform a specific task by sending it an information “message” that describes the task required. Sending a message to an X Server returns control immediately to the application and may or may not provoke a response from the Server.

The different types of messages are collectively called the X Protocol. One message draws a line, another a circle and yet another may print some text.

Any application that displays graphical output by sending X Protocol messages is labelled an X Client in contrast to an application that uses some other means.

In return the X Server may send back to an X Client special messages, such as event messages or error messages. These special messages are also part of the X Protocol.

X Clients typically create windows for their output. It is quite feasible (and generally the case) that a single X Client will create and utilize several windows on the X Server’s screen simultaneously.

Note that an X Server may handle the graphics output for multiple X Clients concurrently and only understands X Protocol requests as a means to produce graphical output - it usually does not produce graphics output any other way.

3.3 An Event-Driven System

X is an event-driven system. That is, X Clients are typically suspended until an action occurs on the X Server for which they have a vested interest. X Clients are restarted by the X Server sending them special X Protocol messages. These event messages include ones that instruct an X Client to redraw its window (for example, if a part of its window becomes uncovered by the movement of another window), that a window’s size has changed or that a key has been pressed. An X Client processes these messages, producing whatever output may be necessary and then returns to a suspended state until another message is received.

This is in direct contrast to the way traditional applications have been written. Those applications are procedure-oriented and are written to assume an active role in the interrelationship between the user and the program. Typically, the program will steer the user through the execution of the task at hand, forcing the user down a narrow set of predefined procedures. The program only accepts input (be it keystrokes or mouse clicks) from the user at predictable times. An order entry application is a good example of a procedure-oriented program.

Event-driven applications take a more passive role in that they respond to input from the user or the system at unpredictable times. This type of application can provide a more flexible framework within which a user may operate. Typically there are no predefined procedures and many ways to complete a task - a user is free to use whatever tools the application provides and in any manner desired to achieve the final result. A drawing/designing type of program is a good example of an event-driven application.
3.4 A Distributed System

Since the X Client communicates with the X Server through information messages, it is possible for the X Protocol requests to be sent over a network to an X Server running on a different machine.

In fact the X Window System was designed around a system of messages specifically to be a networked graphical system.

In the diagram, an X Client executing on machine A is displayed on machine C's screen (using the X Server on C) and an X Client executing on machine C is being displayed on machine B's screen (using machine B's X Server).

3.5 Operating System and Architecture Independence

None of the machines need be from the same vendor or running the same operating system, since all communication between X Clients and Servers is performed over a network using a well-defined message protocol (the X Protocol).

Naturally, a program cannot be copied to a different type of machine on the network and subsequently run - it would have to be recompiled for a different machine's architecture/operating system.

3.6 X Terminals

In the previous diagram, one of the clients running on machine A is being displayed by a special machine that only has an X Server running on it - in effect acting as a remote graphics terminal to machine A. This type of machine is called an X Terminal and its sole purpose is to display graphics from X Clients running on remote machines.

Typically, the majority of PC implementations of the X Window System have been as X Terminals. PCs are notorious for memory limitations and hence an X Server application would normally occupy all of the PC's memory. With the advent of DESQview/X, however, PCs can run X Servers, DOS applications, Microsoft Windows and X Clients simultaneously.

3.7 A Stand-Alone System

In the previous diagram, machine B's X Server was displaying output from an X Client running on machine C, but is also displaying graphics from an X Client running on itself. In this case, the X Protocol messages are not sent out over the network to another X Server, but are routed within the machine to the local X Server.

This concept can be extended to include a scenario whereby the machine is not connected to a network - all X Clients run locally and are displayed by the local X Server. Naturally, this requires a multitasking operating system - such as DOS with DESQview.

3.8 The Window Manager

The X Server only produces graphical output according to X Protocol requests and does not provide functions for the user to control the size, position and stacking order of the displayed windows.

These functions could have been implemented within each X Client, but would have lead to much redundant programming. They could have been implemented within the X Server itself, but the designers of the X Window System took a more flexible approach.

A special X Client is run (either locally or remotely) for each X Server, called the window manager. This program is given special privileges and is allowed to "supervise" all of the windows being displayed by the X Server. The window manager will typically place some form of window decoration around the outside of each X Client window that includes resize and move buttons as well as a title bar. It then becomes a function of the window manager to resize, move, rearrange a window according to the wishes of the user by mouse clicks on a window's decoration or selections from a window manager menu.
At present, there are several managers for the X Window System, the most prominent of which are the OSF/Motif, OPEN LOOK and the Tab (previously known as Tom’s) Window Managers. DESQview/X also supplies its own window manager, DESQview Window Manager (DWM).

Due to the design of the X Window System, a window manager may be closed down and another may be subsequently started—without affecting any of the X Clients being displayed on the screen! The old window decorations disappear from the screen and are replaced by new decorations created by the incoming window manager.

Note that the window manager only creates the “look and feel” of an X Client with regards to its window decoration. Whatever an X Client chooses to display in its output window is independent of the window manager. Program libraries are available to X Client developers that allow them to create an application with a specific look – either an OPEN LOOK or OSF/Motif look, for example. These program libraries are called toolkits and are explored in the next section.

### 3.9 X Development Layers

In order to create an X Client, a developer will call upon a variety of program libraries for assistance. For DESQview/X, these libraries can be linked into each X Client, or may be a shared resource among all X Clients on a system through the use of Dynamic Link Libraries (DLLs).

#### 3.9.1 Xlib

For an X Client to be able to communicate with an X Server, it needs to generate X Protocol requests for transmission to the Server. Building these requests can be cumbersome and hence a library was created called Xlib. Xlib is (generally) the lowest level interface that an X Client uses to communicate with the X Server. It is a set of C subroutines that, for the most part, are a one-to-one mapping from C to X Protocol requests, though some Xlib functions can generate multiple X Protocol requests.

For example, if an X Client uses the function XDrawLine it calls the appropriate code inside Xlib which builds a PolySegment request and transmits it to the X Server.

Note that the Xlib library imparts no specific “look and feel” to an X Client - it merely consists of requests to create a window, draw a line, print some text, etc. The appearance of an application is generally determined by another program library - a toolkit.

X Clients may be written so that they use only Xlib and no other program libraries (toolkits).

#### 3.9.2 Toolkits

Since Xlib is rudimentary in the scope of its capabilities, another program layer may exist on top of Xlib - the toolkit. Toolkits generally have routines for building menus, push buttons, slider controls and the like. Since the toolkit generates these basic window components for the X Client, it is the toolkit which creates the actual “look” of an application.

An individual toolkit function may call several Xlib functions, which in turn can create multiple X Protocol requests.

For example, if the X Client wishes to make a popup window appear, it could call (using one specific toolkit) XtPopup to perform the function. XtPopup in turn makes several Xlib calls which may generate multiple X Protocol requests.

An X Client may still (and often does) call Xlib functions even if it uses a toolkit.

Some of the more prominent toolkits that are generally available are as follows.

- **Athena Toolkit**
  A fairly rudimentary toolkit supplied by MIT (Massachusetts Institute of Technology).

- **OSF/Motif Toolkit**
  This toolkit is supplied by the Open Software Foundation and provides a sculptured 3D look. This toolkit (and its complimentary window manager) is promoted by a consortium of companies (OSF) that include DEC, Hewlett-Packard and IBM.

- **Olit Toolkit**
  A toolkit conforming to the OPEN LOOK* graphical user interface standard that is 3D in appearance. This toolkit and its OPEN LOOK window manager is promoted by Unix System Laboratories.

- **XView Toolkit**
  A toolkit conforming to the OPEN LOOK* graphical user interface standard, but with a different programming interface (SunView) than Olit. It is promoted by Sun Microsystems.
*Note that OPEN LOOK is not a toolkit or window manager in itself - it is merely a design specification for the appearance of a user interface. Olit and XView are toolkits that adhere to this specification and hence create the same look and feel.

The following screen shots should help to illustrate the concepts of a Window Manager, Toolkits and the like.

The X Clients in the previous picture are:

**QOS Background**  
An X Client written using only Xlib. A Toolkit is not necessary since it only creates a simple output window.

**FrameMaker**  
This electronic publishing package was written using the OSF/Motif Toolkit. The X Client is currently displaying two windows - an edit window and a “Generate” window.

**Sun File Manager**  
OPEN LOOK has characteristic buttons with rounded ends. This file manager, which uses an OPEN LOOK toolkit, has these rounded buttons. This X Client is currently displaying two windows - a directory tree and a wastebasket box.

**Xterm**  
This X client uses the Athena Toolkit to display a terminal session with a scrollbar on the left.

All of these X Clients are running under the control of the DESQview/X Window Manager. The window manager has placed a frame around many of the windows on the screen, along with decorations such as title bar and window number.

If the DESQview/X Window Manager is closed down and the OSF/Motif window manager is started, the following display appears:
Despite a change in window managers, the X Clients' window contents remain the same. Only the window decoration has changed - in this case to an OSF/Motif 3D effect. Note that with the OSF/Motif window manager active, the X Client built using the OSF/Motif toolkit (FrameMaker) blends well into the environment, since it has the same appearance style as the window manager.

If the OSF/Motif window manager is now replaced by an OPEN LOOK window manager, the following display appears:

Once again a change in window managers does not change the contents of the X Clients' windows - only the window decoration has altered. In a similar fashion to FrameMaker and the OSF/Motif window manager, it can be seen that the Sun File Manager windows complement the OPEN LOOK window manager's window decoration. This is because both of these products were built using an OPEN LOOK toolkit and hence have an OPEN LOOK appearance.

Although it is unlikely that a user would want to run X Clients without a window manager, the following picture shows how this would appear:

As can be seen in the previous picture, the usefulness of having no window manager is debatable, but not impossible. Having no window manager active would most probably occur when only one X Client is being run on an X Server.

These pictures highlight the concept of a window manager as being a special X Client that decorates the outside of all other X Clients' windows and allows a user to control their size, position and ordering on the screen. The pictures also show how a toolkit influences the look and feel of an X Client and how its appearance is independent of the active window manager.
3.9.3 Intrinsics and Widgets

Some toolkits may only be regarded as a single entity, but others are conceptually split into two parts. One of these parts is termed the Intrinsics and the other part, a Widget Set.

The Widget Set

Widgets are abstract data objects such as buttons, scrollbars and other such objects. An X Client can be easily constructed from a number of widgets. The X Client does not have direct control of the actual appearance of a widget - only its general form, size or contents. The appearance is determined by the toolkit.

A Widget Set uses both function calls in the Intrinsics as well as Xlib.

The Intrinsics

The Intrinsics provide an object-oriented framework on which a Widget Set depends. It handles the creation, deletion and management of widgets as well as their event message handling. It is possible for an X Client to call the Intrinsics directly as well as the Widget Set (and of course, Xlib).

The Athena, OSF/Motif and Oli toolkit consist of a Widget Set and the first Intrinsics to be developed for X - Xt.

3.9.4 Xt Intrinsics

In some cases, an X Client may only call the Xt Intrinsics and Xlib library. This type of application provides its own widget set, hence supporting its own unique set of abstract data objects (widgets) that are manipulated and managed by Xt.

An application that does this is able to provide its own look and feel, all the while saving its developer time and effort by using the object-oriented functions of Xt.

3.10 X11

MIT in association with a consortium of companies who have a vested interest in the X Window System (The X Consortium) releases MIT X distribution tapes containing the Xlib and Xt libraries as well as sample X Clients and an X Server. It is these tapes on which all other toolkits and X products are based.

The current revision of these distribution tapes is the X version 11 release 5 of the X Window System, otherwise known as X11 R5.

3.11 Toolkit Summary

Here follows a table of the Toolkits discussed in this document in summary form for quick reference:

<table>
<thead>
<tr>
<th>Toolkit</th>
<th>Supplier or Promoter</th>
<th>API</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athena</td>
<td>MIT</td>
<td>Xt</td>
<td>(rudimentary)</td>
</tr>
<tr>
<td>OSF/Motif</td>
<td>OSF</td>
<td>Modified Xt</td>
<td>OSF/Motif</td>
</tr>
<tr>
<td>Xview</td>
<td>Sun Microsystems</td>
<td>SunView</td>
<td>OPEN LOOK</td>
</tr>
<tr>
<td>Oli</td>
<td>USL</td>
<td>Modified Xt</td>
<td>OPEN LOOK</td>
</tr>
</tbody>
</table>
This section describes how the X Window System is integrated into the DESQview environment resulting in DESQview/X and highlights the capabilities of the combined system.

4.1 Minimum Requirements

DESQview/X currently requires a minimum of a 386SX processor, an EGA display, 4MB of RAM and 10MB of free hard disk space. In addition, a mouse is highly recommended.

4.2 General Structure

The general structure of a stand-alone DESQview/X system is shown to the right.

DESQview is loaded on top of DOS, the first program booted into the computer. Multitasking within DESQview can be several program partitions - one containing an X Server in the case of DESQview/X.

4.2.1 The X Server

Display output for the system is provided by the X Server program. The X Server is run within a DESQview partition and is multitasked along with all of the other programs in the system. The X Server in DESQview/X v1.0 is based on Release 4.0 of the X Window System.

The X Server controls the display screen (for the most part) and hence the display resolution of the system and compatible display types are determined by the X Server and not by DESQview. Currently EGA, VGA, Super VGA, 8514/A and DGIS displays are supported. XGA, TIGA and S3 displays are expected for the future - check with Quarterdeck Office Systems for an up-to-date list of displays supported.

The X Server is run as a DOS Extended application (up to 16MB) - this gives the X Server more workspace to perform its display functions and enables it to handle more windows concurrently. It is also available in virtual memory form so that it may use less memory than is normally required.

4.2.2 Socket Driver

Communication in most X Window Systems is accomplished using the Berkeley Socket interface. Consequently, DESQview/X includes the DESQview/X Socket Driver, which accepts these communication requests and intelligently routes the message to the appropriate destination. In the case of a stand-alone DESQview/X system, the messages are always routed between the X Server and the applications using the X Server for output. Note that the DESQview/X Socket Driver is loaded as part of the DESQview multitasking kernel.

4.2.3 Regular DOS Applications

If a regular real mode DOS application (for example WordPerfect or Lotus 123 release 2) is running within the system, its display output is translated dynamically (that is on-the-fly) by special DESQview/X Translation Software into X Protocol requests. These X Protocol requests are sent using the Berkeley Socket interface to the Socket Driver which routes them to the X Server for output. In effect, a DOS application is made to appear like a regular X Client.

DESQview/X does this for well-behaved applications by trapping their BIOS and DOS calls and converting them into X Protocol requests.

In the case of ill-behaved real mode applications DESQview/X virtualizes the application. DESQview/X remaps the application’s video RAM to a different portion of memory and scans this logical window buffer for any changes, producing X Protocol requests from the scanning process. Note that this process requires a minimum of a 386 processor - the 286 processor lacks the necessary hardware to perform the remapping operation.
If a regular DOS application is DOS Extended (for example Lotus 123 release 3 or Paradox) and is running within the system, it is treated much the same as a regular real mode DOS application. The major difference being that DOS Extended applications have a far greater workspace available to them than do regular DOS applications (up to 16MB for a 16-bit protected mode application, 4GB for a 32-bit protected mode application).

4.2.4 DESQview API Applications

DESQview API Applications are, by their very nature, well-behaved DOS applications as they use the DESQview API to perform display output. However, the DESQview API allows these applications to create multiple windows as well perform display output to these windows.

This is handled in DESQview/X by intercepting all of the DESQview API calls and generating equivalent X Protocol requests, turning a DESQview API application into what would appear to be an X Client, just as with a regular well-behaved DOS application.

4.2.5 Microsoft Windows and Windows Applications

If Microsoft Windows 3.0 or 3.1 is running in a DESQview/X system along with one or more Windows applications, DESQview/X dynamically translates all Windows display output into X Protocol requests, much the same as it does with regular DOS applications. In effect, Microsoft Windows and Windows applications are made to appear like a regular X Client.

Because of this, a Microsoft Windows session can appear within a resizeable DESQview/X window alongside other X Client windows.

4.2.6 Regular DOS Graphical Applications

Translating a DOS application’s graphics screen into X Protocol requests is possible, but is not implemented in DESQview/X Version 1.0. Currently, DESQview/X runs all regular DOS graphical applications as full screen applications only.

4.2.7 X Clients

X Clients may be running on a DESQview/X machine in one of three forms. If small enough to fit within the conventional memory Application Area, they may run in real mode. If larger, they require a DOS Extender to reside in the system. If the X Client is a 16-bit protected mode application, it may be as large as 16MB. If it is a 32-bit protected mode application, the X Client may (theoretically) be as large as 4GB.

Since X Clients already produce X Protocol requests (unlike DOS or Microsoft Windows applications), they need no translation software. Instead, their X Protocol requests are sent to the Socket Driver from the applicable Xlib routines using the Berkeley Socket interface (the standard method of communication in an X Window System). The Socket Driver then routes them directly to the X Server for display output.

Note that these X Clients may be ported from other X platforms (such as many Unix machines) or else may be developed directly under DESQview/X - see the “Development Issues” section for details.

It should be remembered that an X Client is similar to a DOS graphical application in that it produces graphical output, but is very different in the way it achieves this. DOS graphical applications usually write directly to video RAM; an X Client uses X Protocol requests to an X Server to produce the same effect. Thus an X Client can always be windowed.

4.3 Direct Windows

Note that regular DOS and Microsoft Windows applications can be configured to bypass the DESQview/X translation software and run as full screen direct windows (like regular DOS Graphical applications). Doing this eliminates the overhead of translating an application into X protocol requests, resulting in an increase of display speed, but at the expense of the application not being able to display on a remote machine.

4.4 Available Memory

In a typical DESQview/X system, real mode applications usually have at least 500K available to them regardless of their type - DESQview API, regular DOS or otherwise.

DOS Extended applications (which includes Microsoft Windows in standard mode), on the other hand, are usually constrained only by the total amount of memory in the system.

4.5 The Window Manager

Since a user will want to control the windows displayed on the screen by the X Server, a minimum of one X Client will normally be run in a DESQview/X system - the window manager. The window managers that are currently available include:
4.6 Fonts

The X Window System (through Release 4.0) has typically relied on bitmapped fonts to produce text output on an X Server. That is, a bitmap exists for a specific typeface (for example, Helvetica or Times Roman) realized at a specific point size. If an X Client requests a particular size of typeface and that size is not available (even though other point sizes in that typeface are available), the X Server would normally tell the X Client that the font does not exist and the X Client either terminates or uses a different font.

Drawbacks to this technique include the limited availability of a typeface to a few point sizes (typically 8 to 24) as well as excess use of hard disk space to store the different sizes that are supported.

4.6.1 Scalable Fonts

With the advent of laser printers, Adobe Systems, Inc introduced the PostScript printing language that took a different approach. Each typeface file was coded in such a way that the printer could scale an individual typeface to any size required. This new file format and the typefaces that were encoded in it are termed "Adobe Type 1 fonts".

The "intelligence" inside of the laser printers that produces the scaling function is actually a sophisticated computer program developed by Adobe Systems, Inc. This technology has been licensed by Quarterdeck Office Systems, Inc and has been incorporated transparently into the DESQview/X system. These font extensions, in no way prohibit continued support of Quarterdeck's scalable fonts when DESQview/X supports the X Window System Release 5.0 (which does define the use of scalable fonts).

When an X Client requests a typeface at a particular size, the DESQview/X X Server first checks its list of available fonts - this font list contains both bitmap and Adobe Type 1 fonts. If it cannot find either a bitmap font of the correct size or a scalable font that can be scaled appropriately, the X Server will return an error. If, however, a font was found, the X Server checks to see if it is presently loaded into memory (for another X Client). If necessary, the X Server will load the font and (in the case of Adobe Type 1 fonts) scale it to the requested size.

4.6.2 Using Scalable Fonts

Advantages of the scalable font technology include an almost endless choice of point sizes for a particular typeface as well as the subsequent economies of hard disk space. In addition, the Adobe Type 1 font format has proved to be the most popular and prolific file type resulting in a vast choice of Type 1 typefaces currently available.

Since the interface for using a scalable font is identical to that for requesting a bitmapped font, an X Client which has no knowledge of scalable fonts may, in fact, be given a scalable font realized at a particular point size if the requested bitmapped one is not present!

On the other hand, an X Client that has been written to recognize scalable fonts can use them to its advantage by creating fully scalable windows, wherein if a user resizes a window, the contents of the window (including the text) scales accordingly. In addition, this kind of X Client can also make use of the fractional spacing and kerning information that is stored in the scalable font file. One example of an X Client that uses scalable windows is the Adobe Type Manager that is supplied with DESQview/X which allows a user to install or delete Adobe Type 1 fonts from a DESQview/X system.

4.6.3 Scalable DOS Windows

Scalable fonts have also been used to great advantage in DESQview/X when displaying DOS text windows (regular DOS applications). When instructed to do so, DESQview/X will scale a DOS window to whatever size the user resizes the window - from a window that occupies the full screen all the way down to a size where each character in the window is represented by only a single pixel!

The benefits of this technology become clear within minutes of using it - a user can view many more DOS windows simultaneously than was previously possible and can shrink a window down to its minimum size in order to keep an eye on the DOS application's progress in background (for example, when performing a long file transfer with a communications program).
4.7 Advanced Memory Management

Incorporated into DESQview/X is the DOS/4GX Extender technology from Rational Systems, Inc that provides many useful benefits in the area of memory management.

With this technology, it is possible for DESQview/X to run all three types of application for the PC (real mode, 16-bit protected and 32-bit protected) directly. This produces a substantial saving in memory overhead for protected mode applications.

In addition, the DOS/4GX technology also provides both virtual memory and dynamic link library (DLL) capabilities to protected mode applications.

Note, however, that only applications generated specifically for the DOS/4GX Extender can call upon the DOS/4GX technology in DESQview/X. This does not, however, preclude applications developed using other DOS Extenders from running in a DESQview/X system - they will simply not be as memory conscious as a DOS/4GX application since a separate copy of the DOS Extender will be loaded for each instance of the program. In addition, they will not be able to take advantage of virtual memory or dynamic link libraries unless their individual DOS Extender supports these features.

4.7.1 Virtual Memory

Virtual Memory is a technique used in advanced computer systems, wherein an application is divided up into discrete chunks - usually these chunks are regular in size and are called “pages” (otherwise if the chunks are irregular in size, they are called “segments”, though for the rest of this section the former term will be used).

When an application is actively running, it typically only uses a few pages of the program in a given time frame - these active chunks are referred to by computer scientists as the “working set” of pages. Since only a few pages are being used at any one time, a large program can waste a lot of memory in a system with inactive pages that may never even be used.

To maximize the use of memory, a computer can load only the working set of pages into memory and run the application as normal. If the application requires a page that is not currently in memory (for example, when “jumping” to a different part of the program, crossing over from one page to the next or accessing a piece of data), a “page fault” is generated by the computer hardware. At this point, the computer chooses a page not being used, swaps it out to hard disk, reads in the required page and then continues executing the application. This process is totally invisible to the application and requires no special programming by the application’s developer, hence the term “virtual memory” since the memory always appears to be present to the developer, though physically it may not be all the time.

It is important, however, that sufficient memory is available to hold an application’s working set - too little memory will cause page faults to happen with greater frequency so that the computer will spend most of its time accessing the hard disk.

With its DOS/4GX technology, DESQview/X provides this virtual memory option so that more applications can be run concurrently than the amount of memory would normally dictate.

4.7.2 Dynamic Link Libraries

Most applications call on a standard set of routines which need to be duplicated in every application that uses them. Typically these routines are stored in a library of routines and are “linked” in when an application is being generated (at compile time). A good example of this would be the Xlib programming library that is required by X Clients.

Naturally, this leads to a waste of both computer memory and hard disk space as the same information appears in separate applications.

Dynamic Link Libraries (or DLLs) are a way of sharing these routines among several applications. The routines are stored on disk in only one place - the dynamic link library - saving space on a computer’s hard disk. Whenever an application is loaded that requires a specific DLL, the computer first checks to see if that DLL has already been loaded for another application. If it has been loaded, the computer points the application to the DLL already in memory. If it is not loaded, the computer will load the DLL first before it can be used by the application. Since multiple applications use the same copy of the DLL while running, memory space is conserved. Note that when all applications using a DLL terminate, the DLL is discarded from memory as it is no longer needed.

Along with the advantages of saving disk and memory space, DLLs also provide another benefit known as “late-binding”. Early-binding occurs when routines are linked into an application at compile/link time on the application developer’s machine - the application becomes a single entity that cannot be changed unless the developer issues an update. DLLs, by their very nature, exhibit late-binding - the linking process occurs at run time, on the user’s machine, after the application was compiled.

This difference seems trivial until a scenario is considered whereby several different applications from different manufacturers (or even the same manufacturer) use the same DLL. Assume the DLL provides access to a particular type of device, a tape drive for example, and that the drive manufacturer releases a new drive with a slightly different hardware...
interface. Without DLLs, all applications that used the previous tape drive would have to be recompiled by their respective companies and updates sent to existing customers that purchase the new drive. With DLLs, only a new DLL need be produced and distributed to customers along with the new drive. The more applications that use a particular DLL, the bigger the advantage of late-binding. Note that DLLs are not updated solely because of new features, but can also be updated because of enhancements to a DLL’s routines.

With its DOS/4GX technology, DESQview/X can conserve both disk and memory space as well as delivering the advantages of late-binding through the availability of a dynamic link library option.

4.8 Print Server

The DESQview/X Print Server consists of several components - a Print Manager, an X Print Server and an X Print Driver. In addition, the Print Server calls upon the services of the DESQview/X Resource Manager when printing from DOS applications.

For DOS applications, DESQview/X may be configured such that it will manage contention for the same printer and can spool the print information to disk until a printer is ready to receive it. (Note that DESQview/X can also be configured such that no spooling or contention management is performed and printer output is routed directly to a printer.)

For X Clients, DESQview/X always spools X Protocol requests to disk and translates these requests into the appropriate printer commands thus providing a single output imaging model.

The components of the DESQview/X Print Server and the interrelationships between those components are shown to the right.

Despite there being the interaction of several components in order to print a file under DESQview/X, the user normally only sees and interacts with the Print Manager (which provides choices such as holding, resuming and killing print jobs). The X Print Driver is a “daemon” (unseen) process that is both created and killed by the Print Manager, the X Print Server is implemented inside of the X Server process and the DESQview/X Resource Manager is a special driver loaded by the DESQview multitasker.

4.8.1 DOS Application Printing

When a DOS application prints to a printer, it does so through either the printer ports LPT1, LPT2, LPT3, the communication ports COM1, COM2, or the DOS file handle 4. When running in DESQview/X, the DESQview/X Resource Manager traps these requests and spools the print information into a DOS print file as well as creating a print control file that specifies additional information (such as which printer to print the file on and the number of copies). These two files are created in the DESQview/X spool directory. The Resource Manager then informs the Print Manager of the file that needs printing, whereupon the Print Manager adds the request to the end of its print list.

When the Print Manager is ready to print a particular file, it reads the information from the relevant printer control file and routes the DOS print information from the file to the correct printer. The Resource Manager recognizes that it is the Print Manager trying to print and allows the printer information to pass through (via the printer ports LPTx, communication ports COMx or DOS file handle 4) instead of trapping the print operation.

Note that DESQview/X does not alter the DOS print information in any way. Therefore, all DOS applications must be configured correctly for the printer type attached to a DESQview/X system (PostScript, IBM Proprinter or otherwise).

4.8.2 X Client Printing

Unfortunately, the X Window System does not define a standard for X Clients to produce printer output, with each system manufacturer taking their own approach. It was decided for DESQview/X that printing from an X Client should be performed using exactly the same method as for displaying output on the screen, that is, by using the X Protocol.
This single imaging model has the distinct advantage of simplifying the coding of X Clients as they need only support one type of output device - regardless of whether the output is destined for the screen or printer. In addition, this also makes existing X Clients easier to update to include printing capabilities.

Under the X Window System, an X Client specifies on which X Server it wishes to display output by means of an address that takes the form machine_name:display_number.screen_number (note that in X, the term “display” refers to a workstation that consists of a keyboard, a pointing device and one or more screens). Hence the address radish:2.1 refers to the second screen (0 is the first and 1 is the second) on the third workstation (0, 1 then 2) on the machine called “radish” on the network.

If an X Client connects to a DESQview/X workstation using the display number 7, for example radish:7, (note that if a screen number is not specified it is presumed to be 0), the X Print Server in the DESQview/X X Server recognizes this and spools the X Client’s X Protocol requests into a file in the DESQview/X spool directory. In addition it also creates a print control file that specifies additional information for the Print Manager.

When the X Client disconnects from display number 7, the X Print Server informs the Print Manager of the file that needs printing, whereupon the Print Manager adds the request to the end of its print list.

When the Print Manager is ready to print a particular file, it reads the information from the relevant printer control file and, recognizing that the file is an X Protocol file, passes the file over to the X Print Driver for processing. Note that the X Print Driver is under the control of the Print Manager which both starts and removes the X Print Driver from the system as necessary. When the X Print Driver is handed an X Protocol File, it translates the X Protocol requests into the necessary printer codes and outputs them to the X Printer connected to the DESQview/X system.

The Resource Manager recognizes that it is the X Print Driver trying to print and allows the printer information to pass through (via the printer ports LPTx, communication ports COMx or DOS file handle 4) instead of trapping the print operation.

Note that only one printer may be designated as the X Printer (though, DOS applications may also output to this printer if they are configured to recognize the printer type) - the selection of the X Printer is performed using the DESQview/X Setup program.

4.8.3 Print Manager

The Print Manager can be thought of as a traffic officer, directing files to the appropriate printers at specific times or alternatively to the X Print Driver. It is possible for the user to interact with the Print Manager, list and reorder files in its print queue, suspend and resume printing as well as other operations.

Note, however, that DESQview/X may be configured such that spooling can still occur even if the Print Manager is not present in the system. When the user then starts up the Print Manager, it searches the spool directory for printer control files, produces a resulting print queue and begins printing.

4.9 The Network Connection

When a DESQview/X system is connected to a network, the structure is identical to that of a stand-alone system, but with the inclusion of network software and the DESQview/X Network Manager.

4.9.1 The Network Manager

The DESQview/X Network Manager is the bridge between the DESQview/X Socket Driver and the underlying network software. Since PC networks and their supporting network software vary greatly, a different version of the Network Manager is supplied depending on the type of network installed. Currently, the DESQview/X Network Manager can communicate using the following network APIs and network software: NetBIOS, Novell Netware IPX/SPX, FTP.
Systems PC/TCP, and Novell’s LAN WorkPlace for DOS. Check with Quarterdeck Office Systems for an up-to-date list of network APIs/software supported.

Note that there are many pieces in the network puzzle that must be compatible with each other in order for DESQview/X (or any other piece of software) to function over a network.

The DESQview/X Network Manager communicates with the Network Software using a network API. The network software in turn communicates with a piece of network hardware (using the hardware’s specific interface) which then sends the network data out over a network medium (usually a cable of some sort) according to a network protocol (a particular format for the data). The examples at right should make this relationship clear.

Because of the tremendous variety available between network software and hardware, Quarterdeck Office Systems cannot publish an exhaustive list of networks supported. Quarterdeck has an ongoing program to support popular network APIs/software and will be making them available as soon as they are developed.

### 4.9.2 Operation over a Network

When an X Client (DOS-based X Client, DOS or Microsoft Windows application translated to X Protocol requests) is started under DESQview/X, a parameter is supplied that specifies which screen the program’s output should be displayed on. (This is standard procedure for any X Window System.) If the display specified is not the local DESQview/X screen, the DESQview/X Socket Driver will route the X Protocol requests to the DESQview/X Network Manager. The Network Manager then uses the appropriate network API to transmit the request to the correct machine on the network via the network software. If, on the other hand, the output should appear on the local machine, the Socket Driver will route the X Protocol requests directly to the local X Server as in the case of the stand-alone system.

Conversely, if another machine on the network sends X Protocol requests to the DESQview/X system for display on its screen, the request is first accepted by the Network Manager. The Network Manager then route the requests to the local X Server via the Socket Driver by using the Berkeley Socket interface.

### 4.9.3 Communication Ports

Most networks rely on the notion of “ports” when communicating. An application will connect to a port on a remote machine in order to communicate with it. In machines that run the X Window System, TCP/IP or the Unix operating system, several of these ports are “reserved” and imply a special type of connection.

For example, port numbers starting at 6000 are the X Protocol ports (remember that a machine can have multiple X Servers connected to it so that 6000 refers to the first X Server (or “display number” 0), 6001 to the second, etc.). Whenever an application connects to port (for example) 6002 on a remote machine and sends a message to it, the receiving machine knows that it is an X Protocol request by virtue of the port number. It is then the receiving machine’s duty to dispatch the request to the appropriate X Server (the third X Server, or display number 2, in this case).

Note that there can be multiple connections to a single port. This is because a connection is defined by both the sending machine/port number and the receiving machine/port number. Since most reserved ports do not take into account the number of the sending port, one machine can have multiple connections to another machine’s port by choosing different send port. This is necessary when (for example) multiple applications on one machine connect to the X Server on another.

Other reserved ports imply several other functions - RSH (Remote Shell), REXEC (Remote Exec), FTP (File Transfer Protocol) and Telnet. Unlike the X Protocol port, these 4 other ports typically spawn “daemons” - programs that are invisible to users of the remote machine and execute in the background. DESQview/X supplies daemons for RSH, REXEC and FTP, but not Telnet - see the Telnet section for details.

### 4.9.4 Remote Shell

A remote shell (RSH) is one method for starting up applications on remote (other) machines anywhere on the network. When a user types in an RSH command on one machine, the RSH program connects to the RSH port on the remote machine. At this point, the remote machine (recognizing that the RSH port was connected to), spawns an RSH daemon.
This RSH daemon takes the command supplied in the RSH message and executes it on the remote machine for the user specified in the message, sending any output back to the originating port - typically this output is simply echoed to the screen by the originator’s RSH program.

DESQview/X supplies both an RSH daemon to respond to RSH requests as well as an RSH program that can send RSH requests to another machine.

This is a very powerful concept - remember that X Protocol requests produced by an X Client may be routed to any X Server on the network. A user seated at one machine (be it DESQview/X or Unix) may use the remote shell feature to start up an application on another machine, yet have its output appear on the user’s local machine (or any other display on the network). The user is now able to operate and use the X Client that is running remotely. X Clients that are run this way are termed remote clients.

Naturally, there are safeguards in the RSH feature that are intended to stop unauthorized access to remote machines, however, they are far from complete. Because of this, the Remote Exec feature was developed.

4.9.5 Remote Exec

The remote exec (REXEC) function is very similar to the RSH command except for how it guards against unauthorized access. With REXEC, the user supplies a password that is transmitted along with the REXEC command. If the password is not valid for the user name specified in the message, the command will fail.

DESQview/X supplies both an REXEC daemon to respond to REXEC requests as well as an REXEC program that can send REXEC requests to another machine.

4.9.6 File Transfer Protocol

The file transfer protocol (FTP) function is used to transfer files to and from a remote machine, as well as list directories on the remote machine.

The FTP daemon responds to a limited set of English-like commands that specify actions such as listing a directory, changing to another directory and receiving or transmitting a file. The DESQview/X File Manager application uses these capabilities to perform sophisticated file operations between machines. It connects to the remote machine’s FTP port and issues the low-level FTP commands to gather information required and transfer files.

DESQview/X supplies an FTP daemon to respond to FTP requests and the DESQview/X Network Manager - DESQview/X to Other X Systems includes an FTP program that can send basic FTP requests to another machine. The FTP program is not included in the base product as the File Manager companion is easier to use and more advanced.

4.9.7 Telnet

The Telnet function is used to start a terminal session on a remote machine which is displayed on the local machine. A Telnet request invokes the Telnet daemon, which in turn (typically) starts a “shell” program, such as the login program on most Unix machines. The session then behaves much like a modem communications session - the shell program on the remote machine (and any programs run under the shell) send characters and terminal control sequences which are routed via the Telnet daemon to the Telnet requestor and then to the user’s display. In turn, the Telnet requestor will also send characters typed by the user to the Telnet daemon which routes them to the shell program.

Since Telnet was primarily designed for communicating with a TTY-style (line and character-oriented) device, the Telnet daemon has not been implemented for DESQview/X as this would require a program capable of translating DOS screens into TTY-style commands. Instead, a remote machine running the X Window System can use RSH or REXEC to start a DOS session. Note, however, DESQview/X does supply a Telnet client that can start a Telnet session on a remote (non-DESQview/X) machine.

4.9.8 Remote Clients

The remote shell and remote exec functions open up a wealth of possibilities for users connected over a network by spawning remote clients. All of the X Clients on an X network can be started up and used by any X Window user on the system.

Since regular DOS and Microsoft Windows application screens can be dynamically converted to X Protocol requests by DESQview/X, DOS and Windows applications appear on a network as X Clients. Because of this, non-DOS users on a network may use DOS and Windows applications available on a DESQview/X machine. Applications that may not be used this way are those which cannot be translated into X Protocol requests on the host DESQview/X system. Currently, those applications are regular DOS graphical applications.

In effect, any DESQview/X machines on a network appear somewhat as Unix machines with their DOS and Microsoft Windows applications running as X Clients.
The converse to the above is also applicable - a networked DESQview/X machine may use X Clients available on other non-DOS machines (for example, a Sun or SCO Unix system.)

4.9.9 Interprocess Communications

Communications between processes is implemented in DESQview/X through the industry standard Berkeley Socket interface - the primary means of IPC communications for Unix machines.

This interface was designed to be totally independent of any underlying network and hence can be used by one process to communicate with another on a different machine across a network, regardless of the type of network (TCP/IP or Novell, for example). In DESQview/X, Berkeley Socket interface calls are accepted by the DESQview/X Socket Driver which routes them to the appropriate destination - whether to another application in the same machine, or to an application on a remote machine by broadcasting the message over a network. This results in the simplified coding of an application as it communicates with both local and remote applications in exactly the same way.

In a similar fashion to the DESQview API mailbox interface, the Berkeley Socket interface does not dictate the content of the message sent to another process, hence any manner of dialog may be implemented between two processes.

4.10 Stand-Alone or Networked?

DESQview/X may be run either as a stand-alone system or networked.

If run as a stand-alone system, applications typically run on the system will be the X Server (for display output), a window manager (to control the windows), multiple DOS and Windows applications and multiple X Clients.

If a DESQview/X machine is networked, the minimum required running is the X Server and Network Manager. The window manager and any X Clients (be they regular X Clients or dynamically translated DOS or Windows applications running on another DESQview/X machine) may all be run remotely on other machines on the network. Usually, some local applications will also be run.

4.10.1 Unix Machines and DOS/Microsoft Windows programs

Assume a network to primarily consist of Unix machines and/or X terminals. If a DESQview/X machine is added to the network that has a powerful processor (such as a 386 or 486), all of the Unix X Window users would then be able to use many of the DOS and Microsoft Windows applications that are available on the DOS (DESQview/X) machine.

4.10.2 DOS Machines and Unix Programs

The converse to the above situation is also true. On a DOS-based (DESQview/X) network, the addition of a Unix machine provides the DOS users access to any X Clients on the Unix machine. Large, powerful applications now become feasible that are not available for DOS and which would suffer running under a slower processor. In addition, by using the Xterm application on a Unix machine enables DOS users to access that machine’s character-based non-X applications as well.

4.11 A User’s View

It is not important to the user whether an application being used is running locally or remotely. It is possible with DESQview/X to hide all of these details, such that a user views a screen much like the one shown.

The screen shot shows a DESQview/X system with the DESQview/X Window Manager. Some applications are labelled “remote” or “local” for illustration purposes only, though a user’s implementation of this system may elect not to show this kind of information.

In the picture, DOS 128K (COMMAND.COM) and Borland C++ are DOS applications, one running on a remote DESQview/X machine, the other locally; Lotus 123 is also a local DOS application, but is displayed in a scalable DOS window. Application Manager (labelled “Toolbox”), its Help window and Clock are DOS-based X Clients; Xterm is a remote X Client running on a Sun workstation; and MS Windows is a Microsoft Windows session that is being run on another DESQview/X system, but displayed locally.
4.12 A Consistent Growth Path

DESQview/X is built on the existing technology of DESQview and DESQview 386 - two time-proven DOS multitaskers that are popular worldwide. Because of this, Quarterdeck can provide users with an excellent and consistent growth path that starts with DESQview:

**DESQview**

DESQview provides the DOS user with a multitasking environment on machines with as little as 640K, a hard disk, a monochrome monitor and an 8088 processor. DESQview is a character-based environment, but can also run graphics applications. Features include windowing and program swapping as well as a keyboard macro program, a help system, a DOS Services utility and easy-to-use keyboard or mouse control.

**DESQview 386**

In addition to DESQview’s features, DESQview 386 provides the 386/486 DOS user with a multitasking environment that incorporates superior memory handling, windowing features and program protection.

**DESQview/X**

DESQview/X incorporates the functionality of DESQview and DESQview 386, yet sports a graphical interface that is consistent with the menuing system used by those products. Because of its complete X Window capability, DESQview/X also gives users the capability to run local X Clients as well as access to DOS or Microsoft Windows applications and X Clients on remote machines (using the appropriate network software).

**DESQview/X and OSF/Motif, OPEN LOOK Window Managers**

When DESQview/X is joined by either the OSF/Motif or an OPEN LOOK window manager, users will have a consistent look and feel across all machines on a network, from DOS machines (DESQview/X) to X Terminals, Unix workstations, minis and mainframes.

4.13 DESQview/X System Capabilities

The capabilities of a DESQview/X system outlined in the preceding sections can be dependent on many factors. Consequently, here is a table of DESQview/X’s capabilities:

<table>
<thead>
<tr>
<th>DESQview/X Capabilities</th>
<th>386</th>
<th>486</th>
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<tbody>
<tr>
<td>Remote X Client, Remote DOS Application or Remote Microsoft Windows and Application</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>Local X Client</td>
<td>Real Mode</td>
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<td></td>
<td>16-bit Protected</td>
<td>W</td>
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<tr>
<td></td>
<td>32-bit Protected</td>
<td>W</td>
</tr>
<tr>
<td>Local Well-behaved DOS Text Application or Local Ill-behaved DOS Text Application with Loader</td>
<td>Real Mode</td>
<td>W**</td>
</tr>
<tr>
<td></td>
<td>16-bit Protected</td>
<td>W**</td>
</tr>
<tr>
<td></td>
<td>32-bit Protected</td>
<td>W**</td>
</tr>
<tr>
<td>Local Ill-behaved DOS Text Application</td>
<td>Real Mode</td>
<td>WD*</td>
</tr>
<tr>
<td></td>
<td>16-bit Protected</td>
<td>WD*</td>
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<tr>
<td></td>
<td>32-bit Protected</td>
<td>WD*</td>
</tr>
<tr>
<td>Local DOS Graphical Application</td>
<td>Real Mode</td>
<td>D</td>
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<td></td>
<td>16-bit Protected</td>
<td>D</td>
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<tr>
<td></td>
<td>32-bit Protected</td>
<td>D</td>
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<tr>
<td>Local Microsoft Windows 3.0, 3.1 and Windows Application</td>
<td>Real Mode*</td>
<td>W**</td>
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<tr>
<td></td>
<td>Standard Mode</td>
<td>W**</td>
</tr>
</tbody>
</table>

W Application can be displayed in an X window and can act as a remote X Client for another X Server on a network.
D Application can only be displayed direct and cannot act as a remote X Client for another X Server on a network.
WD Dependent on individual application - most run as W, some may run as D.
* Processor cannot support this type of application.
** Available only with Microsoft Windows version 3.0.
Application may be run as a direct window (full screen) for fastest performance.
5 Development Issues

This section outlines the development procedures for the different program types that DESQview/X supports and examines how these relate to the development of X Clients under DESQview/X.

DESQview/X supports the following kinds of applications: DOS text (regular DOS applications), DOS graphical (regular DOS graphical applications), DESQview API, Microsoft Windows and of course, X Clients. Most of these application types can appear as either real mode, 16-bit protected or 32-bit protected.

5.1 Real Mode Applications Development

In order to generate a real mode application, a developer will follow the traditional steps to produce an application:

First, all necessary source files are compiled using a regular DOS compiler to create real mode object files. Next, a regular DOS linker is used to link those object files with real mode library modules to produce a runnable application.

Often the compiler, linker and library modules are supplied by a single manufacturer as a complete package.

Library modules are available (sometimes from third party manufacturers) with graphic routines to produce a graphical application or Microsoft Windows routines to produce a Windows application.

5.2 Protected Mode Applications Development

To generate a protected mode application for DOS, a developer will require the use of a DOS Extender package and normally follows one of two paths.

5.2.1 Using a Protected Mode Compiler and Linker

If a protected mode compiler is used, it will generate protected mode object files. (Note that the words “protected mode” in the name “protected mode compiler” are referring to the kind of output the compiler generates, not the kind of program the compiler may be - it could actually be a real mode program or a protected mode program running under a DOS Extender!)

These protected mode object files are then linked with protected mode library files and DOS Extender modules to create a protected mode application that is runnable from DOS.

Typically the compiler, linker and library modules are supplied by a single manufacturer as a complete package.

- If a 16-bit protected mode application is required, then a compiler and linker capable of handling 16-bit protected code must be used as should 16-bit protected library modules.

- For a 32-bit protected mode application, a compiler and linker capable of handling 32-bit protected code must be used as should 32-bit protected library modules.

As in the case of real mode applications, library modules are available (sometimes from third party manufacturers) with graphic routines to produce a graphical application or Microsoft Windows routines to produce a Windows application.

Note that a trend in protected mode compilers is to offer a DOS Extender as part of the compiler package, obviating the need to choose and purchase a DOS Extender separately.

Previously, there was not as big a selection of 16-bit and 32-bit protected mode development packages as there are today. To address this situation, many DOS Extender manufacturers supply an alternate route: using regular DOS compilers.

5.2.2 Using a Regular DOS Compiler

If a regular DOS compiler is used, this will create real mode object files. This may seem inconsistent, however real mode is very similar to 16-bit protected mode code, save for a few constraints. Note that if generating code for a 32-bit environment, using a regular (16-bit) DOS compiler will result in code that will not take advantage of the 32-bit architecture of the processor.

At this point either a regular DOS linker or a protected mode linker may be used. Whatever linker is used, it will typically link in real mode library routines and some protected mode modules as well in addition to the DOS Extender modules. The real mode library routines are ones supplied by the regular DOS compiler manufacturer that do not violate protected...
mode guidelines and hence may be used in a protected mode environment. Any library modules that do violate those guidelines are replaced by modules that have been rewritten by the DOS Extender manufacturers and are linked in as protected mode modules.

Sometimes it may be necessary to run a conversion program after the linking stage to create the final protected mode program.

Note that a need for protected mode linkers has become apparent because many regular DOS linkers have certain limitations when creating protected mode programs (since they were not designed to produce these kinds of programs).

5.2.3 DOS Extenders

In order for a protected mode application to run under DOS (or DESQview/X) it requires the use of a DOS Extender. A third-party DOS Extender may be used, though many compilers now supply their own DOS Extender and protected mode libraries. DESQview/X includes the DOS/4GX DOS Extender and the DESQview/X Development Kits (see later) supply the necessary protected mode libraries.

5.3 X Client Development for DESQview/X

Developing or porting X Clients to the DESQview/X platform requires a developer to follow the general steps outlined in the previous section.

Depending on the size of the resultant X Client, a developer will create either a real mode, 16-bit protected mode or 32-bit protected mode application. Typically, X Clients that are ported from another environment (usually Unix) will be implemented the easiest as a 32-bit protected mode application.

In order to create an X Client as opposed to a regular DOS or DOS Extended application, the X Client object files are linked with Xlib and/or Toolkit function libraries in addition to the usual program libraries.

5.3.1 DESQview/X Development Kits

The development kits that are (or will be) available for the development of X Clients in DESQview/X are:

X11 includes XLIB, Xt Intrinsics, Athena Toolkit and sample X Clients.
OSF/Motif add on to X11 Toolkit
OPEN LOOK add on to X11 Toolkit

Each development toolkit includes different versions of the program libraries for use by particular compilers. The versions that are (or will be) available include:

<table>
<thead>
<tr>
<th>Library</th>
<th>16-bit Protected</th>
<th>32-bit Protected</th>
</tr>
</thead>
<tbody>
<tr>
<td>X11</td>
<td>B,M,Z</td>
<td>B,M,Z</td>
</tr>
<tr>
<td>OSF/Motif</td>
<td>-</td>
<td>G,W</td>
</tr>
<tr>
<td>OPEN LOOK</td>
<td>-</td>
<td>?</td>
</tr>
<tr>
<td>B Borland C/C++ 3.1</td>
<td>M</td>
<td>Microsoft C version 5.1 or 6.x</td>
</tr>
<tr>
<td>G GNU C/C++</td>
<td>W</td>
<td>Watcom C/386 9.0</td>
</tr>
<tr>
<td>HIC MetaWare High C 1.7 or 3.0</td>
<td>Z</td>
<td>Zortech C/C++ 3.0</td>
</tr>
<tr>
<td>IC Rational Systems Instant-C</td>
<td>?</td>
<td>Not determined yet</td>
</tr>
</tbody>
</table>

This table is by no means exhaustive and is expected to change - check with Quarterdeck Office Systems for a list of compilers/program modes currently supported.

5.3.2 DOS/4GX Support

Because DESQview/X contains DOS/4GX DOS Extender technology, a separate DOS Extender is not required for use with the DESQview/X Development Kits. Compilers supported by the DESQview/X Development Kits produce code that is compatible with the DOS/4GX support.
There are several products available in the DESQview/X suite of system software - base products, additional window managers, development kits and additional network manager product.

Contact Quarterdeck Office Systems Customer Service at (800) 354-3222 for a complete list of products and services offered as well as current list prices.

**DESQview/X (for 386 PCs)**

This product enables a single user to implement on a 386 processor (or better), the DESQview/X graphical environment system for running DOS, Microsoft Windows and/or DOS-based X Clients. In addition, remote computing facilities are provided so that the DESQview/X system can interact with other DESQview/X systems using either a Novell (IPX/SPX) or NetBIOS network. Specifically, a DESQview/X system may use remote DOS, Microsoft Windows or DOS-based X Clients on other DESQview/X systems as well as being able to transfer files.

It includes QEMM-386, Quarterdeck Manifest, the X Server product, the DESQview/X Window Manager (DWM), several graphical utilities (the DESQview/X Companions - Application Manager, File Manager, Icon Editor and Adobe Type Manager) and support software such as a Print Manager and DESQview/X to DESQview/X Network Manage for IPX/SPX and NetBIOS.

**OSF/Motif Window Manager**

An addition to the DESQview/X base product, the OSF/Motif Window Manager replaces the default DWM window manager to sport an OSF/Motif look and feel.

**OPEN LOOK Window Manager**

An addition to the DESQview/X base product, the OPEN LOOK Window Manager replaces the default DWM window manager to sport an OPEN LOOK style interface.

**DESQview/X Network Manager - DESQview/X to Other X Systems**

This network software product is an addition to the DESQview/X base product and enables a DESQview/X system to communicate with other X machines (DESQview/X or otherwise) over a variety of networks. Note that the DESQview/X base product includes support for NetBIOS and IPX/SPX (Novell) networks - this additional package delivers support for other network APIs such as PC/TCP (FTP Systems) and LAN WorkPlace for DOS (Novell) and includes a coupon for a free copy of Novell’s TCP/IP Kernel for DOS. Since this list may change, check with Quarterdeck Office Systems for an up-to-date list of network APIs that DESQview/X supports.

Note that this package permits a DESQview/X system to communicate with other DESQview/X and X Window machines over a network. It is not a substitute for and does not replace the standard network software that is required to form a network.

**DESQview/XX11 Toolkit**

The DESQview/XX11 Toolkit enables developers to port existing X Clients to the DESQview/X platform or create new ones. This kit contains the X11 program libraries for all supported compilers (Xlib, the Xt Intrinsics, the Athena Toolkit) and sample X Clients. In addition, the kit includes the DOS/4GX Extender tools, Rational System’s Instant-C and Oxygen utility, full printed documentation, and developer support from Quarterdeck Office Systems.

Check with Quarterdeck Office Systems for a list of compilers/program modes currently supported for this and other development kits.

**DESQview/XX11 Library Kit**

The DESQview/XX11 Library Kit is a less expensive version of the DESQview/XX11 Toolkit that does not include Rational System’s Instant-C and Oxygen utility. In addition it only includes standard 90-day end user support from QOS.
**DESQview/X X11 Starter Kit**

The DESQview/X X11 Starter Kit consists of the GNU C/C++ compiler and GNU versions of the DESQview/X X11 Libraries (Xlib, Xt Intrinsics and Athena Widgets). In addition, minimal printed documentation is included that describes compiling X Clients as well as specific details on programming and configuring the DESQview/X environment. No documentation regarding generic X Window programming is supplied with this kit.

Even though this kit does not include the DOS/4GX Extender tools, 32-bit protected mode applications may be developed as the GNU compiler includes its own DOS Extender.

This kit is provided at a very competitive and inexpensive price and only includes standard 90-day end user support from QOS.

**DESQview/X OSF/Motif Toolkit**

An addition to the DESQview/X X11 development kits, the OSF/Motif Toolkit enables developers to create applications with an OSF/Motif look and feel. It consists of the OSF/Motif program libraries, the DESQview/X OSF/Motif Window Manager, Motif and DESQview/X Programming manuals at a very attractive price.

Check with Quarterdeck Office Systems for a list of compilers/program modes currently supported for this development kit.

**DESQview/X Developer Passport Support**

DESQview/X Developer Passport Support (included only with the DESQview/X X11 Toolkit and available separately) provides a year of special access to DESQview/X development support technicians and to the DESQview/X porting laboratories. The porting laboratories offer individual personalized assistance when porting to the DESQview/X platform or creating new DESQview/X applications. Two locations currently exist - Santa Monica, California and Chelmsford, England with more planned.

Note that many components of the DESQview/X Development Kits (including developer support) are available separately - please contact Quarterdeck Office Systems for a complete list of products/services and current list prices.

**FREE EVALUATION DEVELOPMENT KIT**

**DESQview/X X11 Libraries for GNU C/C++**

The GNU C/C++ versions of the DESQview/X X11 Libraries (Xlib, Xt Intrinsics and Athena Widgets) are available on Internet (anonymous ftp server barnacle.erc.clarkson.edu, qdixl100.zip file (note '100' denotes version 1.00 - this can change) in directory /pub/msdos/djgpp) and from the Quarterdeck Office System BBS ((310) 314-3227).

Even though this libraries do not include the DOS/4GX Extender tools, 32-bit protected mode applications may be developed as the GNU compiler includes its own DOS Extender.

These libraries are offered free of charge, but include no documentation or support from QOS.

**Internet Downloading Instructions**

**FTP users:**

File location:
- host: barnacle.erc.clarkson.edu
- login: ftp
- password: <your email address>
- directory: -ftp/pub/msdos/djgpp

**Non-FTP users:**

% mail archive-server@barnacle.erc.clarkson.edu
Subject: <none>
help
index msdos/djgpp
<ctrl-D>
TRADEMARKS

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Writer: Mark Radcliffe
Cover design: Cynthia Ford
Production notes: This document was created electronically using Ventura Professional.
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DESQview/X brings you the windowing, multitasking, DOS and Microsoft Windows compatibility, data transfer, and key-stroke macro facilities, that you would expect from Quarterdeck, the leader in DOS multitasking. With the addition of X Window System graphics, Adobe Type Manager™ for scalable fonts and scalable DOS windows, a graphic desktop, customized menus and icons, and remote computing, DESQview/X redefines the limits of personal computing.
"DESQview/X is a milestone" VAR Business

"A Breakthrough Product" Computer Reseller News

"An enormous technical achievement" Byte

"A 'tour de force'" Michael Gould quoted in Communications Week

"Quarterdeck redefines PC Interoperability" Communications Week

"The multitasking environment your PC needs" DATAMATION

"Editors Choice" (Over OS/2 & MS Windows) Computer Technology Review

"It could prove to be a real Windows killer" Network Computing

"Even NT is not going to be able to do all the things DESQview/X can [already] do."
Dan Heller, quoted in Communications Week

FREE DESQview/X DEVELOPERS TOOLKIT!
The DESQview/X X11 Toolkit can be downloaded for FREE from Internet. This kit contains the GNU C/C++ compiler, GNU versions of the DESQview/X X11 Libraries and minimal documentation. (Free technical support is not included.) Internet details on reverse side.

For more information on the DESQview/X X11 Starter Kit, X11 Library Kit, X11 Toolkit, OSF/Motif Toolkit and Developer Support programs, call our Customer Service Department at (800) 354-3222 ext 5G1.
The GNU C/C++ versions of the DESQview/X11 Libraries (Xlib, Xt Intrinsics and Athena Widgets) are available on Internet in file: qddvxl00.zip file (100 denotes ver 1.00, look for changes), and from the Quarterdeck BBS at (310) 314-3227. Internet Instructions: FTP USERS—host:barnacle.erc.clarkson.edu; login:ftp; password: <your email address>; directory: -ftp/pub/msdos/djgpp. Non-FTP users—% mail archive-server@barnacle.erc.clarkson.edu; Subject: <none>; help; index msdos/djgpp; <ctrl-D>

NAME ___________________________________________
TITLE ___________________________________________
COMPANY _________________________________________
ADDRESS _________________________________________
CITY ______________________ STATE ______ ZIP ________
PHONE ______________________ FAX ________________
☐ Send me more information on DESQview/X. ☐ Please have a salesman call.
☐ I am a ☐ Developer ☐ End user ☐ Reseller ☐ System integrator/VAR
☐ I now use X Window systems ☐ I develop X Window programs
☐ Send me information on professional training for QEMM-386, DESQview or DESQview/X.
☐ Fax me an order form for the toolkits. FAX #:
I now use: ☐ DESQview ☐ DESQview-386 ☐ QEMM-386
I recommend software for: ☐ 1 to 5 ☐ 6 to 10 ☐ 11 to 25
☐ 26 to 50 ☐ 51 to 100 ☐ 101 or more, computers.

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The Information Theater
You've never seen your data quite like this before

MARK A. CLARKSON

The promise of the information age is instant access to the sum of human knowledge from anywhere, at any time. The reality is vast numbers of disconnected databases, each with its own search engine, procedures, and classification scheme. Nothing is more frustrating than knowing that the information you need is out there and having no way to retrieve it.

Retrieving the information you want—and only the information you want—is the focus of an exciting research project at the Xerox PARC (Palo Alto Research Center). The result, called the Information Theater, combines a novel interface with search-and-retrieval technologies to create an information system that brings the promise of the information age closer to reality.

Roots
The notion of the Information Theater was born out of the Interactive Information Access project at Xerox PARC. The Information Theater is about text. It exploits PARC's strengths in user-interface design and natural-language processing to develop new ways of organizing and presenting text on a computer. The results transform database searches and text retrieval into a kind of interactive TV show—with a heavy emphasis on real-time computer animation.

The Information Theater calls on the work of PARC's User Interface Research Group on Information Visualizers (see "An Easier Interface," February 1991 BYTE), which enable databases to appear as physical, 3-D structures that can stretch, slide, and spin in the air (see photos 1 and 2). Information Visualizers use familiar perceptual cues, such as light and shadow, to draw you into their artificial, animated reality. You can see your information, touch it, and rearrange it, achieving a deeper, almost tactile understanding of its structure.

Information Visualizers exemplify the Information Theater's high-bandwidth interaction. This interaction requires high-speed computers, sophisticated graphics, and whole new user interfaces and paradigms. To be effective, the Information Theater has to be more than engaging—it has to be fast. Speed is crucial to maintain the illusion of seamless animation and to make the indexing and searching of large databases quicker. Even if you are merging and sorting a couple of encyclopedias, you don't want to wait forever.

People and Machines
The Information Theater doesn't try to replace human intelligence. Rather, it applies intelligence in ways that seek to
bind you more tightly into the process. In the Information Theater, the computer focuses on those tasks at which it excels. Pattern recognition and language understanding are left, by and large, to you.

Per-Kristian Halvorsen, head of the project's NLTT (Natural Language Theory and Technology) group, says, "An information search-and-retrieval system is most effective if it is viewed as a team consisting of the machine and the user." Each member of the team performs those tasks best suited to him, her, or it: A fast computer is ideal for tasks such as computing the angle between two vectors, each with 10,000 dimensions; you are best suited to understanding your E-mail messages.

In contrast to other natural-language projects that seek ways for the computer to understand text (i.e., drawing conclusions and producing new facts about the text), NLTT's work emphasizes the intelligence needed for the computer to find important text and present it to you in an effective and interesting way.

Theater Foundations
Before the Information Theater could be built, it first needed a foundation: the Text Database. To the Text Database falls the less glamorous tasks of reading, sorting, and, to some extent, understanding tens of megabytes' worth of documents. The Information Theater was built by the NLTT group, which is made up of Halvorsen and the Text Database designers Doug Cutting and Jan Pedersen.

The Information Theater needs a flexible foundation to support research into different information search-and-retrieval systems. The Text Database supplies this flexibility. It is an object-oriented, modular system written in Common Lisp. You can plug in different modules (e.g., search engines, user interfaces, and natural-language analyzers) as you can with Nintendo games.

An important piece of the Text Database is the analysis module. It works like a pipeline, pumping information from the documents to the other parts of the database. As the text passes through the pipeline, it is broken into tokens that are manipulated, massaged, and sometimes discarded. The text emerges at the other end as an inventory of terms. These terms are typically words, but they could be anything from individual letters to noun and verb phrases or whole concepts. These word terms are typically reduced to their roots. For example, banks, banker, banking, and banked might all be reduced to bank.

Along with the terms come statistics about their use in the text (e.g., the number of times the word festoon appears in the document foo and at what positions). You can select or design a different analysis to suit a particular task. Likewise, the analysis results can be translated into several different indexes, depending on your task.

Queries and Indexes
In most text-retrieval systems, a typical search calls for an inverted index. For each term in the Text Database, the inverted index contains the term, the documents it occurs in, and the word positions. In practice, an index might contain more, or less, information. As a rule, the more information you pack in the inverted index, the faster your searches will go.

Inverted indexes are just what the doctor ordered for Boolean search engines featuring queries like "find me all documents containing terrorist and bombing." You can look up the terms terrorist and bombing in the index and see what documents they both occur in.

The Boolean search paradigm dominates the personal computer text-retrieval marketplace, but there are other ways to search for documents. For example, in a similarity search, documents are compared on the basis of the words they have in common. For similarity searches, you select an index that provides a simple list of the terms occurring in the documents and their frequency.

Beyond Boolean
The problem with Boolean and similarity searches lies in the nature of text data. Databases are becoming huge. You can easily find yourself with hundreds of megabytes of information at your fingertips. Projects such as WAISes (wide-area information servers) (see "Browsing Through Terabytes," May 1991 BYTE) promise to up the ante further, providing untold terabytes of information on-line. This raises some fundamental questions: Once you've got the world at your fingertips, what do you do with it? How do you know what to pick up? How do you find what you're looking for amid the morass of uninteresting or nonapplicable data?

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so-called intelligent agents. While great in theory, agents have yet to make a dent in the real world. For now, you have to carry out your own searches.

Searching a database is not an easy task. The designer of a document-search program typically focuses on the problem of finding the documents that match your query. The search program assumes it will receive a good query and leaves it up to you to formulate one.

Pedersen believes that this approach is overlooking something fundamental. "We think the problem is a lot harder—and a lot more interesting—than that," he says. "There's another major issue: How do you get a good query?"

Indeed, how do you formulate a good query? How do you know in advance just what words to use or what words are even relevant? What do you do when different professions and nations use different vocabulary to talk about the same things (e.g., bruises/contusions and cosmonauts/astronauts)?

Some words are too common; others, too rare. Consequently, Boolean search schemes are notorious for returning too many or too few documents. A search for documents about a and b might return 3000 articles—too many to consider. You are faced with reformulating your query, and the system offers you no more help. Narrow the search by looking for documents containing a, b, and c, and you might get back only two or three hits—too few. What now? Do you search for just a and c? Or would it be better to look for a, b, and d? To make matters worse, if this is your first time using a database, you may not know what documents are available or what words you might use to describe a given subject.

Query by Snippet

In contrast to a standard Boolean search engine, the Text Database contains a module called the Snippet Browser that actively assists you in homing in on the documents you're interested in. In the Snippet Browser, you type in a word or words you're interested in. The program shows you snippets of text (i.e., sentence fragments) containing those words so you can see how your words are used in a given document.

Snippets from a search on the word computer might include "...computer industry's largest vendors..." "...the computer graphics..." and "...computer-aided manufacturing...". Because you are searching for documents containing the word computer, it comes as no surprise that these snippets do, in fact, contain it. The Snippet Browser does not highlight the words that were in the query (e.g., computer), but instead the flanking words (e.g., vendors and graphics) that help you establish the context in which the words were used.

Why just snippets, as opposed to titles or paragraphs? In the latter case, the fewer the words, the faster you can leaf through the returning hits and zero in on your target. In the former case, titles are short but often ambiguous, contends Cutting. "If you get a title back, it's not always clear how the words in your query might have been used in the document," he notes. Instead, the Text Database shows where your search target is used and what other words are nearby, which might help to disambiguate its usage. It may suggest some other search terms to you, but it's up to you to figure out if the terms you've used are good or bad. As Cutting puts it, "Sometimes we describe using the Snippet Browser as 'searching for a query.'"

You can see this at work in searching for the word computer. At first, you get thousands of hits, and you're not much closer to your target. There is a myriad of different contexts in which computer appears. But as these hits show up on your screen in the form of sentence fragments, you can immediately begin selecting the ones that interest you (e.g., computerized drafting) and then marking the ones that don't (e.g., computers in the classroom). Inappropriate documents disappear from the screen. Behind the scenes, the Snippet Browser updates your query on the fly, homing in on documents you find interesting. You can expand the snippets, which gives you more of the context in which they appear, or view any of the documents that catch your interest.

Like a Boolean search, the Snippet Browser relies on an indexed index to locate documents containing your search words. Indeed, under the hood, the Snippet Browser is essentially a constrained version of a Boolean search. The difference is in the user interface. You never confront anything resembling a typical search language. Instead, you select certain uses of a word as interesting, others as not, and iteratively narrow the search to include only the documents you need (see photo 3).

Relevant Questions

The Text Database also offers a similarity search to help you retrieve the documents you need. In a similarity search, documents are compared on the basis of the words they have in common. If you have a document in-hand, a similarity search will find other documents on similar subjects.

In the Text Database, each document is rendered as a vector (i.e., a line) in a special high-dimensional document space. This space has one dimension for each unique term in the document collection. In Grolier's Encyclopedia, which uses around 100,000 unique words, each article would be rendered as a vector in a 100,000-dimensional space. On the other hand, a collection of Dr. Seuss children's books might require only a 1000-dimensional space.

The Text Database estimates the similarity of documents by computing the distance between their vectors. The closer two vectors are to one another, the more similar the documents are presumed to be. "If the words you use had nothing to do with what
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In the scatter/gather process, a collection of documents—in this case, articles from the New York Times news service—is scattered or broken up into topics. Some of the resulting topics (e.g., Iraq, Oil, and Germany) are gathered together, forming a smaller, more focused document collection, which is scattered again into new topics. You can iterate this process as often as you wish. (Figure courtesy of Xerox PARC)

you were talking about,” says Halvorsen, “this would not work. But since, typically, the words you use correspond in some way to what you’re talking about, this does work. It can tell you whether two documents talk about related matters.”

A natural-language query, such as “find me articles about copy machines,” is also converted into a vector in this document space. The documents closest to the vector—those containing lots of references to both copy and machine—are returned.

When the similarity search returns documents, you may select one or more of them as relevant. These selected documents become the new query vector, and the documents that are closest to it are returned. Again, the similarity search lets you iteratively approach your target, without encountering a conventional search language.

Calculating Distances
Calculating which documents lie close together seems simple enough, but in practice, it can be complicated; for example, Grolier’s Encyclopedia contains about 30,000 articles. Comparing each document with every other document requires almost 450 million vector-to-vector comparisons, and each of these vectors contains 100,000 elements—one for every unique word in the encyclopedia. This relationship between the number of documents in the collection and the number of possible comparisons between them is quadratic: Double the number of documents in the collection, and the number of comparisons between them increases fourfold.

This quickly gets out of hand with increasingly large document collections. The Text Database avoids this labor-intensive document-to-document comparison by using the statistician’s old trick: the random sample.

Using an algorithm called Shotgun, the Text Database selects a representative sample of documents for extensive comparison. For example, such a search of Grolier’s 30,000 articles might call for a sample of only 574 articles. These require a comparatively manageable 164,000 vector-to-vector comparisons. Moreover, the number of comparisons increases linearly, not quadratically, as the document base increases.

Because of the nature of sampling, a few documents might be misfiled, although not enough to make any significant difference. If you require higher precision, more precise—and slower—algorithms can perform the analysis off-line.

Scattering and Gathering
When documents are plotted as vectors in document space, those documents that use many of the same words will lie close to each other. They appear to be clustering. Until now, clustering has been used mostly as a tool to try to improve similarity searches. In contrast, the Interactive Information Access project is exploring clustering as a means to navigate through large or strange document collections.

At the broadest level, clustering divides a document collection into a handful of clusters—say, 10—that correspond loosely to subjects. An on-line collection of BYTE might yield clusters of articles about Macintoshes, IBM's, laser printers, and programming. In the case of an encyclopedia, clusters might
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correspond to economics, history, science, and art. The computer designates a cluster with a list of keywords that distinguish it from other clusters and with titles from documents most typical of the cluster (i.e., those nearest the center of the cluster).

Like a table of contents, basic clustering gives you an overview of a document collection and how it breaks down. Even if you had never seen a particular database before, you would already have some idea of what is available to you.

Now you can select a few of these clusters, say, IBMs and laser printers, and tell the system to cluster the documents again. The IBM and laser-printer clusters are gathered into a single cluster, which is then scattered into new clusters. These new clusters might be LaserJets, using IBMs with Apple printers, and programming for laser printers.

Every time you iterate this process, the clustering becomes more fine-grained as progressively fewer documents are distributed among the same number of clusters (see the figure). You can iterate this scatter/gather process as often as you like, collecting clusters together and then scattering them apart again, backing up if you make a wrong turn. You could theoretically iterate all the way down to a single document.

The collection can be broken up in an almost infinite number of ways, to whatever granularity suits your purpose. At any time, you can jump into a similarity or snippet search to track down a particular document.

As with the snippet search, nothing here resembles a search language. Indeed, since you will rarely use the scatter/gather process to actually locate a single document, it is not really a search program at all. The NTT group sees it as an information structuring and management tool (i.e., an aid to navigating large databases and understanding their contents).

Dynamic Data

Some databases do not sit still like an encyclopedia. Data accumulates off the New York Times news wire at about half a megabyte a day. Thus, while you're, say, in the Rockies for two weeks on vacation, your news database will accumulate another 7 MB of text.

Inevitably, some of this news will fall outside of existing categories. A new country will be formed, or someone will invent cold fusion. At this point, existing classification schemes fall down. But in the Information Theater, you can use the scatter/gather process to reorganize the database to accommodate this new category. In fact, you can reorganize the entire database around this new category. Halvorsen foresees a time when large text databases (e.g., encyclopedias) will be shipped with something like a scatter/gather capability to allow you to reconfigure or reindex it to suit your own needs.

Information-retrieval tasks run the gamut from simply browsing through a database to searching for a specific document. The Information Theater supports that range of uses. On the one end, it aids you in visualizing the structure of a space of documents. At the other end, it helps you to formulate queries and home in on documents.

All parts are fully interchangeable. You can jump from snippet search to similarity search and back again. If a search returns too many documents, you can use the scatter/gather process to organize them and extract the topics you want.

Now you can find those documents you've forgotten you own, or uncover the hidden structure in your hord of forgotten PROFS notes, or set megabytes of data spinning in the air. It's all possible in the Information Theater.

Mark A. Clarkson is a freelance science writer living in Wichita, Kansas. You can reach him on BIX c/o "editors."
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Digital signal processing makes it possible for computers to interact with the world by enabling them to process real-world signals, usually in audio, video, or electromagnetic form. Signal processing can let you understand the information in a signal, transform it into a practicable form, or use it to synthesize information.

For example, a CAT scanner gathers information about the human body and uses sophisticated signal-processing algorithms to help medical professionals diagnose internal disorders. An audio-compression algorithm allows more audio to fit on a storage device. And signal processing is used extensively to create signals: You can now control an orchestra of instruments using a modern music synthesizer.

Signal processing is getting more attention in the personal computer arena because many host processors are now fast enough to do simple signal processing. More important, fixed-function and programmable DSP (digital signal processor) chips are coming down in price, making it feasible to build them into motherboards. Signal processing makes practical specific applications (see the text box "Digitally Speaking" on page 160). Some people call DSPs the math coprocessors of the 1990s—ICs that provide a significant performance boost for specific applications or operations, including audio, video, graphics, and communications. If the computer you are using doesn't have a DSP in it, your next one most likely will.

What Is a Signal?

People use the term signal in many different ways. You talk about radio and TV signals, traffic signals, and automobile directional signals. In signal processing, signal refers to physical properties that change with time, such as electromagnetic waves. These signals are converted by a transducer into another form (usually electrical) that can more easily be manipulated or processed. Examples of such signals include audio, radio, and TV signals. Other types of signals include multidimensional correlated data (e.g., photographic images and sonograms).

An example of a transducer is a microphone, which converts sound-pressure variations into a voltage that varies proportionally with the sound pressure. Another common transducer is a speaker, which does the reverse of a microphone, converting an electrical voltage to an air-pressure signal.

The electrical signal produced or used by a transducer is referred to as an analog signal. The only limits on the accuracy of a re-created analog signal are the physical properties of the transducer and interference, or noise, in the system.

Signal Parameters

The two basic parameters for signals are the frequency and the amplitude. The frequency of a signal refers to the number of times that the signal varies per second. Frequency is measured in hertz (i.e., cycles per second). For example, human speech is in the frequency range of 300 to 3000 Hz. AM radio is in the 550- to 1650-kHz range. And FM radio is in the 88- to 108-MHz range.

Frequency (f) is an inverse function of the time (T) between fundamental peaks or valleys in a signal: $f = 1/T$. The time (T) is called the period.

Amplitude is a measure of the strength of a signal. It's measured in various units depending on the application. For audio signals, the measurement is in decibels, which is a logarithmic scale based on human-hearing sensitivities. For audio,
SIGNAL COMPUTING

Composite Signals

A signal can consist of many separate components that propagate at different frequencies and amplitudes. Such a signal is called a composite signal. An example of this would be a recording of a chord from a pipe organ: Each note produces a single tone, but when several notes are combined, they form a complex waveform (see figure 1). Another example is the radio spectrum, which is composed of hundreds of signals from radio and TV stations, aircraft, and so forth.

Another important signal parameter is **bandwidth**, which describes the range in frequencies of a complex signal. For instance, the bandwidth of a high-fidelity audio signal is 20 kHz; the bandwidth of a video signal is 6 MHz.

While a complex signal may be difficult to use directly, it's possible to select portions of the signal by using filters. A filter allows the passage of a signal within a range of frequencies and prohibits the passage of signals with frequencies outside of that range. A radio tuned to a station contains a sharp filter that selects only the signal from that radio station and eliminates all others. At higher frequencies (e.g., visible light), you use filters to select or to filter out colors (i.e., frequency ranges). Tone controls on audio equipment are another common type of filter.

Underlying an understanding of composite signals is the Fourier theorem, which states that any periodic signal can be described as the sum of single-frequency sine waves of various amplitudes. This makes it possible to extract the individual component sine waves that make up a composite signal and to synthesize any composite signal with a set of sine-wave generators. The former technique is used to extract information from a signal; the latter is used for music, speech, and waveform synthesis.

Digital and Analog Signals

Historically, most electronic signal processing has been done on analog signals with analog components (e.g., transistors, transformers, and capacitors). But it's difficult and costly to create analog-signal processing components with precise values that do not change significantly with time and environmental fluctuations. Digital electronics let you compute the effect of components on a signal using mathematical operations. Digital signal processing is a precise method unaffected by time and environmental changes.

As digital processing speeds have increased, people have begun to use DSPs to do processing that is not practical in the analog domain. This is due to a number of factors. First, unlike normal electrical components, digital components operate precisely as expected, with no losses, distortion, or other physical effects to the accuracy of the numeric representation used. Second, mathematical operations representing component functions that are not physically realizable are easily computed. And third, because digital components are programmable, you can change the signal-processing function by reprogramming it rather than by resorting to a welding gun.

The result of digital technology is new or better signal-processing functions. For example, selective filters are possible in the digital domain that are impossible at any cost in analog signal processing.

Discrete-Time and Discrete-Amplitude Signals

Most of the signals discussed thus far are continuous-time signals, which can have any value from an infinite number of values within a specific range. This value can be measured at any time. Signals that have values only at specific times are called discrete-time signals. An example of one is the number of people in a theater at a specific time. This will be an integer from 0 (a very bad movie) to the maximum seating limit (a hit movie). The discrete period is one day. You can enter a set of values from this signal into a digital computer for processing in many useful ways.

A discrete-amplitude signal has one of a set of values at each given time. A simple example of this is a traffic light, which can have only one of three values—red, yellow, or green—at one time.

Sampling and Quantization

Before digital computers can process signals, the analog signal must be converted into a digital signal. A digital signal has

![Figure 1: The three notes that make up a chord each produce their own simple signal, harmonics aside. The composite signal results from the combination of the simple signals. DSP systems use techniques based on Fourier's theorem to deal with the construction and decomposition of composite signals.](image-url)

**Signal types**

- audio (e.g., voice, sound, and music)
- video
- radio
- microwave
- images

**Note 1**

Another example is the radio spectrum, which is composed of hundreds of signals from radio and TV stations, aircraft, and so forth.

**Note 2**

Digital systems use techniques based on Fourier's theorem to deal with the construction and decomposition of composite signals.
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both discrete time and discrete amplitude. The first step of the conversion is accomplished by a process called sampling, which converts a continuous signal to a discrete-time signal.

A motion picture is a good example of sampling. The seemingly continuous motion of a movie is made up of a series of discrete-time images presented at a rate of 24 frames per second. The original action is sampled at a rate of 24 samples per second by the movie camera. The human eye reconstructs the original motion from the series of still images.

The second step in converting an analog signal to a digital signal is called quantization, which converts a continuous-amplitude value into a discrete amplitude value. The most common type of quantization is called uniform quantization.

Uniform quantization is simply a matter of putting the analog value of each sample into one of a set of possible bins. For example, if you are converting a voltage from 0 to 1 volts into an 8-bit number (values of from 0 to 255), each digital bin has a voltage range of 1/256 V, or approximately 0.0039 V. Bin 0 is used for voltage from 0 to 0.0039; bin 1 is used for voltage from 0.0040 to 0.0078; and so forth, as shown in figure 2. Clearly, quantizing the signal loses information and introduces quantization noise into the signal. The greater the number of bins, however, the less noise is introduced. This is why a 16-bit audio system sounds much better than an 8-bit system.

The process of sampling and quantization is called A/D conversion. The converter normally operates at a fixed sampling rate, measuring and quantizing the value of the signal once per sample period. These values are passed on to the digital system for storage and processing.

For multidimensional signals (e.g., a photographic image), conversion into the digital domain is accomplished by using a scanning process. This process generates a two-dimensional array of digital pixel values. Video uses a similar process called a raster scan.

**Time vs. Frequency**

You can represent and view signals in various ways. The two most popular representations are the time and frequency domains. The time domain shows the signal amplitude on the y axis and time on the x axis. Figures 1 and 2 are time-domain representations of signals. Time-domain representations show the signal within a particular time slice. You can see a continuous display of time-domain representation with an oscilloscope.

Often, you need to analyze the frequency content of a signal. For this, you must have a frequency-domain representation of the signal. This type of representation has amplitude on the y axis and frequency on the x axis (see figure 3). This representation shows the frequency components of the signal for a particular time slice instead of the time-domain representation. A continuous version of this type of display is often found on more expensive high-fidelity equipment. The equivalent to an oscilloscope for frequency domain is the spectrum analyzer.

The process of going from the time domain to the frequency domain is called a Fourier transform, a mathematical transformation based on Fourier's theorem. A naturally occurring example of such a transform is the prism, which takes in a composite signal—natural light—and breaks it up into the separate frequencies (i.e., colors) that are contained in the light. In effect, the prism is a signal processor.

In the analog domain, the amplitude of a signal at any given frequency is generated by a series of sharp filters tuned to progressively higher frequency bands. In the digital domain, the frequency content of a signal is calculated by using the DFT (discrete Fourier transform). An effective DFT algorithm is called the FFT (fast Fourier transform). This algorithm eliminates unnecessary or duplicate calculations from the DFT and produces the same number of frequency spectrum values as sample values.

**The Nyquist Theorem and Aliasing**

When designing a digital signal-processing system, an important consideration is selecting the sampling rate. If the input signal is band-limited (i.e., the frequencies in the input signal are below a frequency f), the input signal can be reconstructed from the sampled signal provided the input signal is sampled at least 2f times per second. Frequency f is called the Nyquist frequency. Thus, a 20-kHz bandwidth audio signal must be sampled at at least 40 kHz for it to be properly reconstructed.

Figure 2: Note the noise introduced by quantization. Sample 5 is placed in bin 4, and sample 6 goes to bin 2. The signal clearly passes in the range of bin 3, between these two samples, but the sample rate is too coarse to detect this.

Figure 3: Applying Fourier's theorem in the form of a Fourier transform allows you to move from the time domain to the frequency domain, where a composite signal is represented by the frequencies of its constituent simple signals.
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The introduction of DSPs (digital signal processors) has contributed immeasurably to speech-based applications. DSP power is used in many areas, including transmission-noise reduction; signal amplification; speech synthesis for text-to-speech conversions; speech recognition; and voice-message coding.

In text-to-speech conversions, the DSP processes ASCII text, generates a phonetic transcription, and produces the synthetic speech. In speech recognition, the DSP system, in conjunction with an A/D converter, acquires the speech, compares it to stored templates, and indicates what word was uttered. The applications determine how to process the recognition results.

**Voice Coding**
Coding has gained wide use in voice-mail storage. The idea is to let you record messages to a hard disk for future retrieval. Such voice messages, or even voice-annotated documents, can also be sent over networks. On request, you can retrieve, decode, and play back these messages.

Coding rates provide great savings in storage space, an important factor in applications such as dictation, voice annotation, PC-based automatic answering machines, voice mail, and digital telephone-answering machines. An uncoded voice file typically requires about 0.5 MB of memory for 1 minute of recorded speech. Using a DSP on the motherboard or on an add-in board can reduce the memory required by as much as 85 percent. And coding algorithms are a must when documents containing voice annotations are sent over a network or through a modem.

**The SBCELP Algorithm**
A number of different types of voice-coding algorithms are available. Lernout & Hauspie Speech Products of Belgium introduced a coding technique called SBCELP, which is based on a CELP (code-excited linear prediction). It performs coding and decoding of speech signals at fixed bit rates in the range of 2000 to 10,000 bps. After coding, the memory requirement for 1 minute of speech is reduced to a range of 15 to 75 KB. This is as much as a 30-fold savings in storage space over unencoded speech.

The SBCELP algorithm consists of three major parts, each one corresponding to a section of the human speech production system. In the first part, the STP (short-term prediction) analysis extracts the envelope of the input signal. This is performed via a tenth-order LPC (linear prediction coding) filter. The envelope corresponds to the first part of the vocal tract, from the lips to the vocal cords.

You can view the LPC filter as a succession of 10 acoustic tubes that represent the vocal tract. As the vocal tract is warped along the speech signal, the corresponding tubes are modified in length and diameter, furnishing new values for the LPC coefficients. (Because those coefficients are sensitive to quantization errors, the algorithm uses the LSP [linear-spectrum-pairs] coefficients, which are less sensitive to these types of errors.)

The second part of speech—the vibration of the vocal cords—is characterized by frequency, or pitch. The LTP (long-term prediction) analysis furnishes a value related to the pitch of the input signal.

The third part of a speech signal represents the excitation of the signal (i.e., the air coming out of the lungs). Determining the spectral shape of the excitation is important if you want to keep the natural quality of the human voice and avoid the metallic effect of digital-speech playback. To solve this problem, the algorithm determines the best possible excitation candidate for the excitation signal from among the reference signals. These references can be prefixed and stored in a dictionary or codebook, or they can evolve dynamically with the signal, as is done in the LHS SBCELP algorithm.

If you sample a signal below the Nyquist rate (sub-Nyquist sampling), you get aliasing: The sample points do not contain enough information to reconstruct the original signal. Aliasing causes frequencies in the input signal above the Nyquist frequency to generate undesirable frequencies in the digital signal. These frequencies form a mirror image around the Nyquist frequency. For example, if there is a 22-kHz signal in the audio before it is sampled at 40 kHz, the digital signal will contain an 18-kHz signal but not the 22-kHz signal. To ensure that aliasing does not occur, you must filter the signal to remove any components above the Nyquist frequency before it’s converted to the digital domain. This type of filter is called a low-pass filter because it passes all signals below a specified frequency.

You can see aliasing at work in a movie whenever the 24-frame-per-second sampling rate is too low to capture rapid motion. A well-known result is the effect of wagon wheels appearing to turn backward. In effect, there is insufficient information for the human eye to properly reconstruct the original signal.

**Signal Reconstruction**
Once a signal is digitized and processed, you often want to return it to the analog world so that it can be reconstructed to its original form. This can take place in real time, or it can be delayed. Playing a CD is an example of a delayed reconstruction of a digital signal.

A raw digital signal that has been passed through a D/A converter would normally be unsuitable for direct use, because the converted signal is a staircase function following the path of the original signal and contains many additional signals above the Nyquist frequency (see figure 4). According to the Nyquist theorem, you can use a perfect filter to reconstruct the original signal from the staircase generated by the D/A converter. A perfect filter passes all frequencies below the Nyquist frequency and blocks any signal above the Nyquist frequency. Such a filter has a pass-
To carry out this three-part coding on a DSP, you must first sample the analog speech signal at a frequency that varies according to the application. The speech quality offered by the telephone network is usually satisfactory for voice mail, answering machines, and voice annotations. In these cases, the sampling frequency chosen is usually 8000 Hz. Each sample can be represented by 8, 12, or 16 bits, which fixes the amount of memory needed to store a second of speech signal (64,000 bits, or 8 KB, in the first case). The digitized input signal is divided into successive frames of 15- to 40-millisecond duration, depending on the chosen final bit rate (from 2000 to 10,000 bps). The system performs an STP analysis. The corresponding 10 LSP coefficients are then quantified into a 24- or 32-bit number, depending, once again, on the bit rate. These bits are the code for the STP analysis.

At this point, each frame is divided into two, three, or four subframes for the computation of the LTP analysis and the dictionary search. The number of subframes is determined by the final bit rate. This allows you to deal with short frames (of about 5 ms) to keep the values for the pitch and the dictionary as precise as possible along the speech signal. This is necessary because of the continuously changing shape of the excitation and of the vocal cord's vibration frequency.

Obviously, there is a trade-off between the speech quality and the number of bits used to code the LTP analysis and the dictionary candidates. The number of bits allocated to each feature, linked to the size of the frame and the number of subframes, determines the bit rate. The existing values are 2400, 4000, 4800, 7200, and 9600 bps. However, any bit rate between 2000 and 10,000 bps can be adopted after some fine-tuning of the algorithms. Enhanced perceptual- and dynamic-filtering techniques enable the algorithm to keep good speech quality, even for bit rates as low as 4800 bps.

Coded speech is stored in 8-bit chunks. The decoding process enables the reproduction of coded speech in real time. The coding algorithm needs about 12 MIPS of computational power; decoding requires 1.5 MIPS. Numerous low-cost DSPs are available that can perform these tasks. Such processors will enable a new generation of speech applications.

Georges Zanellato is the R&D manager of speech and music coding at Lernout & Hauspie Speech Products. Bart Verhaeghe is the manager of the company's U.S. marketing operations. You can contact them on BIX c/o "editors."

Digital Filtering

There are many forms of filters in signal processing; they are classified according to the function they perform. For example, lowpass filters pass low frequencies while attenuating the higher frequencies. Highpass filters pass high frequencies and attenuate lower frequencies. Bandpass filters pass frequencies in a range, or band, while attenuating frequencies outside the band.

Filters are also classified according to the way they are implemented. One common implementation uses both the input and output samples to calculate the filtered output signal. Because you feed back the past output samples of the filter to compute the current output sample, you continuously recycle energy within the filter. This means that the response of the filter to an impulse (or spike) is infinite in length. This type of filter is called an IIR (infinite impulse response) filter.

IIR filters are often used because of their ability to create sharper transitions with little computation. However, one of the desirable attributes of a filter, called linear phase, is missing in an IIR filter. Linear phase refers to the characteristic where all frequency components of the original signal are delayed by the same number of samples before they arrive at the output. Another common filter implementation called an FIR (finite impulse response) filter uses only its input samples to calculate the filtered output signal. In this case, an impulse applied to the filter will die out after n samples, where n is the number of taps in the filter.

The advantage of FIR filters is that they are linear phase. Unfortunately, more computation is required to achieve the desired sharp transitions with this filter design.

Digital Storage and Real-Time Processing

Digital signals can be stored on hard disks for editing and playback. Although this is an obvious use of these signals, only recently have desktop computers had enough storage and processing speed to make this possible.

Processing-speed requirements can be divided into two major categories: real-time
processing and non-real-time processing (which is also called background, or time-share, processing). Real-time processing occurs when the process can accept or produce sampled data at the same rate as the conversion hardware. Furthermore, real-time processing implies a reasonable guarantee that the process will not be interrupted or late, so a continuous flow of data can be supported between the process and the conversion hardware.

Non-real-time processing is used to process data over a period of many hours or days. The results are stored in memory or on-disk and are analyzed or played back in real time. This type of processing is useful when insufficient processing is available to handle the desired function in real time.

Consider the processing required to handle stereo CD audio in real time. There are 44,100 samples per second per channel that must be processed. If the desired processing is a filter with 40 taps, each of which requires one multiplication operation and one addition operation (multiply-accumulate, or MAC), 7,056 million operations per second are required (two channels x 44,100 samples x 40 taps x two operations). This processing load can be handled by most modern-day DSP chips. However, a standard RISC or CISC processor would require many times this number of instructions per second to do this type of calculation, because separate instructions are required to access, load, and store the data. To process a similar video filter in real time, over a billion calculations per second are required. This is the reason most video signal processing is done with custom chips.

In addition to requiring a great deal of processing power, these digital signals take lots of space. For example, an hour of CD-quality music takes over 600 MB of storage, and a minute of video takes over 500 MB.

**Data Compression**

One of the most popular signal-processing functions is data compression. Signals can be compressed, or coded, to reduce their large storage requirements. There are two basic types of compression: *lossless* and *lossy*. These terms refer to the effect the compression algorithm has on the information in the original signal.

Lossless compression is used when a reconstructed signal must be the same as the original signal. A common example of lossless compression is disk file compression. Lossless-compression algorithms can usually compress digital data up to one-half to one-quarter of its original size. Some common lossless-compression algorithms are Huffman and Lempel-Ziv.

Lossy compression algorithms are used when the reconstructed signal does not have to be identical to the original signal. This is the case with audio, video, and image compression. These data types often have more information than can be perceived by the human receiver. Thus, the compression algorithm can afford to lose information.

Lossy compression can frequently compress digital data to as much as one-tenth to one-hundredth or more of its original size, depending on how much computation can be expended and the desired quality of the reconstructed signal. Lossy algorithms
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include ADPCM (adaptive differential pulse code modulation), CD-XA (Compact Disk Extended Architecture), and subband for audio; JPEG (Joint Photographic Experts Group) for images; and MPEG (Moving Pictures Experts Group) for both audio and video data.

Nonuniform quantization is also used for compressing signals. One of the most widespread techniques is called vector quantization. Instead of the signal being stored one sample at a time, a token representing an entire set of samples (called a vector) is stored. For example, if the sequence “one, two, three, four, five” occurs often in a signal, a token can be used to represent the sequence. This technique derives the correct set of tokens at the compression end and requires an enormous number of calculations. Decompression is fast, however, and requires only a simple table lookup. This allows the use of low-cost playback equipment to decompress the signal.

Sample-Rate Converters
It is often useful to convert a signal from one sample rate to another. This is generally required when passing a signal from one system to another. For instance, a signal recorded at 48 kHz on a professional digital tape deck may have to be converted to 44.1 kHz for storage on a CD. Another example of sample-rate conversion is when a signal is passed between an audio system and a telephone system. Each of these systems has a different sample rate, selected for optimum utility for a given function. Digital telephone systems typically use an 8-kHz sample rate, and digital audio systems usually use 44.1 kHz or 48 kHz.

Sample-rate converters are of two types: up converters and down converters. The up converter generates more output samples than input samples; the down converter does exactly the opposite. In either case, the computational process takes the basic form of a digital filter that removes aliases and unwanted out-of-band artifacts.

Adaptive Filtering
There are numerous cases where simple filtering is not effective or where the cost of the filter is too high for an application. In these cases, adaptive filtering is often used. An adaptive filter adjusts its parameters based on the content of the signal. In fact, adaptive processes can select from a set of possible filters, depending on the signal.

An interesting example of this is the CD-XA compression algorithm. In this technique, audio is broken up into blocks of 28 samples. Depending on the content of each block of audio, one of four different filters is selected that will best match the original signal during decompression. This takes substantial processing during the compression stage—each block must be compressed four different ways and then decompressed and compared to the original signal. The best match is selected, and the coded form becomes part of the compressed data stream. The filter selection is included in the data stream to allow the decoder to use the correct filter for that block.

The advantages of this approach are that the highest computation is required during encoding and that simple filters can be used during decoding. This is desirable because compression usually happens once at the production facility and playback can occur hundreds of times by many people in different locations. Similar operations can be performed with adaptive filters in noise-canceling and noise-reduction applications.

Future Signals
As digital signal processing becomes widespread and processing power increases, more focus will be placed on functions for personal computers and digital assistants that until recently were only dreams. Digital signal processing makes it possible for your computer to use multimedia information in real time.

You can look forward to a rapid proliferation of amazing new capabilities over the coming years based on the marriage of DSPs and standard CPUs. From speech recognition to real-time digital video, DSPs will change the way you interact with your computer.

Eric C. Anderson is manager of the Sound & Signal Processing Group within the Advanced Technology Group of Apple Computer (Cupertino, CA). Stephen Shepard and Phil Sohn are members of the group. You can contact them on BIX c/o “editors” or on AppleLink as “anderson13.”

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The integration of DSP technology on the desktop is already under way

JOHN BRYAN

The integration of DSPs (digital signal processors) on the desktop, either as an add-in board or as a part of the motherboard, brings technologies such as continuous speech recognition closer to everyday reality. And programmable, powerful signal processors are being used for various other new applications.

DSP technology has been available for quite awhile, but until now, only specialized applications (e.g., disk head positioning, spectrum analysis, dedicated audio and video processing, and PBX systems) have migrated to personal computers. With recent advances in hardware, firmware, and software, signal processing is moving into desktop applications that will bring excitement to business computing.

The DSP Difference
What is the difference between a standard CPU and a DSP? There are architectural differences, certainly (see “Inside Signal Computing” on page 177), but the fundamental difference lies in the ability of the DSP to handle real-time data streams generated by sampling analog data patterns. By their nature, signals are constantly changing. If a computer is unable to act on the data as it happens, the computational results, if any, will be invalid. So, signal processors must be able to quickly interpret and react to data and perform the necessary calculations, such as multiply and accumulate.

One of the main advantages of integrating a DSP with a standard CPU is that such an arrangement can provide concurrence of signal-processing operations with respect to general computing tasks. A DSP isn’t inherently any faster than a similarly...
clocked CPU, but DSPs excel at particular functions. The relationship between a DSP and a CPU in a desktop system is analogous to that of a math coprocessor and a main processor. A fixed-point 386 can do all the floating-point calculations that the 387 would normally handle, but the 387 is a lot faster. The same is true for DSPs. For example, for the types of calculations that call for signal processors, Texas Instruments claims that its TMS320C 16-bit fixed-point DSP can deliver three to five times the MIPS of a 386 CPU.

DSP Data
One of the most important facets in determining how to implement a DSP application is ascertaining the sampling rate for data. Speech—at least at the quality you hear over the telephone—is one of the less demanding DSP applications from a processing point of view. A microphone, which is a transducer that converts sound waves into voltage levels, is the most common data source. The data flows into an A/D converter, which produces samples of the data 8 bits wide at the rate of 8 KHz, or 8000 times a second. A DSP takes this data stream and performs whatever calculations the software calls for. The output goes to a D/A converter and then to a speaker, which turns the electrical signal back into sound. If this data goes to disk, it takes up about 8 KB of disk space per second of speech.

ARTA is a multiprocessing system that supports multiple DSPs.

An 8-KB-per-second sampling rate is about as low as you can go and still get decent sound quality. CD-quality sound must be sampled at a faster rate (up to 44 KHz), and the word size of the sound bytes should be 16, 24, or 32 bits. Storage requirements scale accordingly, with typical high-quality stereo sound taking up to 176 KB per second of sound.

Sound is a lightweight in the consumption of storage capacity. Real-time video can require as much as 1 MB per second, which quickly fills up a 40-MB hard drive. In fact, one of the primary uses of the DSP in an application is the compression/decompression of the data stream as it moves onto and off of the disk.

Given that DSPs are adept at handling speech and video data, it's not surprising that the prime motivation for using DSPs in personal computers is multimedia applications. In fact, without DSPs, true multimedia would remain a pipe dream, because general-purpose CPUs just don’t have the horsepower to handle multimedia data effectively.

DSP on the Desktop
Next (Redwood City, CA) was the first major system manufacturer to recognize the value of bringing DSP technology to the desktop. It has included DSP hardware and the necessary operating-system support in every workstation it has produced. Next uses the Motorola 56001, a 24-bit
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processor with expandable local RAM, to support the multimedia efforts of their ISVs (independent software vendors). Next's object-oriented NextStep operating system also includes objects for audio and video data manipulation, ISDN telephony, CD sound (you can listen to your favorite music while you're computing), and other functions.

Another system manufacturer with a commitment to using DSPs is Apple (Cupertino, CA). Apple has always emphasized the value of quality sound in a computing environment, but it has only recently announced its intention to integrate a full-fledged programmable DSP into the Mac platform. Apple started the project in 1987, and after trying synthesis chips, phase-locked loops, and static-program DSPs, the company finally decided that it needed a fully clean, 32-bit, big-endian, byte-addressing processor (e.g., the 68030 and the 68040).

Apple has teamed up with another industry giant, AT&T, to produce ARTA (Apple Real-Time Architecture), a real-time multitasking and multiprocessing signal-processing extension for the Mac. The goal of this DSP architecture is to provide a scalable standard platform for most types of signal processing, including speech, sound communications, image processing, and music.

ARTA features the AT&T DSP3210 processor, which is a fully programmable 32-bit DSP with on-board cache and a 32-bit bus to local static RAM or to page-mode DRAM. The DSP3210 is capable of clock rates of up to 66.6 MHz. ARTA’s kernel is only 512 words (2048 bytes) and takes up one-quarter of the DSP3210’s on-chip memory.

The platform’s software component is composed of two parts. The host portion takes care of management functions, and the DSP portion performs real-time data-stream processing.

ARTA is actually a dual API system. In System 7.0, developers work with the API Toolboxes, which use drivers that link to the hardware of the Mac. For DSP applications, there is the DSP Module (a toolbox equivalent), which links the DSP kernel to the DSP hardware. With this dual-API system, the DSP programmer can write code without knowing or using any Mac code, and the Mac application developer can produce software that takes advantage of the DSP without knowing or using any DSP-specific code.

ARTA is a multiprocessing system that supports multiple DSPs. Apple will supply DSPs only as a part of the motherboard, not as NuBus cards, although it will license ARTA to NuBus developers. Applications developed under license from Apple will operate seamlessly within the ARTA environment. And Mac systems with integrated DSPs will be available next year.

Apple has an array of uses planned for ARTA. Besides digital audio functions (e.g., compression, noise reduction, and

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mixing), Apple plans to promote the development of speech and communications programs. Speaker-independent speech synthesis and speech recognition are an exciting step toward creating the first truly user-friendly human-computer interface. With this feature, a computer could tell a novice user, in English or in any other language, exactly how to set up the system to best suit the environment and proposed uses. Other possible applications are voice-edited documents, video teleconferencing, stereo A/D converters, and telephone AIC interfaces.

**Twin Peaks**

In addition to working with Apple on the Mac platform, AT&T has also come up with a DSP solution for MS-DOS computers. VCOS (Visible Caching Operating System), AT&T’s operating system for the DSP3210, is multitasking and resides in the memory local to the signal processor. Developers can use the VCOS and VCAS (Visible Caching Application Server) modules to integrate AT&T’s DSP technology into general-purpose computing systems. And VCOS relieves applications programmers and system integrators from having to deal with the complexities of DSP programming.

Not to be outdone, IBM (Armonk, NY) has also announced its intentions to get into the personal computer DSP market. IBM has formed an alliance with Texas Instruments and Intermetrics, a software development company, to bring out a product called the MWave (see photo 1). IBM will first be producing a plug-in board for the ISA or Micro Channel architecture bus, but it also has plans to produce PS/2 systems with DSP technology on the motherboard by mid-1993.

TI engineered the DSP chip used in the MWave. The TMS320M500 delivers 17-MIPS performance in a 16-bit data fixed-point package. The processor has seven lines for serial data input and a bus data line (which is host-specific) and multichannel DMA for all I/O. Although the chip deals with 16-bit data, the program memory bus is 24 bits wide. The DSP is integrated into a board that includes a MIDI port, a UART (universal asynchronous receiver/transmitter), stereo A/D converters, and telephony AIC interfaces.

TI will develop an OEM distribution channel for the MWave, offering it to system manufacturers for integration into their motherboards. At this fall’s COMDEX, TI was scheduled to announce a DDK (Driver Development Kit) with sample drivers for speech, audio, and telephony.

Operating-system support is provided by IBM, whose Burlington, Vermont, product group developed a multitasking operating system for the MWave project. This embedded operating system, the MWave DSP manager, sits on top of OS/2 or Windows and can handle functions like JPEG (Joint Photographic Experts Group) video compression, voice recognition, data and fax modems, echo cancellation, music, and text-to-speech conversion.

The MWave DSP manager is a virtual device driver that provides a high-level API for digital signal processing in either environment. This API is the platform that provides a socket for device drivers. IBM wants to use this technology to increase desktop functionality—integrating the fax, telephone, dictation machine, and other office appliances into the PC.

IBM’s objective is for this product to become as pervasive as the math coprocessor. For this to occur, application development will have to proceed at a pace with the development of support hardware. To further this end, IBM is out to enlist the support of major software development houses, such as Microsoft, Borland, Lotus, and WordPerfect.

To support the creation of all these applications, Intermetrics was tagged to come up with the development tools for the programmer. What it’s providing is a standard ANSI C software development kit, complete with language, compiler, assembler, debugger, and a set of programming tools that are generic to the world of C programmers. A provider of DSP applications for the space-shuttle program, Intermetrics has been in the business of developing system application software for embedded systems for 23 years (until recently, most DSP applications were implemented in embedded systems).

One of the more helpful tools in the MWave environment is a nice visual debugger that enables you to trap signals coming in to the DSP in real time and observe their interaction with the host application. Intermetrics will provide one set of tools for Windows and another for OS/2.

**DSP and Communications**

Besides the major systems vendors, other companies, of both hardware and software orientation, are in the desktop DSP market. Many of them, especially the software firms, create products for Next workstations, mainly because Next has had integrated DSP support longer than anyone else. But many vendors have produced hardware/software solutions to specific vertical markets (e.g., radar research or digital instrumentation) for both the PC and the Mac platforms, and many more are moving in this direction, as DSP technology becomes more of a standard than a standout.

This year, Hayes Microcomputer Products (Atlanta, GA) announced the Hayes ISDN Extender, a network-interface module that provides ISDN Basic Rate Access and analog telephone-line connectivity to Next computers. The ISDN Extender can be used for remote LAN connections and...
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Photo 2: The Lightning Effects I Macintosh accelerator from Spectral Innovations targets specific applications. This product provides enhanced performance for image-processing applications.

high-speed digitized voice, data, and fax modem, as well as other multimedia functions (e.g., video transmission).

Ariel (Highland Park, NJ) is another vendor that has concentrated its efforts in the Next market, for which it makes a wide range of products, from the $500 Digital Microphone to the $15,000 IRCAM signal-processing workstation. Even though the Digital Microphone, ProPort, and DAT-Port all deal specifically with CD-quality sound and use the Nextstation's own Motorola DSP56001 DSP, the IRCAM and the QuintProcessor each feature their own DSPs. The QuintProcessor contains five 27-MHz 56001 DSPs, four of which handle DSP functions while the fifth manages on-board memory, storage, and interprocessor communication. The IRCAM uses two Intel 860 RISC processors to provide a parallel-processing environment, with a 56001 DSP for data I/O. The IRCAM also comes with its own operating system, CPOS.

Metaresearch (Portland, OR) is a software firm whose products Digital Ears, SoundWorks, and Color Digital Eye can be used creatively in multimedia presentations. SoundWorks is essentially a sound mastering board, a digital version of the professional mixing board that you might find in any recording studio. Digital Ears is a stereo digitizer that captures CD-quality sound for the Next. And Color Digital Eye is a video frame grabber for entering and editing video images.

Another company that concentrates on sound, music, and professional recording is Digidesign (Menlo Park, CA). Digidesign has been producing products for the Mac for three and a half years, although it does not target the Mac user as much as the recording engineer or broadcast professional. Its three products (Audio media II, Sound Tools II, and Pro Tools) combine the Motorola 56001 with high-end software to do stereo or multitrack recording and mixing functions (e.g., compression, waveform editing, equalization, chorusing, echo, and pitch shifting). They can also do SMPTE (Society of Motion Picture and Television Engineers) synchronization.

Processing Pictures

Giga Operations (Berkeley, CA) is a start-up company whose aim is to develop a low-cost, massively parallel digital signal-processing board for desktop computer systems. GigaOps uses the Analog Devices 2105 DSP, a 16-bit processor rated at 10 MIPS. Giga Operations puts four 2105s, 1 MB of DRAM, and a Xilinx PGA (Programmable Gate Array) into a single
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SIGNAL COMPUTING

A surface-mount module called a SIIMOD (Scalable Intelligent Image Module). Each of the SIIMODs provides 40 MIPS of signal-processing power. The end product, an ISA bus card called the T-800, supports up to eight of these modules, for a total power throughput of 320 MIPS, with 32 DSPs and 8 MB of RAM. With four cards in one system, the total processing power becomes 1280 MIPS, hence the company name.

Giga Operations is targeting the image-processing market. Its long-term goal is the execution of real-time math-intensive image processing at the read/write rate of a fast hard drive. To do this, it provides a proprietary C compiler called the Stream Splitter, which takes the serial data stream of signals and converts them for operation in parallel mode. One of the slick features of the T-800 is that the PGAs allow the user code to dynamically configure the board in real time (on the order of microseconds). Thus, alternative virtual machines can in parallel take advantage of resources as they are required.

Spectral Innovations (Santa Clara, CA) has been making DSP accelerator cards for the Mac since 1988. Like ARTA for the Mac, its cards use AT&T signal processors. But unlike Apple, the company makes a NuBus card with separate software modules for a variety of DSP functions (see photo 2).

In the past, Spectral Innovations focused its attention on the technical marketplace (e.g., signal analysis), but now it’s in the process of producing more mainstream application modules. It intends to announce a fax/modem/telephony module by the end of the year, and it has a number of other projects in the works. The company provides a development environment with each card, and other vendors have made modules that use their hardware to accelerate Adobe Photoshop, LabView, IPLab, and MatLab.

From a consumer’s point of view, one of the terrific things about the integration of DSP technology onto the desktop is that each function—whether it is audio, video, modem/fax, or some other tool—essentially exists as a virtual machine. The underlying hardware does not change while the application software creates the product. Besides keeping the cost down by reducing the number of pieces of hardware you must buy to accomplish various tasks, this could also reduce the size of the host system, especially as DSPs are integrated onto the motherboard. This also simplifies the upgrade process, because vendors need only send another disk to fix bugs or provide new functions.

Forging Ahead

CPUs are not up to the task of working with audio and video data. There are just not enough MIPS available. For now, the best way to handle multimedia data is to add a DSP to your system. You will see more system and peripheral vendors adding DSPs to their products in the coming year.

The logical next step, of course, is the integration of a DSP into general-purpose microprocessors. With advances in chip integration and with the 80x86-architecture vendors trying to differentiate their products from their competition, the addition of DSP functionality to an industry-standard CPU is inevitable. In many ways, DSPs are poised to become the math coprocessors of the 1990s.

John Bryan is a freelance technology writer and consultant based in San Jose, California. You can reach him on BIX clo “editors.”
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DSPs are designed to perform a limited number of functions quickly. The best way to turn an ordinary computer into a multimedia master is to add a digital signal-processing chip. These chips provide the ability to create and modify complicated video and audio signals in real time. That’s why every Next machine is sold with a DSP (digital signal processor) on board, why IBM and AT&T are centering their multimedia offerings on DSPs, and why future Macs will come equipped with them.

What do DSPs do that is unique? Nothing, actually. Standard chips such as the 486 can do everything that a DSP does—just not as fast. Conversely, a DSP can do most things that a standard microprocessor can, but in most instances, a DSP would be much slower than a general-purpose CPU. Occasionally, it would even be incapable of handling certain problems.

The secret of the DSP’s success is the modification of standard microprocessor architectures, which greatly enhances the chip’s ability to compute the operations common in digital signature processing. The canonical signal processing function is the weighted sum. This is usually called a digital filter, or a vector dot product. One simple application of this function is noise reduction via smoothing by averaging the last i values of the signal. Most signal-processing functions are more complex, but by providing an architecture geared to handling this class of problems, DSPs easily outshine general-purpose CPUs.
Architectural Highlights
DSPs contain special addressing features and beefed-up data buses that allow them to keep up with the flow of data and compute signal-processing functions quickly. Many general-purpose DSPs are on the market, and each of them has a different approach to finding the fastest way of moving bits in and out. The differences between a standard microprocessor and a DSP are usually found in four categories: instruction sets, addressing modes, interrupt structures, and structural changes.

Many of the examples in this article are taken from the architecture of the Motorola 56000 and Analog Devices' line of signal processors, but DSPs made by companies such as Weitek or Texas Instruments share many of the same features. This article concentrates on the architectural themes shared by most DSPs.

Instruction Flux
The easiest way to get a processor to compute weighted sums quickly is to add one instruction that computes \( v_1 \times v_2 + v_3 \rightarrow v_4 \) quickly. \( v_3 \) and \( v_4 \) are usually the same register or a memory location called the accumulator, and it holds the partial total of the weighted sum as it's calculated term by term. \( v_1 \) and \( v_2 \) hold the weight and the value of the function. A digital filter can be computed by stringing together a number of these operations.

Adding this instruction to a processor forces you to make changes to standard processor architectures. Most DSPs devote a large section of silicon to a multiplication unit that can multiply \( v_1 \) by \( v_2 \) in one instruction cycle. This unit is often pipelined to save silicon space. In contrast, early versions of the Sun SPARC processors did not have a multiplication instruction. The compiler would simulate the multiplication out of shifts and additions. This points out a major difference between DSPs and CPUs: General machines spend more time moving information and bits around than they do multiplying them; DSPs spend their lives doing multiplication, so it pays to devote a lot of silicon to this feature.

The basic \( v_1 \times v_2 + v_3 \rightarrow v_4 \) instruction takes three values from a register file and sends one back. A general DSP could execute the instruction when \( v_1 \), \( v_2 \), \( v_3 \), and \( v_4 \) are different registers, or memory locations. This would make it easier for the compiler to reduce complex arithmetical expressions to machine code. RISC architectures often place no restrictions on the use of registers for just this purpose.

The architectural cost of this approach, though, is often too high, even in the age of 3-million-transistor chips. You would need three data buses on the chip and extra circuitry to handle all the general cases that might come up. In almost all cases, however, the generality wouldn't be used by a DSP processing filter, which usually includes instructions where \( v_3 \) and \( v_4 \) are the same register. For that reason, many

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DSPs include a special accumulator register and can process only functions of the form $v_1 * v_2 + \text{ACC} \rightarrow \text{ACC}$ (where ACC is the accumulator register). This accumulator is usually twice as big as a regular register to avoid rounding off the results of the multiplication after each step.

Another important addition to the instruction set of a DSP is the loop counter. A general microprocessor must be ready to execute while loops, where a block of code is executed until a specific test is satisfied. Loops that execute a set number of times are only a fraction of the loops in general code for RISC or CISC CPUs. Filter functions, however, almost always use a set number of passes through the loop. In many cases, there is only one multiply-and-accumulate instruction in the middle of the loop. The extra test-and-branch instruction executed at the end of each pass through the loop takes considerable time, and the time spent on this can nearly double the execution time of the loop.

The solution is to add a special counter that can be set at the beginning of the loop. At each pass through the instructions in the body of the loop, the counter is decremented and compared to zero in parallel. This allows the loop to execute as fast as the instructions in the body of it because the increment, test, and branch instructions are handled at the same time the main body is executing. The extra circuitry involved in this loop counter is extensive, but it's worthwhile because DSP applications are heavily devoted to tight loops of predetermined length.

Some DSPs, like those from Analog Devices, include special barrel shifters that speed computations of functions (e.g., the fast Fourier transform). These allow the programmer to quickly shift a word of data over several bits.

The DSP difference

- single-instruction multiply-accumulate
- multiple data buses
- programmer-accessible caches
- specialized interrupt schemes
- loop-optimized addressing

Address Change

The architects who design DSPs also look at the pattern of memory references to determine the quickest way to increase the throughput of data. The standard addressing mode of a RISC microprocessor is to load a value from a direct address. Older CISC architectures (e.g., the 80x86 and the 680x0) also include indirect addressing modes, where a pointer is followed and occasionally incremented. These modes are usually supported by a DSP.

However, DSP designers also included stranger addressing modes that are immediately useful for implementing filter functions on the DSP. In most cases, a DSP takes a signal at time $t$ and computes a filter function over the previous $i-1$ values. The best way to store these $i$ values is as a block of $i$ words of memory. At time $t$, the signal value is stored in word $t \mod i$ ($t \mod i$ is what is left over after dividing $t$ by $i$).

Many DSPs include a modular addressing mode that will look up a value at a location and an offset; increment the offset; and if the new offset is greater than the size of the buffer, reset the offset to zero. It can do all this in one instruction cycle.

continued
This work is handled by a separate ALU for computing the addresses. RISC systems, in contrast, have only one addressing mode to remove the need for the extra ALU, and processing a circular buffer takes many extra cycles. Here is the string of instructions that would handle this for a RISC processor:

\[
\begin{align*}
  t &\leftarrow t+1; \text{ increment time} \\
  r1 &\leftarrow t \mod i \\
  r2 &\leftarrow \text{base}+r1; \text{ add offset to base} \\
  \text{store value in } r2; \text{ store it away}
\end{align*}
\]

Another popular but seemingly strange addressing mode of DSPs is to reverse the bits. For example, an address such as 18 (1010 in binary numerals) is interpreted as 5 (0101 in binary numerals)—in a chip, the addresses take up the full word: 32 bits. This simple flip makes programming fast Fourier series expansions quicker—often as much as 10 times faster than on a similar RISC chip with the same cycle time and MIPS rating. It should be easy to see why when you imagine trying to reverse the bits in a word using standard RISC operations.

### Double-Decker Buses

Getting information on and off the chip is a problem for any microprocessor designer, but DSP architects have made changes to standard processor design that have tuned these chips for high-speed data transfer. The most obvious change is splitting the processor/memory interface into an instruction stream and a data stream. This is an easy modification to make because DSPs often use small looping programs that process large streams of data. This allows the programmer and the processor to optimize the use of both of these paths.

Many DSPs from Motorola, Analog Devices, and other companies take this one step further. They have two data buses that grab data from the main memory simultaneously (see figure 1), which lets the chip read the two operands to be multiplied in the weighted sum in one step. This significantly increases the speed of the DSP because it reduces the bottleneck between memory and the processor.

DSPs don't go the next logical step (i.e., adding a third bus to write the data) because most filter functions take many inputs for each output. Not as much information flows in the other direction.

A traditional microprocessor (see figure 2) has a cache that lies between the chip and the main memory. This cache keeps a copy of the last \( n \) memory items that were referenced by the processor. Thus, it's able to supply these items to the processor faster than the main memory system can.

Caches work on the principle that much of the data that is touched by the processor is often reread a short time afterward. DSPs, on the other hand, have different access patterns. Most data comes into the chip once, and the result computed from the data leaves immediately afterward. When the data is reused, it's often done in a predictable way that can be exploited by the programmer.

Smoothing filters that use circular arrays, for instance, look only at the last \( i \) values of the function. Caches could keep track of these values, but it's better to leave this functionality off the chip because the circuitry required to determine the oldest values in the cache takes up silicon and adds a delay to the data bus.

This is worth the trouble in a general chip, where the complex data-access patterns would not be easily anticipated by the programmer. With DSPs, however, speed is so important that the optimization
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of performance in tight loops and other areas that normally fall to a cache is handled by the programmer.

DSPs often provide a small amount of local memory. For example, the Motorola 96000 has two banks of 512 32-bit words—one for each incoming data bus. The programmer can access each of these banks directly and arrange the access pattern of the program to keep the necessary data on the chip. Someone calculating a smoothing filter would keep the circular buffer in this memory space. A program that did not reuse the data, though, wouldn’t use this special cache.

The instruction stream is handled in much the same way for similar reasons. The chips often provide a small amount of on-chip memory to hold small loops, and it would be possible to include the cache hardware to do this automatically. But that takes circuitry, and a cache cannot do the job as well as a programmer.

Here is one obvious case. Imagine that a program spends most of its time in a small loop that adds reverb to a guitar signal. After every million times through the loop, the programmer/composer slightly tweaks the weights used in the filter functions. When it goes to do this tweaking, a cache would dutifully load the recalibration code on top of the loop. This would slow the system down when it returned to the loop. A programmer, however, would be able to properly allocate the small on-chip instruction memory to avoid this delay. In most cases, programs that run on DSPs have a simple enough structure that programmers can easily predict the pattern of instructions and subroutines.

Making Connections

Many DSPs also include several ports for communicating with other chips. Both Analog Devices and Motorola’s DSP chips have two serial ports for exchanging data with modern chips, A/D converters, and other DSPs. These two lines allow the DSP to maintain its own connection with the outside world without bothering the main CPU. It can get a signal from a modem and interpret it, notifying the main CPU only when the data is ready for consumption.

In the most high-end signal-processing implementations, several DSPs are linked in a long chain. These arrangements can do many different calculations, including complicated matrix operations. But in most cases, each DSP is responsible for its own filter function, and the result of one DSP is fed into another.

Floating-Point vs. Fixed-Point

General-purpose CPUs usually handle two types of numbers: integers and floating-point values. In many cases, however, they don’t explicitly support floating-point calculations in hardware, because most tasks don’t require them. You may need a special floating-point chip (e.g., a 387 or a 68882) to handle floating-point values.

For the same reason, DSPs often come in two flavors: fixed-point and floating-point. Fixed-point DSPs are a cross between integers and real numbers that provide only a fixed level of precision. An example of such a fixed-point system is the U.S. monetary system. Dollars can be broken down into numbers that have only two decimal points of precision. The complexity of the mathematics is closer to integer arithmetic than floating-point arithmetic, because the fractions can be easily converted into integers. For instance, you can do integer arithmetic on U.S. currency by converting everything into cents.

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handle wide ranges of numbers, though. They must be able to multiply $1 \times 10^{10}$ with $2.2 \times 10^{10}$ and find the right value. This requires large shifters that can shift the bits of the two numbers until they align correctly for the operation. This takes space and adds plenty of complexity.

Why have fixed-point chips? Most DSP operations involve plenty of fractions, and the fixed-point representation makes life easier for the programmer who would rather not convert everything to integers. In fact, overflows and underflows are the only big differences a programmer will find between fixed-point and floating-point DSPs. The programmer must watch for numbers that get too big or too small and trap for them.

**Interrupts**

One of the most important jobs of a DSP is processing data in real time. It must be able to handle information from an instrument like a seismometer while the ground is still shaking.

Standard CPUs come with an interrupt structure, which allows other hardware to get the CPU's attention. These general systems are designed to be used in many ways. When the interrupt is called, the state of the system is saved, and the process jumps to a new location determined by the operating system. When the work is done, the interrupt system restores the old state and gets back to work. This is simple, and it handles all possible cases that come its way.

The DSP, however, must handle incoming data without slowing down the process. That's why most DSPs come with a special interrupt mode that inserts a small number of instructions into the standard instruction stream. For example, the Motorola 56000 allows the programmer to define two general instructions as the interrupt. When the signal arrives, the two instructions are placed at the top of the pipeline, and the standard instruction stream is held up for two instructions. Usually, these instructions are enough to grab a value from one of the serial ports and store it in memory. This type of interrupt can be dangerous, because the two instructions can do anything to the state of the machine. When it's used correctly, though, it keeps the data coming in as fast as possible.

**A Workhorse for the 1990s**

DSPs are becoming popular for attacking problems that involve heavy number crunching. The architecture is tuned to get data onto the chip, do multiplication and accumulate instructions, and get the data off-chip as fast as possible. The modifications in the standard processors' instruction set, data buses, and interrupt structure are simple and general enough to be useful in a number of special applications (e.g., matrix multiplication or neural networks).

In one sense, DSPs are the last thriving remnants of CISC architectures. The chips include many special-instruction formats that are useful for frequently occurring instructions. These features are difficult for a compiler to use efficiently in all cases, but this is not a limitation because DSPs spend most of their time in small loops that programmers can hand-tune in assembly code.

An ordinary computer can be converted into a multimedia master by adding a digital signal-processing chip. The popularity of multimedia applications could make DSPs as popular in the 1990s as math co-processors were in the 1980s.

Peter Wayner is a consulting editor for BYTE. You can contact him on BIX as "pwayner."

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The primary data types of this environment are voice, audio, wired and wireless communications streams, and video. With such a platform, you can bring real-time multimedia applications (e.g., digital photography, high-speed image compression, language translation, and teleconferencing) to the desktop.

Multimedia Signals

Many of the above applications already exist. However, each one usually has its own proprietary plug-in hardware platform, with its own signal processor, memory, signal I/O peripherals, proprietary host interface, proprietary applications monitor, and proprietary applications code. Because these were developed as stand-alone, fixed-function applications, it is expensive and difficult to incorporate them into other personal computer-based software.

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Signal-Processing Data Types

The major difference between signal processing and data processing is the real-time nature of the data being processed. Real-time data is simply a signal (e.g., an audio waveform) that is sampled or generated in real time. Signal processors are designed to handle the unique numerical requirements of processing real-time data and to interface with real-time signal-acquisition components.

Modern systems compress data into real-time communications streams to fit narrowband channels. Similarly, high-speed wired networks, infrared LANs, mobile radios, and satellite RF links use signal processors to compress and decompress data in real time. If a real-time processor fails to process a millisecond or two, the consequence is lost signals, resulting in garbled voice or corrupt data.

Voice applications (e.g., cellular phones and digital answering machines) require real-time signal I/O at frequencies as high as 8 kHz for compression and up to 16 kHz for speech recognition (to capture the high-frequency voice tones, such as an s). Audio applications (e.g., digital stereo playback, music synthesis, and digital stereo recording) require real-time signal I/O at frequencies as high as 48 kHz to capture high-frequency audible signals, such as crashing cymbals. And motion video requires real-time signal I/O at frequencies between 1 and 30 MHz, depending on the size and update frequency of the image.

Many other real-time signal-processing systems (e.g., noise cancellation and encryption) require lossless I/O. The lossless characteristic of real-time signal I/O places burdens on the signal processor, especially on its architecture, I/O peripherals, and interrupt capabilities. The signal processor needs the computational bandwidth...
to process the signal data within the sampling frequency. Although data processors can handle some real-time signal applications, they were not designed for these tasks.

**Signal I/O**

To incorporate real-time data types into a personal computer, you need real-time signal I/O ports or mixed-signal peripherals. Such devices preserve the information contained in a signal while transforming its format into one appropriate for the next stage in its journey—for either processing or transmission. They must be capable of sampling the signal stream at a frequency appropriate for the data type and signal processors are the engines.

Third-party companies are integrating audio-band I/O ports into the A/D-signal-processing platform. Wireless communications and video I/O ports (e.g., base-band I/O and infrared/RF components, video-capture boards and scanners, and real-time video-compression components) will be designed into the integrated personal computers of the future. Note that the performance of these signal I/O ports is just as important to signal computing as the performance of the keyboard, disk drive, mouse, and display is to personal computing.

PSTN (public switched telephone network) applications on a personal computer (e.g., modem, fax, and speech) require a direct-interface, single-chip, echo-cancelation front end. This component must handle standard sampling frequencies and include on-chip resampling/interpolation filters for real-time signal synchronization and phase adjustment.

Voice I/O applications require a linear voice-band codec that provides a direct interface with a signal processor, a microphone, and an amplified speaker. The codec should offer on-chip anti-aliasing and anti-imaging filters and good group-delay characteristics that simplify acoustic echo cancellation when the signal is to be broadcast in mobile (i.e., wireless) computer environments.

Audio applications require a single-chip, 16-bit, stereo audio-band codec, which provides a direct interface with the data processor or signal processor; stereo line-level inputs and outputs; stereo microphone-level inputs; and speaker outputs. The audio codec should have on-chip programmable gain amplifiers and automatic-calibration circuitry, as well as support the full spectrum of personal computer audio-sampling frequencies between 8 and 48 kHz.

**Signal I/O ports will be designed into the integrated personal computers of the future.**

Signal I/O ports must also be fully integrated and designed to provide the functionality required by a wide variety of applications for a given signal data type. They will be fabricated with CMOS-process technology at both 5-volt and 3-V levels to enable the signal ports’ integration into the chip sets of the future.

**Signal-Computing Applications**

Today, signal processors are pervasive in communications systems such as high-performance modems, digital mobile radio, digital cordless telephony, satellite communications, and videophones. Narrowband communications channels require the compression and reconstruction of data, and signal processors are the engines.

Voice and data compression are also used in such applications as voice mail, digital answering machines, and data compression for floppy/hard-disk conservation. Real-time data types take up a lot of hard disk space. Even compressed, a minute of motion video can fill a hard drive. More efficient algorithms are being developed to reduce channel usage and data-storage costs.

Digicom Systems, Specom (Santa Clara, CA), and Lernout & Hauspie Speech Products (Ieper, Belgium) are the first IAVs to provide data- and voice-compression technology for communications applications within the signal-computing environment. Digicom provides modem and fax capability. Specom provides CELP (code excited linear prediction) and TIA IS-54 VSELP voice compression capability. And LHSP provides SBCELP.

Signal processors are pervasive in speech-recognition and speech-synthesis applications (e.g., voice navigation, hands-free/eyes-free control, security access control,
The essence of signal computing lies in the integration of three fundamental competencies into a signal-processing solution: signal I/O ports, signal-processing software, and a reprogrammable, digital signal processor.

The signal I/O ports capture or generate the applications' signals, converting them back and forth between the analog and digital domain. In the figure, there are three signal I/O ports: a SUI (Sound User's Interface), which provides voice- or audio-quality I/O; a PSTN (public switched telephone network) interface, which connects to the phone lines for modem and fax I/O; and a TDMA (Time Division Multiple Access) peripheral, which connects to infrared/RF transmit and receive components for wireless communications.

The algorithm software performs the mathematically complex and intensive signal-processing algorithms. The figure shows algorithm code for a fax/data modem, MPEG audio compression, JPEG image compression, and speech recognition. When not in use, the code resides on the personal computer. It's downloaded as necessary by the host processor.

The signal coprocessor provides the mathematical horsepower to process the signal-computing algorithms. It has support circuitry to interface with the signal I/O ports, as well as with a host...

Using the abstraction of a multimedia API, the signal processor and its algorithms are invisible to host-based applications. Interprocess communications between the signal-computing platform and the host are bus-independent, letting the signal processor reside on a motherboard, on an expansion card, or in a peripheral device.
Signal processors will soon be found in car audio systems for improving stereo imaging.

Signal processors are widely used in audio and electronic music. Music synthesizers use signal processors as envelope generators and as digital oscillators to create various voices and such effects as tremolo and pitch blending. One of the first applications of signal processors was in professional audio for delay and artificial reverberation. Now DPs are also being applied in consumer audio for such functions as surround-sound decoding and equalization. In the near future, signal processors will be found in car audio systems for canceling noise or improving stereo imaging.

One IAV working in this area is EuPhonics, whose first algorithm toolkit will be an implementation of Dolby Laboratory's AC-2 audio-compression algorithm, which provides a 6-to-1 reduction of storage requirements for CD-quality audio, with no audible degradation of the sound. EuPhonics also plans to offer unique digital synthesis algorithms that will improve the quality of FM synthesis components that are used in popular add-in cards, such as SoundBlaster from Creative Labs (Santa Clara, CA).

Digital Imaging
Signal processors are widely used in static imaging (e.g., graphics accelerators and digital photography), CAT scanners, magnetic-resonance imaging, satellite imaging, and bar coders. They are also used in real-time imaging applications, such as videophones, radar, and sonar.

One IAV with offerings in the imaging field is Xing Technology (Arroyo Grande, CA), which will initially provide CCITT JPEG (Joint Pictures Experts Group) image-compression algorithms and CCITT MPEG (Motion Pictures Experts Group) audio-compression algorithms. Xing Technology is active on the JPEG, MPEG, and Interactive Multimedia Association committees and has developed its software products using a scalable compression architecture. In real-time video, the viewed size, compressed size, refresh rate of the image, and quality of the image can be scaled to the computing resources available. Future IAVs will offer print- and cursive-handwriting-recognition software, as well as graphics and digital-imaging algorithms.
Space - Savers

Popular Space-Saver Keyboard $98.00

First successful alternative to conventional keyboard saves 60% desk space with a footprint of 27.3 x 15.2 cm. Has full travel tactile responsive keys with standard left-right spacing for easy touch typing. 100 keys, compatible with IBM XT/AT PS/2. Many language versions available.

Stand-Alone LCD Monitor $995.00

This 10" black on white monitor is easy-to-read, yet compact. Resolution is 640x480 with sharp, flicker-free image. Sharp's high refresh rate, triple supertwist nematic technology with back lighting provides a super bright, low radiation screen with a wide viewing angle. The adjustable monitor base is only 29x14 cm. It lets you mount the LCD monitor on vertical surfaces or fold for transport. Comes with 1.5 m cable and VGA adaptor card. No external power required. IBM AT compatible.

Diskless LANStation $1995.00

Combines Space-Saver Keyboard, LCD Monitor and 20 Mhz 386sx CPU w/2 Meg RAM (4 Meg optional) in a single very small footprint (27.4 X 26.0cm). Network ready with 10 Base2, 10 BaseT NE-2000 compatible network adapter built-in. Unit does not fold for portability.

To Order
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1-800-DATALUX

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Spec Sheets Sent By Automatic 24 hr. FAX Transmission
1-703-662-1675

RESOURCE GUIDE

DSP-Based Products

The following list is a sampling of products in a range of categories that incorporate DSP technology.

ARRAY PROCESSORS

Eighteen Eight Laboratories
1247 Tamarisk Lane
Boulder City, NV 89005
(800) 888-1119
(702) 294-1051
fax: (702) 294-2611
PL1250 (PC, Xenix)
PL2500 (PC, Xenix)

Circle 1000 on Inquiry Card.

Image and Signal Processing Corp.
120 Linden Ave.
Long Beach, CA 90802
(310) 495-9533
fax: (310) 495-1258
AP-4, 4E, 6 (proprietary)
Point (PC)

Circle 1001 on Inquiry Card.

Olsson Engineering
561 Pine St.
Edmonds, WA 98020
(206) 771-3994
DSP200 (VME bus)

Circle 1002 on Inquiry Card.

AUDIO/VIDEO BOARDS

Antex Electronics Corp.
16100 South Figueroa St.
Gardena, CA 90248
(800) 338-4231
(310) 532-3092
AV-16 Audiographics (PC)

Circle 1003 on Inquiry Card.

Echo Speech Corp.
6420 Via Real
Carpinteria, CA 93013
(805) 684-4593
ECHO DSP (PC)

Circle 1004 on Inquiry Card.

Seaport Imaging
1340 Saratoga-Sunnyvale Rd.,
Suite 104
San Jose, CA 95129
(408) 366-6400
Seaport VIP-20 (PC, PS/2)

Circle 1005 on Inquiry Card.

GRAPHICS BOARDS

Matrox Electronic Systems, Ltd.
1053 St. Regis Blvd.
Dorval, Quebec, Canada H9P 2T4
(800) 361-4903
(514) 685-2833

Circle 1006 on Inquiry Card.

Seaport Imaging
1340 Saratoga-Sunnyvale Rd.,
Suite 104
San Jose, CA 95129
(408) 366-6400
Seaport VIP-20 (PC, PS/2)

Circle 1007 on Inquiry Card.

IMAGE-PROCESSING BOARDS

Dipix Technologies
1050 Baxter Rd., Unit 7
Ottawa, Ontario, Canada K2C 3P1
(800) 724-5929
(613) 596-4914
P360 Power Grabber (PC)

Circle 1008 on Inquiry Card.

Inclusion in the resource guide should not be taken as a BYTE endorsement or recommendation. Likewise, omission from the guide should not be taken negatively. The information here was believed to be accurate at the time of writing, but BYTE cannot be responsible for omissions, errors, or changes that occur after compilation.
Odyssee lets you avoid the punishment of programming development.

Creating applications doesn’t have to hurt

The extraordinarily complex process of writing software applications is time-consuming and repetitive. And can get you into a lot of trouble.

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Introducing Odyssee from Case Design, a new concept in programming development software that eliminates the need for editors or a high degree of technical skill. Odyssee is a fully integrated tool that features DBMS support, WYSIWYG user interface design and reporting.

In the development cycle, you can access a wide variety of helpful features including a data dictionary, physical and logical independence, tasks, actions, events and expressions. Resulting applications can run on a variety of OS platforms (DOS, WINDOWS, UNIX) with no change.

Creating the data structure and manipulating the database are features of Odyssee that are transparent to the developers. Odyssee can simultaneously access and simplify the use of many different DBMS, including XBASE, ORACLE, UNITY, SYBASE and DB RAIMA.

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9111 Jollyville Road • Suite 207 • Austin, Texas 78759
Phone (512) 346-8991 • Fax (512) 346-7920

Circle 243 on Inquiry Card (RESELLERS: 244).
STALKING THE ULTIMATE WORKSTATION

The BYTE Lab tests eight workstations with CAD and DTP applications

BEN SMITH AND RAYMOND GA CÔTÉ

This month, the BYTE Lab goes in search of the ultimate workstation. We put eight high-end machines through their paces. We tested performance on real applications, concentrating on CAD and DTP (desktop publishing). And we looked beyond the numbers to the element that most contributes to (or detracts from) productivity—the operating-system environment.

Taking all these factors into consideration, we arrived at some surprising results. If you’re willing to look beyond the nameplate and put aside preconceptions about processors and operating systems, you may find yourself rewarded with good performance, reasonable cost, a system that’s easy to work with, and a wealth of off-the-shelf applications.

To Begin With, a Definition

The term workstation has been applied to everything from Sparcstations to computer furniture, so, to begin, here’s our definition: For us, a workstation is a computer designed for a single user, built for network integration, and equipped with high-resolution graphics and enough speed to handle demanding engineering and graphics tasks. Notice that we don’t say anything about running Unix or about RISC architectures. If a DOS PC fits well into a network and makes a suitable host for CAD applications, we call it a workstation.

In this review, we’ve included four pure workstations: Sun Microsystems’ Sparcstation2 GX, DEC’s DECstation 5000/120, Hewlett-Packard’s Apollo 9000 Model 710, and IBM’s RISC System/6000 Powerstation/350. We also looked at two more personal workstations, Next’s Nextstation and Silicon Graphics’ Iris Indigo, which focus on blending the rich toolkit environment of Unix with desktop ease of use. And finally, we evaluated two not-so-humble personal computers, the Apple Mac Quadra 950 and the Compaq Deskpro 50M. Two notable platforms are not represented: Amigas and OS/2 systems. Commodore declined to participate in these applications, citing the Amiga’s multimedia orientation; for the OS/2 story, see the text box “Where’s OS/2?” on page 200.
**ACTION SUMMARY**

- **WHAT WORKSTATIONS ARE**
  They are fast, powerful, personal systems with high-end graphics hardware and network support. We measured these systems on their performance in CAD and DTP applications.

- **LIKES**
  The systems are fast and easy to use; they present consistent environments and offer broad software support for popular platforms.

- **DISLIKES**
  Some systems delivered surprisingly slow performance and had poor administrative tools.

- **RECOMMENDATIONS**
  The Mac Quadra 950 is the ultimate DTP machine. For CAD and raw high-end processing power, we recommend the IBM RS/6000 Powerstation/350.

---

**Two Test Environments**

There is no way to divorce an evaluation of these workstations from their underlying operating systems and the implementation of the applications software. We tested the systems on CAD and DTP, two of the most common workstation applications, which are demanding of graphics and floating-point hardware, as well as CPU speed. Besides performance, we evaluated features like ease of use and administration, which are critical in determining the most productive environment in which to work.

For our performance benchmarks, we ran tests using the same application on each system. The results appear in the benchmark figure, and the testing details are fully outlined in the text box “ModusOperandi” on page 198. Naturally, the quality of the software implementation varies from platform to platform, so the applications play a big part in determining performance. However, the whole environment—including applications software—will determine the performance that end users see, so that is what we timed.

We timed CAD operations with AutoDesk’s AutoCAD, and DTP jobs with Frame Technology’s FrameMaker. Both are available on every platform we tested. However, we also ran Ashlar’s Vellum 3D 2.12 on the Mac; Interleaf 5 on the DECstation, HP/Apollo 710; and Sparcstation2 GX; and Aldus PageMaker on the Mac and under Windows 3.1 on the Compaq Deskpro. Thus we got a feel for the breadth of applications available for each system.
WORKSTATION FEATURES

Comparing features illustrates how broadly the term workstation can be applied. These systems present an eclectic mix of processors, processor speeds, and peripherals. Note that the prices for the configurations (CAD and DTP) we tested represent complete packages, including operating-system and applications software as well as hardware. (N/A = not applicable.)

<table>
<thead>
<tr>
<th></th>
<th>Apple Mac Quadra 950</th>
<th>Compaq Deskpro 50M</th>
<th>DECstation 5000/120</th>
<th>HP/Apollo Model 710</th>
<th>IBM RS/6000 Powerstation/350</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating system</td>
<td>System 7.0.1</td>
<td>DOS 5.0/Windows 3.1</td>
<td>Ultrix 4.2</td>
<td>HP-UX 6.05/HP VUE 2.01</td>
<td>IBM AIX/6000 3.3</td>
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<tr>
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<td>$9498</td>
<td>$5319</td>
<td>$9495</td>
<td>$13,890</td>
<td>$26,500</td>
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<tr>
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<td>$17,196</td>
<td>$12,163</td>
<td>$12,995</td>
<td>$17,390</td>
<td>$36,260</td>
</tr>
<tr>
<td>DTP configuration</td>
<td>$14,491</td>
<td>$7019</td>
<td>$10,960</td>
<td>$15,895</td>
<td>$30,790</td>
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**COMMON CONFIGURATION INFORMATION**

<table>
<thead>
<tr>
<th>Processor</th>
<th>33-MHz Motorola 68040</th>
<th>50-MHz Intel 486DX2</th>
<th>20-MHz MIPS R3000A</th>
<th>50-MHz PA-RISC</th>
</tr>
</thead>
<tbody>
<tr>
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<td>64</td>
<td>64</td>
<td>32</td>
<td>64</td>
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<td>Hard drive size (MB)</td>
<td>400</td>
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<td>330</td>
<td>420</td>
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<td>SCSI</td>
<td>IDE</td>
<td>External</td>
<td>Internal</td>
</tr>
<tr>
<td>Type</td>
<td>Internal</td>
<td>Internal</td>
<td>Internal</td>
<td>Internal</td>
</tr>
<tr>
<td>Other storage</td>
<td>SuperDrive floppy</td>
<td>1.44-MB floppy</td>
<td>CD-ROM</td>
<td>DEC Tape</td>
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**Networking/communications**

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<th>LocalTalk, AUI Ethernet</th>
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<th>Thin-wire Ethernet</th>
<th>AUI Ethernet</th>
<th>Thin-wire, AUI Ethernet</th>
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<td>Serial ports</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Parallel ports</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other ports</td>
<td>ADB, audio</td>
<td>Audio</td>
<td>None</td>
<td>Audio</td>
<td>Tablet, audio</td>
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**Expansion**

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<tr>
<th>Bus type</th>
<th>NuBus 90, 1 PDS</th>
<th>EISA</th>
<th>TurboChannel</th>
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<th>Micro Channel</th>
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</thead>
<tbody>
<tr>
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<td>5</td>
<td>5</td>
<td>3</td>
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<td>4</td>
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<tr>
<td>Internal mass-storage bays</td>
<td>4</td>
<td>7</td>
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**Service**

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<tr>
<th>Warranty</th>
<th>1 year</th>
<th>1 year</th>
<th>1 year</th>
<th>90 days</th>
<th>1 year</th>
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</thead>
<tbody>
<tr>
<td>On-site service</td>
<td>Option</td>
<td>1 year</td>
<td>1 year</td>
<td>90 days</td>
<td>Option</td>
</tr>
</tbody>
</table>

**CAD CONFIGURATION**

**Video controller**

<table>
<thead>
<tr>
<th>Company</th>
<th>Radius</th>
<th>Matrox</th>
<th>DEC</th>
<th>Hewlett-Packard</th>
<th>IBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>PrecisionColor 8X</td>
<td>MG-124/color upgrade</td>
<td>Included</td>
<td>Included</td>
<td>2770 Color Graphics Adapter</td>
</tr>
<tr>
<td>Price</td>
<td>$899</td>
<td>$1695</td>
<td>1536 x 1024</td>
<td>1280 x 1024</td>
<td>$2310</td>
</tr>
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<td>Maximum resolution (pixels)</td>
<td>1152 x 882</td>
<td>1024 x 1024</td>
<td>1024 x 1024</td>
<td>1280 x 1024</td>
<td></td>
</tr>
<tr>
<td>Color depth</td>
<td>8-bit</td>
<td>8-bit</td>
<td>8-bit</td>
<td>8-bit</td>
<td>8-bit</td>
</tr>
</tbody>
</table>

**Monitor**

<table>
<thead>
<tr>
<th>Company</th>
<th>Radius</th>
<th>ViewSonic</th>
<th>DEC</th>
<th>Hewlett-Packard</th>
<th>IBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>PrecisionColor Display/20s</td>
<td>ViewSonic 7</td>
<td>VRT 19</td>
<td>A1497A</td>
<td>6091</td>
</tr>
<tr>
<td>Price</td>
<td>$3299</td>
<td>$1399</td>
<td>Included</td>
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<td>$3950</td>
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<td>Maximum resolution (pixels)</td>
<td>1280 x 1024</td>
<td>1280 x 768</td>
<td>1024 x 1024</td>
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<td>Diagonal screen size (inches)</td>
<td>20</td>
<td>17</td>
<td>19</td>
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**Tested software**

<table>
<thead>
<tr>
<th>AutoCAD 11</th>
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<th>AutoCAD 11</th>
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<tbody>
<tr>
<td>Vellum 3D 2.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DTP CONFIGURATION**

**Video controller**

<table>
<thead>
<tr>
<th>Company</th>
<th>Radius</th>
<th>Compaq</th>
<th>DEC</th>
<th>Hewlett-Packard</th>
<th>IBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>PrecisionColor 8X</td>
<td>QVision 1024/E</td>
<td>Included</td>
<td>Included</td>
<td>2760 Gray-Scale Adapter</td>
</tr>
<tr>
<td>Price</td>
<td>$899</td>
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<td>1536 x 1024</td>
<td>1280 x 1024</td>
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<td>Maximum resolution (pixels)</td>
<td>1152 x 882</td>
<td>1024 x 768</td>
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</tr>
<tr>
<td>Color depth</td>
<td>8-bit</td>
<td>8-bit</td>
<td>8-bit</td>
<td>8-bit</td>
<td>8-bit</td>
</tr>
</tbody>
</table>

**Monitor**

<table>
<thead>
<tr>
<th>Company</th>
<th>Radius</th>
<th>Compaq</th>
<th>DEC</th>
<th>Hewlett-Packard</th>
<th>IBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>PrecisionColor Display/20</td>
<td>QVision 50</td>
<td>VRT 19</td>
<td>A1497A</td>
<td>5856</td>
</tr>
<tr>
<td>Price</td>
<td>$3299</td>
<td>Included</td>
<td>1536 x 1024</td>
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<td>Maximum resolution (pixels)</td>
<td>1280 x 1024</td>
<td>1024 x 768</td>
<td>1024 x 1024</td>
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<td>15</td>
<td>19</td>
<td>19</td>
<td></td>
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</table>

**Tested software**

<table>
<thead>
<tr>
<th>FrameMaker for Macintosh 3.0</th>
<th>FrameMaker for Windows 3.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>FrameMaker for DEC X3.1, HPLX 3.1A, Interleaf 5</td>
<td>FrameMaker for IBM 3.1A</td>
</tr>
</tbody>
</table>

**Notes:**

1. As tested price is for configuration listed below, plus keyboard, mouse, OS, and documentation. It includes monitor and graphics adapter only if they are listed below as "Included."
2. System evaluated included a 400-MB drive, nonstandard on the Nextstation. Pricing is for the standard configuration, which includes a 105-MB drive.
3. The CAD configuration includes baseline features plus CAD graphics features and AutoCAD.
4. The DTP configuration includes baseline features plus DTP graphics features and FrameMaker.
Common Factors

Whether you intend to set up a group of workstations for CAD, DTP, or some other application, you should consider some factors beyond the desired application. Chief among them is the availability of commercial applications software for the platform you choose. Although applications such as AutoCAD and FrameMaker are available on a wide variety of platforms, they are not necessarily the best applications to solve your problems. In many cases, you’ll end up selecting applications from the same companies that provide the hardware. HP, for example, which is well known for engineering applications, offers a wide variety of software support that is tightly coupled to its own hardware.

Another consideration is your current environment. If you are already a Unix shop, you’ve invested in the steep learning curve associated with the operating system, and scrapping it for better applications support is probably a bad option. Keeping Unix and adding a modern windowing interface may be a suitable answer. Remember that windowing systems add a lot of overhead to your system and that the applications you are using must support the windowing system as well as the operating system.

But don’t let an installed base keep you from adding a little variation to your environment. The name of the game today is compatibility. Unix workstations have always communicated well, and now PCs and Macs are joining the chorus. Silicon Graphics is making the added effort to ensure that its Iris Indigo systems blend in well with Macs by supporting Apple file-sharing protocols and a wide variety of data formats. Even a moderate-size network can take advantage of a mix of desktop personal computers linked through Unix workstations or communicating with minicomputers and mainframes.

Finally, don’t forget the system administrator. Ease of setup and installation and the sophistication of management tools should play a part in your decision.

To identify our ultimate workstation, we spent quite a bit of time setting up these systems, performing some basic system maintenance, linking each workstation into the network, and using the system-supplied applications and tools. Of course, we also ran the benchmark applications and other applications, as noted above.

Our evaluations follow. In each case, we balanced the application timing results with our feel for the environment the system provides, and the type, breadth, and scope of applications available. The table gives configuration details for each workstation.

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### WORKSTATION FEATURES

<table>
<thead>
<tr>
<th>Next</th>
<th>Silicon Graphics</th>
<th>Sun Microsystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Next</td>
<td>Iris Indigo</td>
<td>Sparcstation2 GX</td>
</tr>
<tr>
<td>$4995</td>
<td>SunOS 4.1.2/OpenWindows 3</td>
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<table>
<thead>
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<th>25-MHz Motorola 68040</th>
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<th>40-MHz SPARC</th>
</tr>
</thead>
<tbody>
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<td>Integrated</td>
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<th>150-MB QIC tape</th>
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<td>1.44-MB floppy drive</td>
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</table>

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<td>SUN 3.1A</td>
<td>Interface 5</td>
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* Instruction cache/data cache.
* System also includes built-in video as part of common configuration; we tested with these additional products for greater resolution and/or monitor size.
Apple Mac Quadra 950

In our opinion, a major attribute of the Quadra 950 is simplicity. It’s simple to install, simple to administer, and simple to use. For example, it took us a mere 10 minutes to add a second monitor to the system and only 2 minutes to connect the system to the network. Once connected, the extra monitor was immediately recognized by all our test applications without our lifting a finger. This level of attention to detail is what makes the Quadra a joy to use (see “Racing at 33 MHz: Quadra 950 and Radius Rocket 33,” October BYTE).

When we started this review, we were prepared for the Quadra to fare poorly. After all, it’s only a personal computer up against some of the most powerful RISC-based workstations on the planet. However, experience proved otherwise. The speed of its 33-MHz 68040 and the elegance of System 7.0.1 created an unbeatable combination.

In head-to-head competition in the DTP arena, the Quadra 950 excels in its user interface and holds its own in speed (see the benchmark figure). Not so surprising, the Quadra 950 also beats most of the other workstations on price, coming in at $14,491 for a full DTP configuration, including a 20-inch Radius monitor and a Radius PrecisionColor 8X display adapter. The added screen real estate helped to make the Quadra 950 an outstanding DTP system.

We used the Quadra 950 to produce the bulk of our sample document. FrameMaker proved to be well adapted to Mac user-interface conventions, as did PageMaker. We quickly and easily exchanged data among multiple text editors, image scanners, and photo touch-up software, and between networked applications on multiple machines. None of the other workstations provided such a tightly integrated environment.

However, some cracks did show around the edges. For example, although PageMaker 4.2 ran properly on a second monitor, it insisted on moving the active window to the primary monitor whenever the window was zoomed.

The Quadra 950 did not fare as well on the CAD testing. Again, price was very good ($17,196), but, as the benchmarks show, AutoCAD performed poorly on the Quadra. Vellum 3D 2.12 ran most of our tests close to twice as fast, but even with this advantage the Quadra wasn’t able to compete with the other workstations.

Also, there simply isn’t the variety of engineering applications for the Mac that there is for other platforms. Apple is consciously targeting this area for improvement, but today this is a weak spot for the Quadra. However, Vellum 3D is an...
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We benchmarked system performance on CAD and DTP (desktop publishing) jobs using two popular commercial applications, AutoCAD and FrameMaker. Although these two products are not the most popular programs in every environment, they are available—and among the leaders—on every platform we tested.

The benchmark figure shows the results of these tests. Each bar is a composite score based on timing a series of operations. For each operation, the fastest machine scores 1, and the other systems receive fractional scores based on their relative performance. The bar in the figure represents the average of these scores.

**Designed to Sail**

Our data file for AutoCAD performance tests was a 3-D hull and keel design for an America’s Cup–class racing sailboat. Pedrick Yacht Designs of Newport, Rhode Island (designer of the Stars and Stripes), provided us with the test file. The AutoCAD drawing contains 327 polylines, each averaging about 450 vertices (roughly 150,000 points in 3-D space) split into eight drawing layers. We timed four tasks:

1. Loading the file from disk and generating the drawing, regen, redraw, and a 30-degree rotation of the entire hull in user-coordinate space.
2. Measured system speed for DTP by timing three tasks with FrameMaker. First, we opened a 100-page formatted document that included four EPS (Encapsulated PostScript) bit maps (i.e., 180- KB, 5-MB, 1-MB, and 150-KB images). Then we measured the time it took to reformat the body of the text after changing the default font from 10- to 12-point type. Finally, we timed an import of 100 pages of raw ASCII text and the 5-MB image.

**Compaq Deskpro 50M**

If you need to run one application, run it very quickly, and do little else, then a PC running DOS is nearly unbeatable. PCs have several advantages: The hardware is well standardized, there are lots of speed-increasing add-on peripherals (e.g., the vector-based Matrox MG-124 video card we used for AutoCAD testing), and the small operating system allows your application to have almost complete control of the hardware. When an application runs on a PC, it receives nearly 100 percent of the available processor time.

Our AutoCAD benchmark shows that the Deskpro 50M held its own against most of the workstations. The reason is twofold. First, the Matrox video card provided display-list processing with drivers tuned specifically for AutoCAD. Second, since DOS is a single-tasking operating system, AutoCAD did not need to contend with the overhead of a Unix installation.

AutoCAD looks the same no matter which system it runs on. This is annoying at best on graphical platforms, which have their own ideas of what a windowed application should provide, but AutoCAD is right at home on the Deskpro 50M. As the best environment for the world’s most popular CAD package, the Deskpro certainly earns a few points.

Adding a second high-resolution monitor for the AutoCAD benchmark was straightforward. The MG-124 video card worked straight out of the box; we just added an AutoCAD driver. Installing the 17-inch ViewSonic 7 monitor was a matter of connecting a few cables, and it provided an excellent display. Unlike the Mac environment, however, the operating system itself (DOS and Windows) doesn’t recognize the second monitor.

Including AutoCAD and the optional video hardware, the Deskpro came in at $12,163, making it the least expensive CAD platform by far. Furthermore, even using standard Vison video and a Compaq monitor, the Deskpro came in second to the Nextstation as the least expensive.
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Circle 153 on Inquiry Card.
DTP platform ($7013).

DTP on the PC has come a long way with the popularity of Windows. The Deskpro 50M finished a respectable third on our DTP timings. FrameMaker for Windows and PageMaker both take good advantage of the Windows interface. DTP typically requires multiple applications cooperating on a single document. For example, our test document consists of text that originated from a word processor, combined with scanned images and clip art. True multitasking may not be required, but cooperative multitasking greatly simplifies the task.

The user environment on the Deskpro 50M, typical for DOS/Windows PCs, still leaves a lot to be desired. Many of today's PC users find themselves time-sharing between DOS and Windows. Unfortunately, the boundary between these two environments is rather fuzzy. Windows users still have to resort to the DOS command line to perform most maintenance and administrative jobs.

DOS has two rather serious difficulties. First, you must continually worry about the amount of available memory being used in the first megabyte of address space. Even with DOS-extender-based applications such as AutoCAD, which take full advantage of system memory, you still need to worry about how much space is being consumed by network and peripheral drivers.

Second, multitasking DOS applications is a risky proposition. Windows and environments like Desqview have made multitasking possible, but these environments are incredibly complex and hardly stable. Windows' greatest difficulty is its tendency to crash, leaving behind only a cryptic message or sometimes just leaving you staring at the DOS command line with no indication of what went wrong. Although the Deskpro was not by any means the only system we crashed during this review, it seemed the easiest to break while running Windows.

Even though Windows has been around for several years, it still struggles through its infancy. System administration remains difficult, with many administration functions needing to take place in DOS before Windows is run. Windows' dual requirements of compatibility with DOS applications and having to run on a broad range of nearly compatible platforms have also given rise to a set of arcane initialization files that have to be tuned for each environment.

In all fairness, most of these difficulties are the result of Windows' need to remain backward-compatible with DOS applications. Windows was neither a ground-up original work (like the Mac operating system) nor an overlaid interface (like any of the X Window System-based Unix GUIs).

Although it lacks a pleasant working environment, the Deskpro 50M is an inexpensive, fast performer on single applications. In summary, if you have a very focused, single-application environment, a DOS platform like the Deskpro 50M is an excellent choice.

DECstation 5000/120

Until recently, DEC has demonstrated a lack of commitment to advanced development for Ultrix, its BSD-based version of Unix. The DECstation line still seems to be an Ultrix adjunct to DEC's extensive VAX/VMS offerings. When they first came to market, DEC's R3000-based DEC stations were performance leaders, but they have been losing ground ever since. Given this history, it's not surprising that the DECstation lacks the dazzle of other workstations.

We configured the DECstation identically for CAD and DTP; the price difference ($12,995 for CAD, $10,980 for DTP) represents differences in AutoCAD and FrameMaker licenses only. The DECstation 5000/120 came in second to last in both application tests. The lack of speed comes not only from its 20-MHz processor; the system's hard drive was the slowest of any of the systems we evaluated.

In addition to running AutoCAD and FrameMaker, we spent a great deal of time with Interleaf 5, a very popular DTP system on the DECstation, Sparcstation, and other Unix platforms. We found that Interleaf, like AutoCAD, has a very demanding interface that's inconsistent with the system's resident GUI. Like AutoCAD, Interleaf 5 is a windowing application within a windowing environment.

The DECstation 5000/120 requires two separate boxes: a CPU box (with a CD-ROM drive) and an expansion chassis. The tape format is the proprietary single-spool DEC tape cartridge.

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Circle 230 on Inquiry Card.
even simple. Software installation went without a hitch. DEC was instrumental in the development of X and Motif, so its implementation of the user interface is excellent. Each user’s session is controlled by a session manager, a special console window from which you launch application programs and receive messages from the system. The User Executive (i.e., file manager) is character-based and simple to understand and configure. As a rule, the system software extensions are designed so that they work as well in an X window as on a character terminal. Our only complaint is that the default icons (for scrolling the window and launching programs) are very small and require fine dexterity. There are no other frills to the GUI.

The clumsiest elements of the DECstation are the keyboard and mouse. The keyboard has no Escape key (you have to map it to another key for each program). The mouse is circular, like a hockey puck, which means that you have no automatic registration between your hand and the mouse buttons when you grab it. Despite the raised pattern on two of the mouse buttons, it’s easy to press the wrong button. The mouse is light, is easy to move accidentally, and lacks feedback. The keyboard and mouse complaints may sound trivial, but these input devices are the human interface for the workstation, and it’s important that they be comfortable.

**HP/Apollo Model 710**

The Hewlett-Packard/Apollo 9000 Series 700 workstations have the reputation for being the fastest in their price range (see "A New Workstation Standard," June 1991 BYTE, page 52). Surprisingly, the Model 710 did not perform very well on the DTP application benchmarks despite its prowess on our low-level tests. This discrepancy underscores the importance of the application you choose in determining system performance.

As with the DECstation, we ran the Model 710 with the same configuration (16-inch color graphics) for both DTP and CAD tests. With AutoCAD, the Model 710 sells for $17,390; with FrameMaker, it sells for $15,385. These prices put it generally on a par with the Quadra 950.

If engineering is your field, you may already be sold on the HP/Apollo workstation; Hewlett-Packard is a very popular name in engineering. Along with this reputation come many fine engineering applications (including CAD) that may not exist on other platforms. This alone is reason enough to put an HP/Apollo workstation on your list of preferred systems.

The 710 performed well on our CAD tests, scoring second only to the IBM Powerstation/350. However, its DTP score placed it a disappointing fourth, behind even the Deskpro 50M. As with the DECstation, Interleaf is the better-known DTP package for the 710. However, with the advance of Motif and X on HP workstations, we expect that FrameMaker will supplant Interleaf, especially if Frame Technology polishes it up for this platform.

The 710 is a classy workstation. You can replace the internal floppy drive with an optional DAT (digital audiotapec) drive. Its internal disk storage space is sufficient for a stand-alone workstation.

HP’s VUE (Visual User Environment) is the most elegant Unix interface. An X- and Motif-based window manager, VUE lets you have several different workspaces, each with its own collection of windows and applications. You toggle between workspaces via the screen button (an icon, of sorts) that represents that workspace. When you end a session, you can save information about what applications are running and where their windows are located so that when you start a new session, VUE puts you back where you left off.

Besides VUE, HP provides a simple but useful icon-based file manager. However, in no way does it rival the file-handling systems of the Mac or Iris Indigo. System administration is simplified thanks to HP’s SAM (System Administration Menu) and special features of HP/UX.

HP has maintained a consistency over the years in its keyboard and terminal-screen layouts. This has led to some problems, particularly with HP’s DOS systems, where they’ve conflicted with the designs of PC compatibles. However, HP’s terminal design works well for Unix. Keyboards are more compact and take up less space.

**IBM RS/6000 Powerstation/350**

There is little question that IBM’s RISC System/6000 Powerstation/350 is a robust and well-engineered machine. The monitor is crisp; the display is snappy. In performance, the Powerstation was undisputed champ, handily taking first place on CAD and DTP applications tests.

On the negative side, the 42-MHz RISC System/6000 system is much more expensive than most of its competition. We tested a color Powerstation for CAD ($36,260) and a monochrome system for DTP ($30,790). The 19-inch displays are gorgeous, and the system runs like a thoroughbred, but the prices are well beyond those of the other systems in this review.

Also, AIX is far from easy to become used to, particularly if you have worked with more standard versions of Unix. The default user interface is merely the character-based screen, not Motif/X. The GUI is there, but the administrator must install it as the default log-in interface. IBM is lagging behind the other workstation manufacturers in its development for OSF/Motif, even though it was one of the original members of OSF (Open Software Foundation). Although its PowerDesk icon-based file and application control looks as though it might develop into something very attractive, the window manager and file manager still have a long way to go.

However, AIX is not only different from other versions of Unix, it’s also very sophisticated. It has unique features like the virtual volume manager, which lets you modify the size of disk partitions without going into single-user administrative mode.
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With this feature, you can even change the size of a file system on the fly.

IBM also offers a system-administration tool called SMIT (System Management Interface Tool). SMIT is a hierarchical tree of menus for configuring and controlling the operating system and installing hardware. Admittedly, learning SMIT is far simpler than learning the esoterica of Unix system administration through editing the dozens of syntactically divergent tables that underlie any Unix system. But SMIT and AIX are so unlike any other Unix variation that a system administrator seasoned on a more conventional system will agonize over learning entirely new procedures. Despite IBM’s creation of a better Unix than that delivered by Unix Systems Lab (or even OSF), it’s unlikely that the rest of the world will follow IBM’s lead.

We had more difficulty installing the software on the Powerstation than we did on any other system. SMIT is not idiot-proof—we corrupted the boot file system by improperly attempting to enlarge another file system. Once we rebuilt the disk and operating system, we still had problems installing FrameMaker. Even the common Unix commands that are part of the installation have uncommon options and actions. IBM can be commended for its work in trying to improve Unix, but there is something to be said for going along with industry standards.

**Silicon Graphics Iris Indigo**

One of us has had an Iris Indigo on his desk for many months, choosing it over a number of other workstations. Its user interface makes it a very comfortable system, and we found day-to-day performance to be adequate. But quantitative benchmarks are another matter. The Indigo came in dead last on our DTP tests and placed only fourth among CAD systems.

Nevertheless, the Indigo presents an outstanding user environment and an attractive price. At $16,495 for the system plus AutoCAD and $14,490 for the system plus FrameMaker (including an optional DAT drive), the Indigo is one of the least expensive workstations we tested.

Unlike most other Unix workstations, the Indigo case is a mini-tower that can sit in the back corner of a desk or on a bookshelf. You can upgrade hardware and install peripherals without tools. The keyboard is laid out like PC keyboards, and the mouse can plug into the right or left side, as it can on a Mac.

Of all the Unix workstation environments, the Indigo is unquestionably the nicest for casual users. But it still has all the tools that experienced technical users and system administrators want.

Silicon Graphics’ Workspace GUI doesn’t have multiple workspaces, like HP’s VUE, but the Workspace file manager rivals even that of the Macintosh. It can determine a file type using a rule set that includes information on permissions, filename, and data within a file. This makes it possible to define actions that are appropriate for any number of different files. The files appear as icons corresponding to applications. Double-clicking on a file brings up the application—just as on a Mac. You can also drag and drop...
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Sony Enhanced Data Grade D8. A memory worth celebrating.

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files to applications. Finally, you can carry out most common system-administration jobs through the iconic interface.

We had no difficulty installing any software on the Indigo. Everything about the machine is attractive and fun; it’s no wonder that software developers provide excellent support for it. What the Indigo lacks in performance, it more than makes up for in ease of use and support.

Sun Sparcstation2 GX

S

ay the word workstation, and most people will probably think Sun Microsystems. Big screens, paper-white displays, and graphical interfaces have always been its trademark. Sun systems are the quintessential workstations, and application support is phenomenal. A quick browse through Sun’s software-support catalog shows just about every possible application category you can imagine—from CASE to CAD to DTP to medical imaging and more.

The Sparcstation2 GX came in a single configuration that we used for both DTP and CAD benchmarking. The “GX” designation means accelerated graphics. Including AutoCAD, our test workstation costs $23,940; including FrameMaker, it costs $23,685. Although these prices put the Sparcstation2 GX close to the top in price, our configuration also included several mass-storage options; you can get units minus the CD-ROM drive, QIC tape drive, and 1.3-GB hard drive for $15,295.

The system is available with a variety of windowing environments, among them Sun’s own Solaris Open Windows. Open Windows is a combination development and user environment. The user portion delivers a set of 15 standard productivity-enhancing applications, including a file manager, text editor, calendar manager, and multimedia mail tool.

Several of these tools are designed to increase group productivity. For example, the calendar manager provides password-protected access to other people’s calendars. The multimedia MailTool allows you to attach arbitrary binary files, including audio and image data, to a standard mail message.

The Open Windows environment also provides ToolTalk, a development service that gives users a standard high-level interprocess communications protocol. The major advantage of ToolTalk is that it offers a standardized mechanism through which processes can communicate without your having to hard-craft messages. In addition to interprocess communications, ToolTalk also lets developers send messages to particular objects (e.g., windows, dialog boxes, and text selections) within applications.

By creating a standardized tool through which the messages pass, Sun has delivered a backbone around which loosely coupled applications can be arranged.

Open Windows provides a rich environment for both developers and users. However, the Sparcstation2’s performance was disappointing. The system’s benchmark scores were mediocre despite its speedy graphics: The Sparcstation2 GX was next to last running FrameMaker and came in fifth running AutoCAD.

On the positive side, there are more applications for Sun workstations than for any other Unix workstation. And there are more Sun workstations out there than any other. As with the PC, there is much value in simply being the most popular. But this broad installed base may be misleading in that there have been so many incompatible versions of Sun operating systems and GUIs that you may not be able to take advantage of the newest versions of the operating system with older software.

Unfortunately for the Sparcstation2, being the top gun has a major drawback—people are always shooting at you. The IBM Powerstation/350 beat the Sparcstation2 in speed; the Iris Indigo has a more innovative visual shell. And there are always the Mac and PC-class machines gaining from below with improving performance and much better pricing.

The Sweetest Workstation

Despite our preconception that the sweetest workstation was going to be a Unix system, we chose the Quadra 950 as our favorite. The Quadra is the winner not only because of its performance on our DTP tests, but also because there is more
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software that is better supported and easier to install, manage, and use than for any of the Unix workstations. The Quadra is the ultimate workstation for most computer users. However, its CAD performance is weak, and engineering support is generally lacking.

Our second choice is the IBM Powerstation/350 running AIX. This is our favorite CAD system. We make this selection with some reservation, because the operating system is unusual and its GUI is far behind the others, especially HP’s VUE and Silicon Graphics’ Workspace. However, the performance results turned in by the Powerstation make it hard to resist.

In third place, surprisingly, is the Compaq Deskpro 50M running DOS (not Windows). Despite its shortcomings when compared to other operating systems, DOS dominates the world; while the user interface may not be the most comfortable, there is usually someone nearby who knows enough to help a new user get started. We chose this PC-class machine because of its speed and its simplicity. A lot of users simply want a machine that they can dedicate to doing one task very well. Pedrick Yacht Design (which provided our AutoCAD test file) bears this judgment out: Most of its workstation users, Unix and PC users alike, do nothing but run AutoCAD.

Honor mention goes to the Iris Indigo. This Unix workstation has many of the user-interface attributes of the Macintosh while also offering the best features of Unix. It delivers true multitasking with correspondingly sophisticated memory management, integrated networking, client-server-based applications, and classic Unix shells as command-line interfaces (to simplify complex file management operations and automate multistage file processing). Silicon Graphics’ new R4000-based Indigo, which should be out by the time you read this, may also offer the power of some of the faster workstations.

For us, the decision comes down to this: If you are choosing a workstation for processing power, pick a racehorse like the Powerstation despite the cost. But if you also require a rich user environment and excellent applications support, look beyond traditional Unix systems.

Ben Smith and Raymond GA Côté are testing editors for the BYTE Lab. Ben is the author of UNIX Step-by-Step (Howard W. Sams, 1990); you can contact him on BIX as “bensmith” and on the Internet at ben@bytepb.byte.com. Ray has worked in industry designing interpretive languages and user interfaces. You can reach him on BIX as “rgacote” and on the Internet at rgacote@bytepb.byte.com.
These 26 33-MHz 486 systems strike a solid balance between cost and performance

HOWARD EGLOWSTEIN AND STAN WSZOLA

If you think that a shiny new 33-MHz 486 computer is out of reach, you should take another look. We did and found that $3500 buys you a lot more computer these days than it used to. And a 486 is more than a luxury. If you’re planning to do any serious work with Windows, OS/2, Windows NT, or Unix, a fast 486 CPU is practically a necessity. These operating systems and environments demand fast video, large and fast hard drives, and lots of memory. A 486 CPU also is a must if you need to run multiple applications at the same time. Although 386 systems offer more than enough processing power for standard DOS office work, they simply can’t handle the demands of multitasking.

Our review of moderately priced systems compares 26 machines worth considering—some from the biggest vendors in the industry. Many are brands you’re sure to have heard of; others are from firms you may not recognize. The features table starting on page 218 provides background on the full complement of systems, which includes models from Advanced Logic Research, Atlas Industries, Axik, Bi-Link, Comex, Compaq, CompuAdd, CompuTrend, Daly, Dell, DFI (Diamond Flower), Duracom, Everex, Gateway 2000, Insight, Lodestar, NEC, Northgate, Packard Bell, Polywell, QSI, Tandy, Tangent, Tri-Star, Univ, and Wyse.

What makes a good 486? We’ll cover that in more detail in a moment, but in essence, we looked for a blazingly fast machine that uses standard components and comes packed in a standard case with plenty of room for upgrades. We also looked for a company that will be around for the duration of the computer’s warranty.

The Criteria
All the machines tapped for review have a 486DX CPU running at 33 MHz, 8 MB of RAM, one or two floppy drives, a keyboard, a hard drive with a capacity of about 200 MB, and a Super VGA adapter capable of displaying a resolution of at least 800 by 600 pixels. Vendors that bundle in Microsoft Windows with their systems usually also include a mouse. To meet our price ceiling, the complete system with DOS and a monitor must retail for under $3500. If you consider the price that some of the big name brands sold for just a few months ago, this is no mean feat for companies that historically charge top dollar for high-end machines.

Part of what makes this target price so accessible is the ready supply of standardized parts. We discovered that many of the machines have motherboards from AMI, and high-quality hard drives from Maxtor, Conner, and Western Digital were common. The video cards varied widely, but a few systems came with boards from top-notch firms, such as Orchid, Diamond, and ATI. A few vendors shipped us machines with local bus video and disk-caching controllers.

By our reckoning, the machine you buy today must satisfy your company’s needs for some time. That means it has to run not only today’s software, but it also must have enough flexibility to run new software coming down the pike. Programmers will continue to write software that consumes ever-increasing amounts of disk space and RAM, and you don’t want your new machine to become obsolete overnight. The best way we’ve found to ensure longevity is to compare machines operating system by operating system, benchmark by benchmark, and component by component.
Three of our favorites: the Lodestar 486 LB Data Master, the Compaq Deskpro 4/33i Model 210, and the Axik Ace Cache 486All-33.

The Sum of Their Parts
To start the testing, we installed MS-DOS 5.0 and Microsoft Windows 3.1 on each of the machines and then ran BYTE's low-level CPU, FPU, disk, and video benchmarks (see the graphs on page 224). The next step was running our DOS and Windows applications suite. Finally, we installed The Santa Cruz Operation (SCO)Unix version 3.2.4 and fired up our Unix test suite. Running Unix provides us with a third method of exercising the disk subsystem and checking for any system design faults that may make the machine incompatible with alternative operating systems.

The tests dealt us a few surprises. We expected that because all the systems use a 33-MHz CPU, the results for the CPU and FPU benchmarks would be similar. The sometimes wide gaps that surfaced point out the positive effect that disk-caching controllers, high-speed drives, and accelerated video can have on performance. The DOS and Windows applications suites also were revealing. Machines with especially speedy disk drives and fast video have a definite advantage here. The database and desktop publishing portions of the tests, in particular, take full advantage of these features.

For judging the compatibility of the primary computer component—the motherboard—the best test we have is our low-level benchmarks (which directly analyze both a machine's hardware and ROM BIOS) and the applications test suites. Machines are, for the most part, fully compatible if they can run a good selection of the most popular software. Our test suites do a good job of ferreting out a computer that may have future incompatibilities.

If you're planning to run DOS or Windows, a good quality BIOS is a must. We prefer to see ROM BIOSes from companies with sufficient resources to test them carefully—companies such as AMI or Phoenix or large manufacturers, such as Compaq, that write their own BIOS code. Another advantage of using a machine that accepts a standardized BIOS is "upgradability." It's likely (although not guaranteed) that you can upgrade an AMI or Phoenix BIOS ROM at a later date, if the need arises.

The ability to add more RAM—as much as 16 MB and preferably in standard SIMM or SIPP (single in-line pin package) configurations—is another primary consideration. Be wary of machines that require special proprietary memory configurations, unless you know you can get memory if you need it. Otherwise, you may be locked into buying the RAM from the computer's vendor, which can prove expensive. Happily, numerous third-party vendors traditionally support Compaq's proprietary memory configurations.
They say you can’t get good chili in Hong Kong. Apparently Dell didn’t find a 486™ color notebook there either. But just because they settled for 386SL™ power is no reason for you to. Especially when there's the American-built ALR, Ranger MC486. The ALR Ranger MC486SX/20 gives you 20-MHz 486SX™ power for only 50 dollars more than Dell's system. And that’s just the beginning of the ALR advantage.

RANGER'S HUMAN INTERFACE
When you’re on the road, you need to be flexible. The Ranger MC486’s full-size display can adjust to any lighting or works space. Dell's display won't go beyond 90 degrees. And ALR's fully sculpted and spaced keys help make typing easier too.

RANGER'S BATTERY RECHARGE TIMES
The ALR Ranger MC486 recharges in about two hours, whether or not you're using the system. The Dell takes 3-1/2 hours to recharge with the system off. Just be sure not to forget about recharging the Dell system while it’s running. So much for working efficiently.

RANGER'S BATTERY RECHARGE TIMES

RANGER'S POWER MANAGEMENT
ALR's Advanced Control™ software works with a dedicated power management microprocessor to give the Ranger MC486 over four hours of possible battery life. A detailed on-screen status display provides accurate, up-to-the-minute battery information. Dell's monitoring system (a warning beeper), is considerably less sophisticated.

RANGER'S DOCKING STATION
With the optional ALR Ranger Docking Station, you can quickly turn the powerful notebook into a full-featured desktop PC—complete with three I/O expansion slots and four drive bays. We'd like to compare our docking station to Dell's, but we can't. Unfortunately, Dell doesn’t build a docking station.
ISA or EISA bus? The benchmarks don't have much to tell in this regard, because this choice doesn't make as much difference as vendors may tell you. Most of a 486's functions are integrated onto the motherboard; video, disk-caching controllers, and network adapters are the only cards that usually take advantage of the EISA slots. With local bus video cards and a disk-caching controller, you'll get plenty of performance. Whether the extra boost EISA gives you controller, you'll get plenty of performance. Because this choice doesn't make as much difference as vendors may tell you. On systems with slower CPUs, putting a cache on the controller makes sense; it's not so clear-cut on 486 machines.

One last thing: You may need some help with your new machine or want some help debugging that big scary card you add next year. If you buy a machine with proprietary parts or case designs, you're locked into that vendor for support and upgrades. Ask yourself whether the firm will be around when you need it. Will the company still support your machine in a few years? All other things being equal, we prefer machines that use standard "clone" cases and motherboards. If your vendor can't—or won't—support you in the future, you can call any local computer dealer for parts or service. Proprietary designs may give you smaller footprints or a lower profile, but you'll have to weigh for yourself whether small really will prove beautiful in the long run.

A Look at the Numbers

The BYTE low-level benchmarks isolate specific parts of the system and test each

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separately. The CPU tests perform integer math functions and memory movement. By shuffling 8-, 16-, and 32-bit pieces of memory, the CPU test can pick out motherboards designed with crippling memory configurations or equipped with large external caches.

The FPU tests don’t mean much on a 486DX. The FPU always is the same built-in coprocessor that all other 486 chips have. Because, on these machines, the coprocessors all run at the same clock speed, we expect the performance to be essentially the same. Disk performance is greatly improved by caching controllers; likewise, a good on-board or local bus video design provides better performance on the video tests.

The applications and Unix tests provide an extra measure of compatibility and performance in real-world situations. The DOS and Windows tests are broken down into word processing, spreadsheet, database, CAD, and scientific areas. Because most users run a variety of these applications, we’ve combined the benchmark results into two overall indexes: one for DOS and one for Windows.

As noted earlier, the low-level benchmark results followed a pattern. Machines that incorporate fast disk systems turned in the best disk performances. In particular, the Northgate Elegance ZXP and the Uniq UTI 486DX-33 easily led the pack. The Tandy 4833 LX/T had a very sprightly video performance—something we usually don’t see in Tandy machines.

The CPU performance varied depending on memory configuration and cache size. A few machines—most notably the Dell 486D/33, DFI Diamond Series Model 433D, and Everex Tempo M Series 486/33—had lower CPU ratings than our reference machine, a Compaq 386/33L. The Compaq is a speedy 386, but we didn’t expect it to beat any 33-MHz 486es. Except for the Dell, the systems’ FPU performances were much faster than the Compaq 386’s 387 coprocessor. We’ve seen similarly slow performance on other Dell machines, so this didn’t surprise us. The Dell, however, did manage to hold its own on the applications tests, where it counts most.

On the DOS and Windows applications tests, those machines with the best DOS performances also turned in shining Windows results. Axik’s Ace Cache 486All-33 and Lodestar’s 486 LB Data Master were clear standouts in the applications suites. The Unix tests were less conclusive. The machines from Comex, Lodestar, Northgate, and Tangent all earned an impressive score of 1.6.

The Last Detail
After running the performance tests, we factored in the other considerations and found three machines worth recommending. The Axik Ace Cache 486All-33 performed well and shipped with a 14-inch Viewsonic 6e display. The Axik’s case is a baby tower configuration that provides easy access to the system’s vital parts and easy upgradeability. Similarly, the Lodestar did well on our tests and comes in a baby AT case.

Neither the Axik nor the Lodestar comes in the popular “low-profile” styling. If you have to put the machine on your desk, and you need a low-profile case, the Compaq Deskpro 4/33i is a better-than-average performer. The Deskpro’s display and keyboard are

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### 33-MHZ 486DX DESKTOP COMPUTERS

Make sure you get everything you expect from a 486 system. Consider your upgrade options by checking the support for processors, the number of drive bays, and maximum RAM.

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218 BYTE • NOVEMBER 1992
### Computer Corporation Comparison

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#### 1.2-MB 5¼-inch, 1.44-MB 3½-inch

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<td>120 MB and 240 MB</td>
<td>40 MB to 1.5 GB</td>
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<td>Lodestar local bus SVGA</td>
<td>Tseng Labs ET-4000</td>
<td>STB Ergo</td>
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<td>Utilities, tutorials, Lotus Write, Lotus 1-2-3 for Windows</td>
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| 30-day money-back; 1 year parts and labor; 30-day limited 
upgrade policy | 30-day money-back; 1 year parts and labor; 30-day limited 
upgrade policy | 30-day money-back; 2 year parts and labor; 1 year on-site service | 30-day money-back; 1 year parts and labor; 1 year on-site service | 30-day money-back; 1 year parts and labor; 1 year on-site service | 30-day money-back; 1 year parts and labor; 1 year on-site service | 30-day money-back; 1 year parts and labor; 1 year on-site service |             |
| Technical support | •                  | •                                | •                 | •                     | •                               |             |             |
| **LIST PRICES** |                     |                                  |                   |                       |                                  |             |             |
| Standard configuration | $2395            | $1999                           | $1799             | $2099                 | $1999                           | $2919       | OEM pricing Approx. $2030 |
| Review unit | $2892            | $3069                           | $256                 | $3069                 | $256                             | $3069       |             |
|------------------------|----------|------------|----------------------|------------------------|----------------|---------------------|
| OSI Corp.              | Konradus 486/33 | Tandy 4820 LX/T | Tangent Model 430i | Tri-WIN 486DX/33 EISA  | U11Q Opti 4862X-33 | Decision 486si |
| Poly 486/20V         | 486DX/33; 486DX2/66 | 486DX/33; 486DX2/66 | 486DX/33; 486DX2/66 | 486DX/33; 486DX2/66 | 486DX/33; 486DX2/66 | 486DX/33; 486DX2/66 |
| •                     | •        | •            | •                    | •                      | •               | •                  |
| Weitek 4167          | Contaq | VLSI/topcat | SIS                  | Intel                  | OPTI            | OIF socket         |
| •                     | •        | •            | •                    | •                      | •               | •                  |
| 4                     | 8        | 4            | 4                    | 8                      | 4               | 4                  |
| 32                    | 32       | 64           | 64                   | 64                     | 64              | None               |
| None                  | None    | None         | None                | None                   | None           | None               |
| 256                   | 256      | None         | 256                 | 256                    | None           | 256                |

1.2-MB 5½-inch; 1.2-MB 5½-inch; 1.44-MB 3½-inch; 1.2-MB 5½-inch; 1.2-MB 5½-inch; 1.2-MB 5½-inch; 1.2-MB 5½-inch; 1.44-MB 3½-inch

120
Maxtor XT7120A
IDE (SCSI opt.)
Varies
Varies
Varies
Maxtor LXT2135
Conner CP2064E
Quantum, Maxtor, or Seagate

130 MB to 2.5 GB
100 MB to 510 MB
210 MB to 1.2 GB
80 MB to 1.2 GB
120 MB and 200 MB

Viewsonic 4e
CTX 546/4A
Tandy VGM 441
Relays
MAG MX14H
Aston
Wyse WY-670

1024 x 768
1024 x 768
1024 x 768
1024 x 768
1024 x 768
1024 x 768

8
8
8
2
2
6
6
None
None
None
None
None
None
None
None

250
200
300
300
230
220
200

None
None
None
None
None
None
None
None

30-day money-back; 1 year on-site service; 2 years parts and 5 years labor
1 year parts and labor; 1 year on-site service
1 year parts and labor; 1 year on-site service
2 year parts and lifetime labor; 1 year on-site service
1 year parts and labor; opt. 1 year on-site service

$1890
$3475
$2129
$5368
$2495
$3695
$5126
$1989
$1709
$999
$999

6 MB RAM, 240-MB SCSI hard drive, caching controller, 250 MB tape drive
240-MB hard drive, SVGA color monitor
240-MB hard drive, upgrade to 8 MB RAM
4MB RAM, 128 KS cache RAM
Equip. down degrade: 210-MB hard drive, caching controller, SVGA board
CPU upgrade, 4 MB RAM, 200-MB hard drive, SVGA color monitor

continued
Introducing Intel OverDrive™ Processors for your i486™ DX PC.

Would you like to visibly increase the speed of all your applications? Then it's time you shift your i486 DX or SX system into OverDrive.

Using Intel's ingenious "speed doubling" technology, an OverDrive Processor gives you plenty of added power—up to a 70% performance boost systemwide.

And that power will benefit every application you run on DOS, OS/2®, Windows®, or UNIX®—from

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*In cases where there is no OverDrive socket, Intel recommends installation by a qualified technician.
ware into overdrive.

AutoCAD® to WordPerfect® and over 50,000 applications in between.

It's easy to install an OverDrive Processor. Just plug the single-chip upgrade into the vacant OverDrive socket and you're ready to go. Faster.

So to rev up your i486 system and keep up to speed on all the latest software developments, you need the future of PC upgradability: Intel OverDrive Processors.

Call 1-800-538-3373, ext. 228 for more information. Because when it comes to running software, there's only one gear. High.
The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990. Version 2.2 of the BYTE low-level benchmarks is available in the byte.bmarks conference on BIX, or you can contact BYTE directly. All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 is assigned a value of 1. For each index in the Unix tests, the performance of a Sun Sparcstation IPC is assigned a value of 1. The overall index is the average of all tests.
Promise introduces the First Truly Affordable Caching Disk Controllers.

Our new ultra-low cost disk accelerators will finally end the data bottleneck that takes up so much of your valuable time and at a fraction of the cost of similar cache controllers. They install in minutes and require no special tools or expertise. Satisfaction guaranteed!

"If you're tired of watching your hard drive slowly give up its data, Promise Technology may be able to put the spring back into your data handling... There are other caching IDE controllers available, but they don't share the flexibility and simplicity of the DC-2032. These two attributes will make it a sterling addition to your computer. Bill O'Brien, PC Sources.

"★★★★ An enormous improvement in performance was immediately obvious compared to the un-cached controller... Overall, this controller increased performance by a factor of around 8 times when using large database applications. At a more general level, the whole machine seemed faster and more responsive... At the new lower price, this is an extremely good value and extra features make this controller (DC-2031) a particularly attractive option. Dave Pearman, PC+ (U.K.) March '92

Toll Free in USA 1-800-888-0245
The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990.

Version 2.2 of the BYTE low-level benchmarks is available in the byte.bmarks mailing list. To subscribe, visit the BYTE Lab labarchive.bitnet or send a Request-Receive to labarchive.bitnet. If you would like to contact BYTE directly, you can order a copy of the benchmark suite for $30 per set (six sets available). All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 is assigned a value of 1. For each index in the Unix tests, the performance of a Sun Sparstation IPC is assigned a value of 1. The overall index is the average of all tests.
A monitor touched by Michelangelo

Buy an IOcomm ThinkSync 7A 17" color monitor with a Michelangelo VRAM 1280 Graphics Accelerator and you've got a graphics subsystem that delivers unmatched performance for large screen, high resolution users (up to 1280 x 1024 non-interlaced resolution). All for the unbeatable price of $1295*.

Ideal for CAD, Desktop Publishing, Windows.

Michelangelo’s 1280 x 1024 non-interlaced resolution coupled with the monitor's .26 dot pitch gives CAD users crisp, stable definition, even on hairlines.

Graphic designers and desktop publishers appreciate the larger, distortion-free flat image area that allows edge-to-edge graphics, and redraws them with lightning speed. Windows users go for the rock-solid, flicker-free image made possible by refresh rates up to 72Hz, and all that color—32,768 colors in low-resolution; 256 in high resolution modes.

No wonder Infoworld said IOcomm's color fidelity was “the best in this product comparison.”

More sizes, too.

17" too small? For a few dollars more, you can get Michelangelo with the new ThinkSync II 20" Trinitron screen. But if you need something slightly smaller, we’ll send you information on the whole ThinkSync line, including our 14” and 15” monitors.

For order support or the nearest dealer, call us today at (310) 644-6100 or 1-(800) 998-8919.

With IOcomm, the cost of high performance is within your reach.

*Limited time only (MSRP $1545)

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Circle 64 on Inquiry Card.
# Your Natural Resource

## Keyboards

- 8088/286/386/486 compatible
- Automatically switch between XT or AT
- One-year warranty

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Product No.</th>
<th>Description</th>
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## Hard Drives (IDE)

- Conner IDE
  - 8088/286/386/486 compatible
  - Requires host IDE adapter
  - One-year warranty

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<th>Part No.</th>
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<td>25ms</td>
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<td>NB14066</td>
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<td>200MB</td>
<td>16ms</td>
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## Jameco Power Base

- Masterpower switch and 3 auxilliary switches for each outlet
- 15A, 125 VAC, 1875 watts, 60Hz
- Maximum spike: 80 joules one time
- Maximum spike volts: 6,000V
- Clamping response time: 10ns
- Color: beige

<table>
<thead>
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<th>Part No.</th>
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## Six-Outlet Power Strip

- Built-in safety circuit breaker (15 amps)
- Master switch with pilot light
- Three-prong, 6-foot power cord
- UL listed

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## Floppy Controllers

- One-year warranty

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## Power Supplies

- One-year warranty

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## KaLok Hard Disk Drives

- 90-day warranty

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<th>Part No.</th>
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<td>NB22302</td>
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<td>$169.95</td>
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<tr>
<td>NB22331</td>
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<td>$189.95</td>
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## KaLok Hard Disk Drives

- 90-day warranty

<table>
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<tr>
<th>Part No.</th>
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<td>NB22331</td>
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<td>$189.95</td>
</tr>
</tbody>
</table>

**Call for information on controller cards.**
Only A Phone Call Away

80386/80486 Motherboards

Part No. Description
NB75627 8038GDX 40MHz
NB75619 80386DX 33MHz
NB75643 80486DX 50MHz
NB75651 80486DX 50MHz
NB75635 80486DX 33MHz

Addtional Warranty
• One-year warranty

Part No. Product No. Description Price
NB75643 VGG700 40MHz 8038GDXMotherboard $499.95

Additional Jameco Motherboards

Part No. Product No. Description Price
NB19536 JE1010 8088 Floppy controller $19.95
NB19705 JE1050A 8088/286/386/486 monochrome graphics adapter $49.95
NB19180 JE1060 8088 I/O $49.95
NB19128 JE1062 8088/286/386/486 RS232 serial (16550 UART) $39.95
NB19703 JE1062A 8088/286/386/486 RS232 serial (16550 UART) $39.95
NB19144 JE1065 80286/386/486 I/O $39.95
NB19185 JE1070 8088 multi I/O w/floppy controller $69.95
NB19908 JE1076 80286/386/486 multi I/O w/floppy controller $69.95
NB19975 JE1080 8088 memory expansion half card $49.95
NB29513 RAMQUEST 8088/386/486/Orchid 32MB memory card $154.95

Cables, Gender Changers, and Adapters

Part No. Product No. Description Price
NB28716 6PG6 10-foot DB25-pin male to female cable $7.95
NB28708 6PG12 12-foot DB25-pin male to female cable $10.95
NB31721 6PG10 25K 10-foot DB25-pin male to female cable $5.95
NB39511 6PG10 25K 10-foot DB25-pin male to female cable $9.95
NB39538 6PG10 25K 10-foot DB25-pin male to female cable $9.95
NB18420 6PG10 25K 10-foot DB25-pin male to female cable $4.49
NB18446 6PG10 25K 10-foot DB25-pin male to female cable $4.49
NB10395 AD925 DE9 female to DB25 male serial adapter $4.95
NB10321 AD925 DE9 male to DB25 female serial adapter $4.95

Metrix Digital Multimeters

Part No. Product No. Description Price
NB27078 M3610 3.5 digit multimeter $39.95
NB27140 M3900 3.5 digit multimeter with tach/dwell $59.95
NB27066 M3650 3.5 digit multimeter with frequency $74.95
NB27158 M4650 4.5 digit multimeter with frequency/capacitance and data hold switch $99.95

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Circle 65 on Inquiry Card.
BYTE's applications performance suite measures the performance you can expect to achieve running a given applications category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.1. We test six applications categories for each environment, running test scripts with the programs listed in the following software categories: Word Processing (WordPerfect 5.1 and Lotus Ami Pro 2.0); Spreadsheet (Lotus 1-2-3 release 3.1+ and Microsoft Excel 3.0a); Database (Software Publishing Superbase 4.1.3 and Borland dBase IV); Development (Borland Turbo Pascal for Windows and Microsoft C 6.0); Scientific/Engineering (MathSoft MathCAD for Windows 3.0, The MathWorks MathLab 3.5x, and Computing Resource Center Biturbo Sta 2.1); CAD (Autodesk AutoCAD release 11); Desktop Publishing (Adobe PageMaker 4.0). The data files and test scripts are available from BYTE.

Our Unix tests show relative performance for double-precision arithmetic, the Dhrystone 2 benchmark, spawning a process (exec1()), file-copy throughput, pipe-based context switching, and running a shell script with eight concurrent scripts running. Unix benchmarks are available on Usenet, in the listings area on BIX, or on disk.

### BYTE SYSTEM BENCHMARKS

| Advanced Logic Research | Atlas Industries DX33 | Axil Ace Cache 486All-33 | BI-Link DT 433 | Comex 486DX/33 | Compaq Deskpro 4/33i Model 210 | CompuAdd 433 | CompuTrend Premio 486-33 | Daly DC486/33C | Dell 486D/33 | DFI Diamond Series Model 433D | Duracom DeskSaver 486/33 | Everex Tempo M Series 486/33 | Gateway 2000 486DX/33 | Insight 486-33 Cache | Lodestar 486 LB Data Master | NEC PowerMate 486/33i | Northgate Elegance XXP | Packard Bell PB 486DX/33 | Polywell Poly 486/33VF | QSI Kronimus 486/33 | Tandy 4833 LX/T | Tangent Model 433i | Tri-Star Tri-WIN 486DX/33 EISA | Uniq UTI 486DX-33 | Wyse Decision 486si |
|------------------------|----------------------|-------------------------|---------------|-----------------|-------------------------------|-------------|-----------------------------|-------------------|-------------|-----------------------------|------------------------|------------------------|-------------------------|-------------------|---------------------------|-----------------|------------------|---------------------|-------------------|-------------------|------------------|------------------|-----------------|----------------------|------------------|------------------|
| **DOS Applications**   | **Better**           | **Worse**               | **Better**    | **Worse**       | **Better**                  | **Worse**  | **Better**                  | **Worse**       | **Better**  | **Better**                  | **Worse**             | **Better**            | **Worse**             | **Better**    | **Worse**                  | **Better**    | **Better**  | **Better**        | **Worse**          | **Better**  | **Worse**   | **Better**        | **Worse**          | **Better**  | **Worse**   |
| **Windows Applications** | **Better**           | **Worse**               | **Better**    | **Worse**       | **Better**                  | **Worse**  | **Better**                  | **Worse**       | **Better**  | **Better**                  | **Worse**             | **Better**            | **Worse**             | **Better**    | **Worse**                  | **Better**    | **Better**  | **Better**        | **Worse**          | **Better**  | **Worse**   |
| **Unix Applications**  | **Better**           | **Worse**               | **Better**    | **Worse**       | **Better**                  | **Worse**  | **Better**                  | **Worse**       | **Better**  | **Better**                  | **Worse**             | **Better**            | **Worse**             | **Better**    | **Worse**                  | **Better**    | **Better**  | **Better**        | **Worse**          | **Better**  | **Worse**   | **Better**        | **Worse**          | **Better**  | **Worse**   | **Better**        | **Worse**          | **Better**  | **Worse**   |

BYTE • NOVEMBER 1992
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.

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Determined to make those long years pay off, he called on every distributor, VAR and dealer in the world. He drove from Beantown to San Diego. Flew from Dublin to Borneo. Everyone loved the program. So he did. Soon everyone was calling the key a dongle, after Don Gall — the lonely software developer who did what he had to do.

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**Insight 486 ISA**

<table>
<thead>
<tr>
<th>Model</th>
<th>CPU</th>
<th>RAM</th>
<th>Hard Drive</th>
<th>Other Features</th>
</tr>
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<tbody>
<tr>
<td>486SX-25MHz</td>
<td>Intel 80486</td>
<td>4MB Cache</td>
<td>210MB w/o Stackerm™</td>
<td>Non-Interlaced 14&quot; Super VGA Color Monitor</td>
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<tr>
<td></td>
<td>486-33MHz</td>
<td></td>
<td></td>
<td>24 Bit 1MB Graphics Accelerator</td>
</tr>
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<td></td>
<td>486DX2-50MHz</td>
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<td></td>
<td>1.2MB 5.25&quot; Floppy Drive</td>
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<tr>
<td></td>
<td>486-50MHz</td>
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<td></td>
<td>1.44 MB 3.5&quot; Floppy Drive</td>
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<tr>
<td></td>
<td>486DX2-66MHz</td>
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<td></td>
<td>2 Serial, 1 Parallel, &amp; 1 Game Port Enhanced</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>101 Key Keyboard</td>
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<td></td>
<td></td>
<td></td>
<td>MS-DOS 5.0 - Mouse</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Full Vertical Case, Desktop Available</td>
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<td></td>
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<td></td>
<td></td>
<td>Stackerm™ and Dr. Solomon's Anti-Virus™ Software</td>
</tr>
</tbody>
</table>

**Insight's 24 hour shipping:**
Need a fully-loaded, value-packed '486 right now? No problem! We've specially configured and pre-built our hottest selling systems and they're ready to ship today!
Place your order before 5 P.M. (MST) and we'll ship your computer within 24 hours!

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Order is subject to credit approval. P.O.'s subject to additional conditions.
You must order a 486 ISA as listed here (Custom orders take a tad longer).

---

**CD-ROM**

<table>
<thead>
<tr>
<th>CD-ROM</th>
<th>Price</th>
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<tbody>
<tr>
<td>Talon High Performance TA-200</td>
<td>$599</td>
</tr>
<tr>
<td>Sony TA-100</td>
<td>$279</td>
</tr>
<tr>
<td>CD Software - Pick any 5 for $99*</td>
<td></td>
</tr>
</tbody>
</table>

Free with any CD-ROM drive -
- 1992 Multimedia Encyclopedia
- Stereo Headphones
- Reference Library
- Game Pack.

New for 1992! Toolworks Multimedia Encyclopedia - complete 21 volume set. Over 33,000 articles with 3,000 pictures, 250 maps, 35 minutes of video, 35 minutes of sound recordings and 55 video sequences.

---

<table>
<thead>
<tr>
<th>Software</th>
<th>Price</th>
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<tbody>
<tr>
<td>Aircraft Encyclopedia</td>
<td>$299</td>
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<tr>
<td>Bible Library</td>
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</tr>
<tr>
<td>Career Opportunities</td>
<td></td>
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<tr>
<td>CIA Facebook</td>
<td></td>
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<tr>
<td>Civil War</td>
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<tr>
<td>European Monarchs</td>
<td></td>
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<tr>
<td>Game Pack II</td>
<td></td>
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<tr>
<td>Guinness Drivd</td>
<td></td>
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<tr>
<td>Great Cities (MM)</td>
<td></td>
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<tr>
<td>Interactive Storytime</td>
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<tr>
<td>KGB factbook</td>
<td></td>
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<tr>
<td>Korea</td>
<td></td>
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<tr>
<td>MM Mavis Beacon Teaches Typing</td>
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<tr>
<td>N American Indians</td>
<td></td>
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<tr>
<td>USA State Fact Book</td>
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<td></td>
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<td>US Civics</td>
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<td>US Presidents</td>
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<td>Vietnam</td>
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<td>World Atlas</td>
<td></td>
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<tr>
<td>World War II</td>
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</table>

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Super Selection. Super Service. Super Direct!

120MB to 2100MB Hard Drives

<table>
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<tr>
<th>120MB</th>
<th>IDE</th>
<th>170MB</th>
<th>IDE</th>
<th>200MB</th>
<th>IDE</th>
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<tr>
<td>Talon TA3020A, 16ms, 3.5&quot; HD</td>
<td>Bare $279 8 Bit Kit $319</td>
<td>Western Digital WD2170A, 12ms 3.5&quot; HD</td>
<td>Bare $349 16 Bit Kit $369</td>
<td>Western Digital WD2200A, 12ms 3.5&quot; HD</td>
<td>Bare $399 16 Bit Kit $419</td>
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<tr>
<td>520MB</td>
<td>IDE/SCSI</td>
<td>353MB</td>
<td>IDE/SCSI</td>
<td>660MB</td>
<td>SCSI</td>
</tr>
<tr>
<td>Fujitsu FZ2640A, 12ms 3.5&quot; HD</td>
<td>Bare $599 16 Bit Kit (IDE) $1,019 16 Bit Kit (SCSI) $1,149</td>
<td>Maxtor MX355A/S, 12ms 5.25&quot; HD</td>
<td>Bare $1,159 16 Bit Kit (IDE) $1,179 16 Bit Kit (SCSI) $1,309</td>
<td>Micropolis MC1624A, 15ms 5.25&quot; HD</td>
<td>Bare $1,399 16 Bit Kit $1,549</td>
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<tr>
<td>1000MB</td>
<td>SCSI</td>
<td>1050MB</td>
<td>SCSI</td>
<td>1080MB</td>
<td>SCSI</td>
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<tr>
<td>Seagate ST41200N, 15ms 5.25&quot; FH</td>
<td>Bare $1,699 16 Bit Kit $1,849</td>
<td>Micropolis MC1598, 14ms 5.25&quot; FH</td>
<td>Bare $2,199 16 Bit Kit $2,339</td>
<td>Fujitsu F22652S, 14.5ms 5.25&quot; FH</td>
<td>Bare $2,499 16 Bit Kit $2,639</td>
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<td>1535MB</td>
<td>SCSI</td>
<td>1752MB</td>
<td>SCSI</td>
<td>2100MB</td>
<td>SCSI</td>
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<tr>
<td>Micropolis MC1528-15, 14ms 5.25&quot; FH</td>
<td>Bare $2,999 16 Bit Kit $3,149</td>
<td>Fujitsu F22652S, 11ms 5.25&quot; FH</td>
<td>Bare $2,849 16 Bit Kit $2,999</td>
<td>Micropolis MC1924, 11ms 5.25&quot; FH</td>
<td>Bare $3,299 16 Bit Kit $3,449</td>
</tr>
</tbody>
</table>

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Standard QIC 80 attaches to existing floppy controller or dedicated unit, w/data compression. 2-3MB/min.

- Talon
  - 120MB includes one tape $189
  - 250MB includes one tape $249
- Colorado
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- 2GB 3100 External Kit $1,299
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JetLAN lets you plug your HP LaserJet printers directly into your network...anywhere!

Here's how you can connect your HP LaserJet printers where you want them: near your network users. Without sacrificing centralized file servers for LAN maintenance and network security. Without the expense of dedicating a PC as a print server. And without software that degrades performance and hogs memory on a user’s workstation.

Simply slide ASP's JetLAN™ print server card into the ‘Optional V0’ slot of your HP LaserJet II, IID, III, or IIID. Connect it to the existing twisted-pair or thin-wire cabling anywhere on your Ethernet LAN, the same way you’d add an additional PC. It’s that easy! JetLAN installs in less than five minutes. There’s no need to shut down the network for installation, and your existing Novell software is all you need.

JetLAN Speeds Up LAN Printing!

The JetLAN enhances LAN performance and improves printing speed for graphics and complex documents. And because JetLAN plugs directly into your printer and your existing network cabling, there are no individual PC-to-printer cables, external boxes or power supplies to clutter your office. Your system security is enhanced because there’s no keyboard or monitor for access to the network.

Maybe your network users are tired of wasting time running across the building to get their laser printer output.

Or you’ve tried to juggle between security needs and printing convenience when you’ve located your file servers. And ended up compromising both.

Then take control of your network. Place your printer near the people who need it – with JetLAN. From ASP, your “hassle-free workgroup solutions” specialist.

To order your JetLAN, or for further information, fax ASP at:

1-800-9 LAN ASP
Dept B2140
International 408-746-2965

Here quite good, and it’s a safe bet that its parts will be available for some time to come.

Considering that the price of most of these machines hovers right around $2500, it’s hard to think of any reasons to buy anything less than a 486. For word processing, maybe. But that justification may not hold for long, because most word processors are moving to Windows. The way the tides are flowing, it’s probably better to opt for the most power you reasonably can afford.

Howard Eglowstein and Stan Wszola are BYTE Lab testing editors. You can reach them on BIX as “eglowstein” and “stan,” respectively.

COMPANY INFORMATION

Advanced Logic Research, Inc.
9401 Jeronimo
Irvine, CA 92718
(800) 444-4257
(714) 581-6770
fax: (714) 581-9240
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fax: (602) 792-9722
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Houston, TX 77070
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continued
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Cut to Video: Four Programs for Moving Presentations

TOM YAGER

Business presentations boil down to one thing: You’re selling something. Be it a product or a service, an idea, or even yourself, the challenge is to win over others’ minds. Make an effective presentation and you could be on your way to your own parking spot. Make a bad presentation and you could be on your way to a career in Fryolator operation.

The most persuasive selling tool multimedia offers is the moving image. For this roundup, I have selected products that share a broad purpose: They integrate video into business presentations. For the Macintosh, I looked at Adobe Premiere and Diva VideoShop. For PCs, I took a look at Mathematica’s Tempra Show and AT&T Graphics Software Labs’ Panorama. These products use either digital or analog technology to get video into presentations.

There are other programs (e.g., AiM Tech IconAuthor, HSC Interactive, and Macromedia Authorware Professional) that let you mix moving pictures with other types of media, but they are designed more for developing interactive applications, such as information kiosks and automated product demonstrations, and less for presentations you give in front of an audience. These programs can certainly be used to put together slick business presentations, but that isn’t their primary application.

QuickTime and the Digital Route

Apple’s QuickTime provides a foundation for the acquisition, storage, and playback of digitized moving video and sound. Both Premiere and VideoShop give you the tools to assemble and edit video and sound into QuickTime movies.

Apple is mounting a campaign to take QuickTime beyond the Mac and have it adopted as the prevailing desktop digital-video standard. If successful, it will become the first widely accepted method for passing digital video between different types of computers.

Two benefits of the QuickTime video are that it’s inexpensive and easy to use: A $500 board, such as SuperMac’s VideoSpigot, and the software that comes with it, are all it takes to turn video into a digital file. QuickTime files, called movies, can be played back on other Macs without special equipment.

The QuickTime video, and digital video in general, is not without its cost. Video files are huge, even when compressed, so a few seconds of video can occupy several megabytes of disk space. That’s costly, especially once you start thinking about moving that data through networks or modems. The other drawback is that digital video, except in high-end, disk-hogging implementations, delivers material of a lesser quality than the original.

The Analog Alternative

These drawbacks have Boosted analog video combined with two other technologies: video overlay boards and computer-controlled video players. These make use of existing analog video equipment to add video to computer-based presentations.

Video overlay, and the similar video-in-a-window boards, typically accept input from external analog video sources (including videotape, laserdisc, and TV) and display it on a computer’s monitor. A special class of video overlay boards display their output on ordinary TV sets or video monitors instead. Either way, these boards allow you to combine computer-generated graphics with moving video. Since that video is never digitized to disk, its quality does not suffer nearly as much, and the higher-quality hardware can actually make video look better as it passes through your computer.

A relatively recent development—computer-controlled video recorders—is bringing new capabilities to presenters. Once you hook your computer’s serial port into a specially equipped video deck, the same program that sequences your computer graphics for you can position...
and play video clips on command. This provides a level of convenience similar to that offered by digital video, but with a far better quality-to-cost ratio.

Computer-controlled video decks are still expensive—in the $2000 range. The big drawback to analog video is that it has to come from somewhere. You can produce QuickTime movies, combining material from several sources, right on your Macintosh. You can produce analog videos using your computer, but it costs a lot more and requires additional equipment.

Making Mac Movies
The two QuickTime editing programs I looked at string captured video clips together, letting you add digital audio and computer-generated graphics. Both give you the freedom to carry out complex edits, including transitional special effects that bridge video clips or graphics with computer-generated animated transitions.

To test the Mac products, I used the BYTE Multimedia Lab’s Mac Quadra 700 with 20 MB of memory and a 400-MB hard drive (you need at least 4 MB of RAM in your Mac). It was equipped with a VideoSpigot QuickTime acquisition board from SuperMac Technology. This board has an RCA jack for a single composite video input.

To record audio with your video, you need either an external audio digitizer (like the MacRecorder) or a newer Mac, such as a Quadra, with a built-in audio input. The Quadra 700 has a microphone jack. An attenuating patchcord from Radio Shack allowed me to hook the line-level output from the video decks directly into the Mac.

For video input, I used a Panasonic AG-7650 professional Super-VHS player and a Sony CVD-1000 VDeck, a compact Hi-8 VCR. Neither deck was placed under the Mac’s control, although both decks support it.

continued
Adobe’s Newest Premiere

The latest version of Adobe Premiere, version 2.0, was in beta testing at the time of this review and was slated for an early autumn release. This new software is a major upgrade, showing that Adobe is serious about making Premiere what a colleague of mine called “the Photoshop for video.”

In addition to incorporating its own QuickTime movie-capture facility, version 2.0 has a new titling module. Titles can be animated and can be rendered with transparency and smoothed edges. There’s also room for vendors to add device-control software to Premiere. With that, you can arrange precise, automated capture and “print to video” using computer-controllable video decks.

Anticipating the availability of higher-quality video capture and playback hardware, Premiere 2.0 has some features that make it a useful tool for serious video production. If your hardware supports it, Premiere will now handle digital audio at rates as high as 44 kHz, with 16-bit resolution (1.0 is limited to 8-bit resolution). Movies can be turned into, and created from, numbered PICT files. Those who plan to use Premiere as a component of an existing video-editing suite will appreciate 2.0’s support for SMPTE time code and EDLs (edit decision lists). With these, producers can use Premiere to define their edits and then export EDL files to professional editing systems. These files execute the edits using the original tapes and produce broadcast-quality results.

Overall, Premiere 2.0 addresses many needs of QuickTime producers. It has the potential to appeal equally to the dabbler and the pro.

Adobe Premiere

Screen 1: Adobe Premiere uses a “collection and storyboard” approach to acquiring and editing video. You assemble and edit clips in the construction window, shown here in the upper right corner.

Adobe’s Premiere was one of the first QuickTime tools to appear (see “Two Tools of the QuickTime Trade,” June BYTE), and so it has come to be the embodiment of QuickTime itself for many people. The text box “Adobe’s Newest Premiere,” above, offers a preview of Premiere 2.0, which at first blush is impressive indeed. But its predecessor certainly deserves top consideration when you’re looking for a video-editing program.

Premiere, like most digital (and some analog) video-editing applications, employs a “collection and storyboard” interface (see screen 1). Using a utility external to Premiere (QuickTime acquisition boards come with simple capture programs), you acquire your video clips. The program displays them as little icons in a tidy collection window (in Premiere parlance, a project window). Digital audio files and still graphics are collected here as well.

You edit movie and audio clips by setting In and Out points. These points determine what portion of a clip will play. If a clip is too long or too short, you can simply adjust the In and Out points.

To create the most basic kind of presentation, you drag movie icons from the project window and lay them end-to-end in the storyboard. Premiere’s storyboard is a series of rows, with each row dedicated to a specific type of data. There are three video rows, including one for transitional effects, and three audio rows. The “Super” row in the storyboard is reserved for videos and still graphics that you want to superimpose over playing videos. This lets you add titles, animation, and even video as layers above the rest of your material.

If you lay movie clips end-to-end on the same row in the storyboard, you get an instant transition between scenes, called cut edits. If you have a yen for something more visually exciting, Premiere has a library of digital transitional effects. These are cataloged in a floating window, with animated icons that clearly show the effect of each transition. Premiere sports an excellent mix of traditional and eclectic transitional effects, ranging from fairly sedate wipes and dissolves to wilder page turns.

Premiere’s video filters have a practical side, adding anti-aliasing, brightness/contrast control, color balancing, and tinting effects to selected video segments. These filters help you enhance your video by compensating for problems in the original material.

Audio in Premiere is mixed using controls that rest under each audio clip in the storyboard. The level controls are single horizontal lines (one line controls each clip) that represent the audio playback level. The line is initially anchored on both ends by movable points. You can vary the audio playback level over time by moving the points around (they move in all directions). The result is a graph that represents your requested audio mix.

I’m struck by how Adobe has managed to craft a simple interface for such a complex idea. There is very little in Premiere that doesn’t feel perfectly natural after its first use. I was initially surprised to find the program accompanied by a very thin manual, but now I get it: A program this well-written requires very few trips back to the documentation.

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I was pleased to find that, despite the same basic collect/storyboard interface, Diva's VideoShop program incorporates many unique attributes that make it a worthwhile alternative to Premiere. VideoShop uses HyperCard to create a complete environment, even to the extent of providing Finder-like menu options like Find and New Folder. These are all part of VideoShop's desktop, intended to be a Mac-like environment tuned specifically for video (see screen 2). QuickTime movie files are optionally shown in VideoShop's collections, called folders, as animated icons that play the first several frames of the movie contained there. These "micons" (movie icons) animate only when you select them, so CPU time is not consumed needlessly.

Another VideoShop specialty is its constant preview window. In Premiere, previews are played in a tiny window and can be played only forward, and they are jerky, rough approximations. VideoShop's preview window allows you to play the current storyboard (called a sequencer) forward, backward, and at variable speeds, simply by clicking on the preview window's controls.

VideoShop's sequencer window supports an arbitrary number of video and audio tracks; you add more as you need them. To edit a clip, you click on a magnifying-glass icon and then double-click on a clip in the sequencer. This opens a window with an expanded view of the selected clip, giving you a visual that looks and handles remarkably like film. This metaphor is used effectively throughout VideoShop. To trim a clip, you drag over a portion of it with the mouse and press Delete. You can undo edits, but unlike with Premiere, when you make a cut in VideoShop, it stays. It does not, however, affect the original clip; you can always revert back to the original by dragging it in again.

Perhaps the most unique quality of VideoShop is its support of an arbitrary number of video channels. The multiple video channels can effectively create complex effects like video-in-a-window and title overlay. While Premiere supports the notion of a fixed-size master playback window in which all elements, unless modified by effects, play back at the master window's size, VideoShop uses a resizable playback window in which you can position and size multiple video clips. The clips can play in sequence, simultaneously, or any way you like. Video channels can include still graphics, which VideoShop (oddly) converts into QuickTime movies while importing them.

With Premiere, VideoShop supports both transitional effects and video filters. But there's a difference in how each program has you apply effects. In Premiere, effects and clips are all distinct, movable pieces, laid out in separate rows in the storyboard. VideoShop applies transitional effects to video clips laid end-to-end on the same line in the sequencer. Transitional effects take place within a channel rather than between channels. This feels a little strange at first, but it's not without its merits. Each video channel can have its own effects, and it's OK for those effects to overlap, which is not the case with Premiere.

VideoShop doesn't offer a very extensive selection of effects. It sticks with basics, like the dissolve layer (cross-fade) and wipe effects. And VideoShop doesn't provide either Premiere's animated effect icons or Premiere's depth of control over the effects.

Compared with Premiere, VideoShop gives you less power to manipulate effects. You get one chance to preview the effect on your own video, a very nice touch that makes up for the lack of the animated icons, and one chance to press Undo after you commit to the effect. After that, you're stuck with your changes unless you choose to rebuild the affected portion of your video. That's the one serious drawback of the film metaphor. While VideoShop provides you with constant, high-quality previews, that comes at the price of some changes (like effects) being difficult to undo.

While I found that trade-off acceptable, I could not accept VideoShop's inability to manage audio tracks. Except for a "set audio level" menu option (which never worked for me), there is no control over the mixing of audio. Video transitional effects don't touch the audio, which abruptly shifts from one clip to the next. I also found disconcerting the program's inability to automatically scale video clips to fit the playback window.

VideoShop does let you record new clips from within the program. I had some trouble with that, however, probably because VideoShop and Premiere 2.0 require the use of a special driver, called a video digitizer, that SuperMac still had in beta testing at the time of this writing.

In general, I find Premiere to be the more useful of the two QuickTime tools. I like the film metaphor and the WYSIWYG emphasis in VideoShop, but the lack of audio handling and automatic scaling are enough to keep me running back to Premiere. I have no misgivings about recommending VideoShop for those projects that suit it, such as presentations that need multiple video sequences running simultaneously, but I think Premiere is the better choice for most uses.

Yes, You Can Do This Under DOS
Multimedia development is usually associated with graphical environments, but there are a couple of very capable presentation-making programs that run under plain old MS-DOS. You do not have to be using Windows or hefty Windows applications to build video into your presentation.

Both of the DOS packages I cover here use analog video input. To evaluate the PC products, I used two systems: an ALR Flyer 32LCT multimedia PC and a Uniq 486/50 server. The ALR was equipped with a Cardinal Technologies SnapPlus combination VGA/video-overlay board, while the Uniq had a Truevision ATVista 24-bit video board. With this hardware, both systems were equipped to handle incoming analog video.

The SnapPlus displays the video in a window on a VGA monitor, and the board also has the benefits of on-board VGA and recordable video output. The ATVista displays incoming video, combined with graphics, on a dedicated TV monitor.

continued
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Mathematica’s Tempra Show is a DOS (not a Windows) program that has a GUI wrapper. Presentations created with Show can be played back on any properly equipped DOS machine (a PC with at least a 286 processor, 540 KB of main memory, and 5.5 MB of disk space). This is a very capable but easy-to-use presentation package, and I like its results.

I call Tempra Show a “presentation sequencer.” You can’t create any new material with it. Its function is to string together various types of multimedia data, generated from other sources, into a self-running presentation. Show can incorporate all sorts of data into presentations: still images (PCX and TGA formats); Autodesk Animator/3D Studio FLI and FLC files; digitized audio, MIDI, and CD audio; text; and, of course, video.

Bringing these data types together in Tempra Show is the script’s job. Using the graphical interface, you build the script one event at a time; dialog boxes pop up to prompt you for additional information when needed. The GUI walks you through the parameters associated with each event, such as Screen (to load and manipulate graphics). Once you get used to what some of the cryptic button labels mean (e.g., 80Butn is a Button event in 80-column format), it’s not a bad way to navigate (see screen 3).

Building a presentation one line at a time makes it difficult to maintain continuity. You can dismiss the GUI and go down one layer to the text-based interface underneath, but that’s a little bewildering. You will, however, be able to see more than one event’s worth of the script on the screen, and you can switch back to the GUI very easily.

Tempra Show’s handling of the SnapPlus board’s video-window capability couldn’t be simpler: All you have to do is drag out a rectangle at the size and position you want the video window to appear, and when that event plays back, the video window pops up. With the SnapPlus, video windows popped up, disappeared, and resized rapidly in response to script events, making it easy to maintain a smooth flow. (Show also supports the Creative Labs Video Blaster.)

Tempra Show supports computer-controllable video decks, including the Sony Vdeck, which Show controls through a serial port. The program has a set of VCR events (e.g., play, forward, and rewind) that simulate pressing remote-control buttons. These controls allow for precise seeking and automatic segment playing on time-code-striped tapes. The combination of Show, Vdeck, and the SnapPlus board is one of the most painless and efficient setups I have used for video presentations. While Show’s scripts can’t rival the programmability of more advanced tools such as Asymetrix’s ToolBook and Aimtech’s IconAuthor, neither of these can match the ease with which Show compiles even fairly demanding presentations.

The package deserves extra credit for its Build Demo function. Build Demo provides an easy way to let you package your presentation and share it with other people. This part of the program loads a floppy disk or a hard disk directory with a distributable run time of Show, your script, and all the files needed to run the presentation on another machine. It even creates a batch file that launches everything from the command line. This is a simple touch, but it shows that Mathematica realizes that people don’t build presentations to show them to themselves.

Tempra Show, even with its couple of quirks, is an excellent solution for many kinds of presentations that incorporate video. Mathematica’s program is unique and is an ideal choice for PC users who don’t have lots of time or money to invest.
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CUT TO VIDEO

Panorama

Screen 4:
AT&T GSL's Panorama is a script-oriented sequencing program. Components of a presentation are shown in a list rather than as visual movie icons.

The second DOS program I looked at is a fairly high-end solution: Panorama from AT&T Graphics Software Labs (see screen 4). It's the only one I reviewed that is specifically geared toward creating presentations intended for output to video (or a TV monitor or video projector). It uses the combined video I/O capabilities of Truevision Targa and Vista video boards to bring in video from an external source, combine it with graphics, and send the result out as recordable video. The quality of the graphics output, thanks to the ATVista's 24-bit color, is superb. What Panorama offers is professional-looking output, suitable for trade show booths, presentations before large crowds, and other situations where image is everything.

Like Show, Panorama is a script-oriented presentation sequencer. The simplest Panorama presentation consists of a string of TGA-format graphics files. Truevision Targa and Vista boards have the ability, rarely tapped, to perform impressive special effects, and Panorama makes use of this power for creating transitions between graphics slides. All the effects are tasteful and suitable for professional applications, but there are some (e.g., squeeze, roll up, and pour) that are custom-made for turning heads.

You can capture and save video still frames from within Panorama for use in your presentations. The program also supports capturing motion video. You can capture as many frames as will fit in your video board's memory at once. For example, with a 4-MB ATVista, I could capture 64 frames. At full speed, this movie would play back in 2 seconds, but by specifying frame delays you can lengthen the movie's time by reducing the frame rate. Panorama movies aren't meant to be substitutes for video, and at the 64-frame resolution the images look pretty horrid close up. Still, for material that doesn't call for great detail, the movie feature comes in handy.

You can also add motion to a Panorama show through animation. It supports simple path-based animation of any graphics, but it is tuned for clips, images that are some fraction of the display size. A simple interface lets you set key points along the animation path and adjust the spline tension of the lines running between the key points. When you play the script, the animation event moves the clip along the path you specified.

Targa and Targa+ owners benefit from additional features in version 3.0 of Panorama, which is not available for the ATVista board. Version 3.0 adds the ability to play back digital audio files (through Sound Blaster and Pro Audio Spectrum boards), as well as interactivity for kiosk-style applications, more transitional effects, and the ability to animate multiple graphics clips at once.

I'm put off by GSL's failure to release Panorama 3.0 for the ATVista, but the Targa boards are more popular. The quality of Panorama's output sets it a bit above the rest of the pack, and the enhancements in version 3.0 widen that gap even more. For presentations that require video output, Panorama is an excellent choice.

A More Elegant Solution

The tools described here are good representatives of the kinds of practical applications that exist today. They are all good, solid packages. For editing QuickTime movies, Premiere is a cut above VideoShop because it gives you better control of effects and has slick audio-handling facilities. Tempra Show is inexpensive and easy to use; it's an ideal solution for people who don't have lots of time or money to invest. Panorama stands out for the superb quality of its output.

Using video in presentations used to mean setting up a VCR next to an overhead projector. Computers offer tight integration of video with other data, making for presentations that flow smoothly and leave a strong impression. Only video can transport audiences to another place.


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Adobe Systems, Inc. (Premiere)
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as stand-alone printers become a necessity
and PAGEMARQ 20 ($5499) offers output
mini-stratos. Based on a Fuji/Xerox print
engine, Compaq's PAGEMARQ 15 ($3999)
and PAGEMARQ 20 ($5499) offer output
speeds of 15 and 20 pages per minute,
respectively. Options on the PAGEMARQ 20
that I tested included 8 MB of RAM, NICS
(network interface cards; AppleTalk for
$269, Token Ring for $799, and Ethernet
for $599) for connecting directly to a LAN,
a 9600-bps Group 3 internal fax ($659), a
1-MB font module ($259), and a 60-MB
internal hard drive ($659). These are list
prices, and they'll probably be discounted
through dealers.

An on-board AMD 29000 RISC pro-
cessor, operating at 20 MHz on the 20-
ppm unit and 16 MHz on the 15-ppm mod-
el, along with Compaq proprietary ASICs
(application-specific ICs) and transmission
data compression, work in conjunction
to speed printing. Both units ship with 4
MB of RAM. The PAGEMARQ 20 can be
expanded to 20 MB, and the PAGEMARQ 15
can go to 18 MB with convenient SIMM
upgrades. One parallel and one serial port
are included; both printers can receive and
process print data simultaneously from ei-
ther port. The PAGEMARQ supports the latest
versions of the two industry-standard PDLs
(page-description languages), version 5 of
Hewlett-Packard's PCL (Printer Control
Language) and Adobe PostScript Level 2.

I used to share a standard HP LaserJet
Series III printer networked with other
writers and illustrators. We had to generate
lengthy aerospace technical manuals, and
problems often arose when switching
between PCL and PostScript. Since the
LaserJet III was a PCL printer, we would
install a PostScript emulation cartridge to
print from Windows applications; howev-
er, for CAD plots, most of us printed with-
out the cartridge using PCL. Checking the
printer cartridge's installation status was
mandatory before each print job. Anyone
who has ever inadvertently printed a single
page of PostScript data to a printer in PCL
driver mode knows of the reams of paper—and
time—wasted when a printer is improperly
configured.

Emulation sensing solves this problem.
The PAGEMARQ automatically determines
the language required to service a print
job and routes the job to the proper inter-
preter. No user intervention is required. I
tested the automatic-sensing feature be-
 tween PCL and PostScript emulations from
both DOS and Windows applications. In
either environments, I first used an HP Se-
ries II driver, and then I switched to a
PostScript device driver (an Apple Laser-
Writer IIINTX). The feature worked flaw-
lessly, and print speeds between the two
modes were almost identical.

In addition, multiple computers and net-
works can access the printer at the same
time, thanks to the port-switching feature
that can simultaneously service jobs from
all active ports (i.e., serial, parallel, fax,
AppleTalk, and the NICS). In a diverse
computing environment, emulation sensing
and port switching are mandatory features.

PAPER HANDLING

The PAGEMARQ 20 arrived with three front-
mounted, 500-sheet, 8½- by 11-inch mo-
tORIZED paper trays as standard features.
Unfortunately, you cannot tell visually
whether the paper is low. Even though the
printer beeps loudly when all trays are
emptied, most administrators would prefer
a better way to keep track of the paper
load. Single sheets and envelopes can be
fed manually into the printer, but only via
a rear-access flip-down panel. If you work
with a lot of envelopes, you'll want the
optional multipurpose feeder.

For print runs longer than 500 pages,
you can configure the trays for auto-
selection; when one tray empties, the next
loads. The only hitch here is that you
will still have to empty the paper-output
receptacle after 500 sheets have come
through.

You can select individual trays from the
front panel or on-screen using a remote
printer control utility (more on this later),
allowing different paper weights or col-
ors to be selected from separate trays with-
out reloading. I tested a variety of papers in

EQUIPMENT SPECS

COMPAQ PAGEMARQ 15:

-20 ppm, 16 MHz
-300 dpi (PCL), 300 dpi
(PostScript)
-8 MB RAM (expandable to
20 MB)
-1 MB font module
-60 MB internal hard drive
-1-MB internal fax

COMPAQ PAGEMARQ 20:

-20 ppm, 16 MHz
-400 dpi (PCL), 600 dpi
(PostScript)
-16 MB RAM (expandable to
40 MB)
-1 MB font module
-60 MB internal hard drive
-1.5-MB internal fax

COMPAQ UNVEILS A NEW NETWORK PRINTER
The Pagemarq 20 compared favorably to the HP LaserJet III Si in the BYTE PostScript tests.

the 16- to 28-pound weight range and the output was identically crisp, with deep un-streaked blacks, on all paper stocks in my arsenal.

For CAD/CAE applications, both Pagemarq units can also print to 11- by 17-inch paper, using the optional B-size tray ($99). In my print tests from AutoCAD release 12, in both PCL and PostScript modes at 800 by 400 dots per inch, 11- by 17-inch plots were outstanding and, at this resolution, rivaled some of the best electrostatic and plotter output I’ve seen.

Getting Directions
A small 2-row by 15-column LCD and a slick little eight-button control panel provide convenient access to the printer’s setup attributes and menus. The Pagemarq uses “on-line” documentation: Four extensive printer-setup menus are built into the unit’s control ROM. Each menu is loaded with submenus and branches that take you to a specific printer-setup function, such as emulation sensing (on or off), lines per page, and page orientation.

You can access all menus easily via the front control panel, but it helps to know where you’re heading. At any main or branch menu display on the LCD, you can get a hard-copy “road map” for that particular menu, complete with every sub-branch and current printer setting.

In a network environment, some users will output only text documents while others will print documents with embedded line art and halftone graphics. The Pagemarq has multiple dpi resolutions (up to 800 by 400 dpi) that can satisfy all these needs. At 300 dpi, both text and graphics using PostScript Level 2 look great, but 800- by 400-dpi printing is where the Page­marq really shines. Halftoned images output using Aldus PhotoStyler and Page­Maker 4.0 look almost as good as results from a high-resolution typesetter.

The Administrator utility is a point-and-shoot GUI invoked from DOS (it can also be called as a full-screen application within Windows). With it, any authorized user can access most printer-setup and configuration parameters directly from a network node.

Typefaces and Other Fax
Both Pagemarq printers ship with 15 PCL fonts and the 35 standard Adobe Type 1 typefaces. Using the Administrator utility, you can download additional Type 1 or PCL typefaces directly to printer RAM or, for permanent storage, into the optional 1- or 2-MB ($259 and $399) programmable font module, a nonvolatile EEPROM. Once downloaded to the printer module, the typefaces are automatically available from your application. You no longer need to worry about downloading fonts. Typefaces can also be downloaded and stored on the optional $659 60-MB internal hard drive.

Downloading typefaces through a parallel connection is relatively slow, but once accomplished, you can delete typefaces from your system’s hard disk, freeing up valuable space. It took 6½ minutes to download 27 Type 1 faces (2.2 MB) from my Zeos 486/25 system to the printer’s hard drive. Times were identical for downloading to the module. The optional hard drive is expensive, but it can also be used as a print and fax document-caching device to enhance performance. Using Compaq’s Administrator utility, or from the printer’s LCD control panel, you can remotely output printed reports detailing all faces stored in printer RAM, ROM, or on the printer’s hard drive.

continued
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COMPAQ NETWORK PRINTER

The internal 9600-bps send/receive fax modem ($659) is CCIT Group 3-compatible and allows any networked user to generate and send fax documents from within Windows or DOS applications using pop-up utility menus. When you print a document from within any DOS or Windows word processor, a pop-up window asks whether you want to print or fax the document. If you choose fax, a cover page is generated and the document is sent down the network to the Pagemarq for fax transmission. You can even send PostScript files directly to another Pagemarq. It’s an elegant fax implementation.

To the Test
In straight parallel tests of the Pagemarq 20 unit, print speeds were compared with those of network printers previously tested by the BYTE Lab (see the figure). The tests are a customized subset of the industry-standard Genoa Technology test suite. The First Page test indicates how fast a printer can pump out short memos or business letters. The Spreadsheet test prints pages from different versions of Lotus 1-2-3 and Microsoft Excel, including heavily formatted text and 3-D graphs. The CAD/Drawing test uses samples from AutoCAD, several illustration packages, and desktop publishing software. The Word Processing test generates formatted documents with numerous font changes.

Although the Pagemarq posted median-to-swift print speeds in these tests, note that the unit was compared against a network printer almost three times more expensive (the QMS-PS 2000) and in a parallel environment. In the end, your network print times will be increased or decreased by network server speeds and interface cards. Data transmission times using NICs, dependent on the network and how it is tuned, can be much faster than a straight parallel connection, with rates up to 16 MIPS. For a description of the LaserJet IIISi and the QMS-PS 2000, as well as descriptions and test results of some other major network printers, refer to the network printer roundup “Laser Muscle: Five Printers Built to Handle Networks” in the February BYTE.

Compaq’s Pagemarq printers should be viewed as total network print solutions rather than just laser printers. The Pagemarq 20 can do everything the LaserJet IIISi can do—for less money. It’s a good value and a recommended solution for your network printing needs.

Greg Loveria is a computer graphics and desktop publishing consultant, animator, and writer in Binghamton, New York. He can be reached on BIX as "loveria."
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Borland Targets Windows Developers with Latest C++ Release

OTHAR HANSSON

Borland C++ 3.1 is the latest release of the best-selling object-oriented development environment. In addition to the expected support for the Windows 3.1 API, Borland C++ purports to offer "all you need" to produce Windows applications. However, what you mostly need to develop Windows applications at the moment is patience, and Borland's integrated browsers and editors, fast compilation, and reusable code modules are all designed to speed the process for the Windows developer.

Development Environment

Borland has significantly extended the functionality of its Windows-hosted IDE (integrated development environment). The IDE now permits developing optimized Windows code under Windows and debugging multiple applications, such as DDE clients and servers. It also contains some of the features we've been waiting for in Windows development environments. There is a speed bar under the main menu bar, providing quick access to commonly used commands.

Most impressive is the context-sensitive editor. The editor provides cues for different elements of a program's structure, as in the screen's italic blue constant strings, boldface black keywords, and red function names. Colors and character attributes are user-defined, of course, and are available in both the DOS and Windows environments. Suitably garish colors can be assigned to catch unexpected characters and preempt some typographical errors.

In addition, the IDE features a graphical class browser, which provides an overview of the inheritance hierarchy. A double-click on a class brings up a scrollable list of class members. A speed-bar button brings up an editor window containing the class declaration. The browser is particularly useful in getting up to speed on a large body of existing code, such as the Borland ObjectWindows Library.

Language Lawyers

In contrast to Microsoft C/C++ 7.0 (see "Microsoft's Lucky Number," September BYTE), Borland C++ 3.1 is intended to comply with the AT&T Cfront 3.0 de facto standard. Microsoft C/C++ 7.0 (also known as C7) is based on the previous Cfront 2.1 release. As more publicly available code and widely read books begin to rely on Cfront 3.0 syntax and features, this will be an advantage to Borland users.

Borland also achieves better marks on C++ compiler validation suites, such as Plum-Hall and Perennial. Of course, this latest-generation compiler retains the ability to compile Kernighan-Ritchie or "classic" C code, with appropriate warnings. Borland C++ 3.1 implements the Cfront 3.0 template mechanism. Templates permit the specification and instantiation of generic classes. Common examples are the container classes: lists, queues, stacks, and so on. Templates make it convenient to declare two classes to represent lists of integers and lists of employees (assuming there is an employee class).

More important, the list template contains a single copy of the code for lists, simplifying maintenance and debugging. In contrast, Microsoft C7 provides a simple macro-preprocessor for achieving results similar to those of templates. By using a preprocessor, the Microsoft mechanism is more flexible, in that template arguments (e.g., integer and employee) can be used in preprocessor directives: This is because there are two preprocessor phases. However, this permits the development of code that is unlikely to be supported under future standardizations of templates.

Borland C++ 3.1 does not implement the exception mechanism that has been discussed by the ANSI X3J16 C++ standards committee. Microsoft C7, in a questionable implementation of the proposal, uses a simple set jmp/long jmp mechanism to modify the call stack when an exception arises. The problem with this is that destructors, which normally would have been called during procedure call returns, are not called as the stack is unwound. This can leave data structures in an ambiguous and volatile state.

Windows Message Handling

Language designers, as a rule, ignore I/O and other such "implementation details," as anyone who has ever internationalized a C program or handled I/O in Pascal can attest. C++ seems to be suffering a similar tale of woe in the area of GUIs. For example, one major motivation for the interest in applying object-oriented languages to the implementation of GUIs is the ability to have class-specific GUI event-handling (or message-handling) routines and to subclass by changing only a few event handlers. Sample events include mouse-clicks, window exposures, and window resize requests.

Unfortunately, because of the large number of events that must be handled, each class incurs the high space and time penalty of lookup in a large virtual-function table. Both Microsoft C7 and Borland C++ provide a way to work around this problem. Microsoft uses a clever macro
scheme to define and implement a single message-handling routine using a sparse table. Borland provides the much simpler mechanism of annotating member function declarations with the set of messages that they will handle.

Unfortunately, this is a Borland-specific extension to the C++ language standard. Although this has enraged the language lawyers, it seems to me to be a fairly insignificant practical issue. Maybe someone will argue that Borland, like the proverbial 700-pound gorilla, will do whatever it wants regardless of the language standard.

In addition, there are many more significant hurdles to portability: The Borland extension seems to be convertible to C7 with a simple script. Furthermore, the time spent in tying events to event handlers is minimal compared to the rest of the software development process—for example, in the X Window System toolkit, many such event "translations" can be defined by the user at run time.

Precompiled Headers

In Windows applications, which are built on deep hierarchies of type and class declarations, the unnecessary recompilation of "-h" header files is a significant overhead cost on each source file. Borland C++ 3.1 uses precompiled headers to speed recompilation, relying on the fact that declarations in header files typically change much more slowly than the corresponding definitions in source files. Headers are compiled automatically (based on a user-settable option) and recompiled when necessary. Borland does all the bookkeeping for you. Microsoft C7 requires specification of a file that contains the precompiled headers. Even though the headers may have changed, you can still use the old precompiled headers. Needless to say, this could be confusing.

Microsoft claims several other advantages in this area, which on second thought appear to be either rarely useful or achievable by other means (e.g., in-lining). Programmers may reserve the right to care about code generation and optimization, but they shouldn't have to care about how to optimize compilation at this low a level, and thus Borland's approach seems more workable. In fact, I hope that such techniques will evolve into incremental recompilation and linking, where a change to a single declaration in a header file will cause recompilation of only those functions that use that declaration (as in Lucid's Energize system for Unix C++ development).

Application Frameworks

Borland's OWL (ObjectWindows Library) provides a significantly abstracted object-oriented interface to the Windows API. There is little change from the 3.0 version of OWL. While Microsoft Foundation Classes are based directly on the structure of the existing Windows API, OWL provides building blocks such as built-in files and editor windows with automatic scrolling. If OWL is deep in some areas, then Microsoft Foundation Classes are broad.

Of course, the wonderful thing about class libraries is that one can compile and use the Microsoft Foundation Classes library within Borland C++. The Borland C++ 3.1 package also includes the Resource Workshop, an integrated tool for specifying the menus, dialog boxes, string constants, and bit maps that form the look and feel of an application, and for modifying these resources within an existing application. Also in the package are WinSight (an improvement on the Microsoft Software Development Kit's Spy program) for tracing Windows messages and displaying window hierarchies, and WinSpector (analogous to Microsoft's Dr. Watson) for trapping and analyzing UAEs (unrecoverable applications errors).

Borland continues to provide support for DOS developers. In addition, many developers will continue to build Windows applications under DOS, using either the DOS IDE or their favorite editors, make files, and the stand-alone Borland compiler. TurboVision complements OWL, providing an application framework for DOS. TurboVision provides classes to support development of event-driven, mouse-and-menu-based applications for DOS, including built-in editor windows and other modules. DOS overlay management, allowing the use of extended memory, is handled by VROOMM, as in previous versions of Borland C++.

Comparisons

There are many other differences between Borland C++ and its main competitor, Microsoft's C7. For example, Borland C++ has advantages in the area of using the power of C++ in DLLs: The OWL itself can be placed in a DLL and shared by several applications (offsetting the size of the library). Other compilers have advantages over the front-runners in 386 support, debugging, or optimization. These and other differences underscore the importance of head-to-head comparison on your project before choosing or switching among the many strong development environments out there, particularly if you have a large body of existing code that you need to work with.

Microsoft has some innovations in C7 (its first C++ compiler). But with several major releases over the past few years, Borland has been a consistent leader in innovation and ease of use in development environments. Borland C++ 3.1 continues this tradition. Its interface and ease of use make it the obvious choice for new C++ programmers, and its stability and portfolio of features make it a serious candidate for the experienced C++ programmer.

Othar Hansson is vice president of Heuristicats Research, Inc., a software R&D firm in Berkeley, California. He received his Ph.D. in computer science from the University of California—Berkeley, and he has been a C++ user since 1986. He can be reached at BIX c/o "editors."
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Circle 185 on Inquiry Card.
If you think the charts drawn by your spreadsheet program look like something you'd find on the wall of a cave, then take a look at DeltaGraph Professional for Windows. DeltaPoint's program has been one of the finest technically oriented charting packages on the Macintosh. Now many, but not all, of these features are available to Windows users.

DeltaGraph can quickly turn a flat chart into a slick and colorful graphic suitable for presentation. The default charts are fairly mundane, but you can easily enhance them with depth, color tints, shadowed text and objects, gradients and shades, illustrations, logos, and slick backgrounds. The bar chart in screen 1, for example, took only minutes to create.

But this program is not just for people whose primary concern is snazzy visuals. Besides basic calculation functions that businesspeople need, DeltaGraph offers data analysis that can serve statisticians and others working in technical, number-intensive fields.

Nevertheless, the Windows product is not without flaws. I found it to be much slower than its Macintosh counterpart. Also, DeltaGraph for Windows had an annoying penchant for redrawing entire screens after I made only minor changes, which added even more time to the creation process. Overall, however, the package brings excellent charting capabilities to Windows users.

The first thing that DeltaGraph Professional has over spreadsheets and presentation programs is a bigger collection of chart and graph types. Most of today's spreadsheets and slide-making programs can do 3-D charts, and a few, like Informix's Wingz and 3-D Visions Corp.'s Stanford Graphics, can do some technical-type graphs. But none has the range of options that DeltaGraph offers. (This could change with the arrival of Stanford Graphics 2.0, which wasn't yet shipping at the time of this review.)

The package comes with 40 basic chart types. These include 2-D standards like column, bar, and pie charts, in regular or stacked format; contour charts, with either two or three axes; text charts; tabular charts; and more esoteric types like bubble, spider, and triangle charts. For people in scientific and technical jobs, there are true x,y,z-coordinate charts, double-y and double-x charts, and a variety of 3-D formats, including wireframe, surface fill, ribbon, and scatterline charts (see screen 2). The program can also do curve fitting and error bars.

Getting data into DeltaGraph is easy. You can use the program's spreadsheet-like notebook window and type in the numbers yourself, or you can import numbers from another program. DeltaGraph can take in data from just about any application, including Lotus 1-2-3, Quattro Pro, and Excel, as well as common formats like dBase, DIF, SYLK, and delimited ASCII. Using DDE and OLE, you can link to other Windows programs (DeltaGraph can work as both an OLE client and server).

DeltaGraph can import just about any...
kind of common graphics file: EPS, TIFF, PICT, PCX, AutoCAD, HPGL (Hewlett-Packard Graphics Language), CMY, Windows metafiles, and Windows bit maps. Harvard Graphics charts can be brought directly into DeltaGraph. Similarly, DeltaGraph charts and objects can be exported in those formats. Everything won’t necessarily look the same when opened up in another application, however, for example, HPGL does not handle perspective text.

The Windows version can swap files with the Mac version. You’ll need a Mac with a SuperDrive to read the PC disks, or a network connection to ship files back and forth; I used both methods successfully. Only once did I hit a snag: A Mac file I brought in over the LAN was missing half its graphs. Somewhere between the Mac and the PC, four graphs disappeared. Otherwise, compatibility appears solid.

Want Some Advice?
After you’ve got the data into the notebook page, all you have to do is press the plot button and then pick the kind of chart you want. A preview of the chart shows up in a little window. By clicking on the names of different chart types, you can see what each looks like. If you’re not confident that you can pick the best type of chart or graph, you can call on the Chart Advisor (see screen 3). This is a mini expert system designed to suggest the best graph according to the number of data points, whether the audience is “scientific/technical” or “business/finance,” and whether you are trying to show a trend or comparison. The advisor makes reasonable suggestions; as with any advice, you can ignore it if you like.

In DeltaGraph, every element of a chart or graph is a customizable object. In order to change the color of a bar, for example, you just select it, then call up the color palette and pick the color you want, and the change is made in the chart. The same goes for styling text, backgrounds, legends, labels, and so on. DeltaGraph’s artistic capabilities are extensive—besides fancy gradient fills and color-mixing tools, the package incorporates basic Bézier drawing tools—so a person with good visual sense could use it to render very attractive data graphics.

Formulas and Functions
Besides its technical charts, DeltaGraph’s calculation tools help it surpass programs like Aldus Persuasion and Harvard Graphics. If you need basic data analysis, like figuring the frequency of certain values, DeltaGraph has a component for building formulas. Working within a dialog box, you click on functions, such as Avg(), Diff(), and Freq(), select source columns, and pick operators by pushing buttons.

The program isn’t meant to be a full-blown analysis package—it supports 50 data functions, compared to Microsoft Excel’s more than 300—but it’s got sufficient functionality to handle many types of mathematical and statistical problems. In fact, statisticians represent a prime target market thanks to the calculation capabilities and technical charts.

Good Variety of Output
DeltaGraph can send files to PostScript or GDI (Graphical Device Interface) printers, which covers just about any output device you’re likely to want to use, including color laser printers, film recorders, and plotters.

You can also print a PostScript file to disk, so you could send it off to a service bureau for high-resolution printing.

A Funny Thing Happened on the Way to the PC
Despite its benefits, the Windows version of DeltaGraph isn’t as good as its Mac counterpart. The most noticeable difference is speed. Generating a fairly typical graph—a 3-D stacked-column chart representing 12 months of sales for six recording artists (similar to the one in screen 1)—can take as much as 2 minutes on a 33-MHz 386. On a “comparable” Mac, the same job takes 13 seconds. In fact, the Mac version generally renders a chart in less than 10 seconds.

DeltaGraph for Windows’ mania for redrawing is even more tiresome. If you make a change to a chart, the program usually redraws the whole thing, as well as anything visible in other windows. This isn’t so bad with plain charts, but it gets tedious with complex graphics. The program first redraws the background, then the grid,
then the chart itself, then any illustration material, and then the labels and legends. Every time you scroll down, for example, the program redraws everything on the screen. If you close one window, the program redraws everything on the screen. One unattractive way around it is to think ahead and try not to make many changes.

The program also has a bothersome way of closing windows. Instead of just clicking on a button in the top left corner of the window frame, you have to go into the File menu and pick Close or go into the Chart menu to delete it. Not a flaw, really, but people who use Windows regularly will find this takes some getting used to. (With the Mac version, the close button works the way it does in every other Mac application.)

Also troubling is DeltaGraph’s handling of backgrounds. You draw a background in one window and then apply it to the chart in another window. But the background window stays up on the screen (one more thing to be redrawn), so you have to put it behind the chart window. I guess this is so you can get to it quickly if you want to make changes. I don’t like calling up a file and seeing the background window sometimes coming on top, obscuring the related notebook page and chart window. Chances are you’re going to want to work with the chart or the data worksheet rather than the background, so it’s strange that the background window gets prominence.

Version 1.0 shows that there are still a few kinks to be worked out, including UAEs (unrecoverable applications errors). Other problems are inconsistencies with text. In one chart, some of the labels came up boldface, some didn’t. I selected them all and changed the style to bold. Only some of them came out bold. In another chart, some of the text came up 24-point shadowed, while the rest came up 14-point plain. Other times I found typos in labels; they weren’t there in the text on the worksheet page. You can fix all these things, but you shouldn’t have to.

The Best Graphing You Can Get
DeltaGraph is used by some serious chartmakers, including The Wall Street Journal, Eastman Kodak, Boeing, Lockheed, and DuPont. There are reasons for that. It has a wide choice of chart and graph types, particularly technical graphs; an excellent set of graphics tools; an adequate suite of data-analysis functions; good support for output devices, including high-resolution devices; and now, compatibility between Windows and Mac environments. Plus, it’s very easy to learn and use.

It’s got flaws and quirks, most of which were acquired in the migration to Windows. But these are not serious flaws. I found no evidence of errors when turning numeric data into visual form. Despite a few idiosyncrasies, DeltaGraph is the top choice for a Windows charting program. Unless you need it today, though, I would recommend waiting for the next (maintenance) release. By then, DeltaPoint will have ironed out the quirks and oddities.

If you’re happy with the charts you can crank out with your spreadsheet program, or if you’re content using Quattro Pro to do presentations, then you probably won’t appreciate DeltaGraph. But if you’re working with statistical or scientific data and need to present it in a visually appealing way, check out this program. At $295, it’s an excellent value.

D. Barker is a BYTE Lab technical editor covering applications software. He can be reached on BIX as “dbarker.”
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Style Meets Substance in Matrox Studio

TOM YAGER

If anything typifies the business environment of the 1990s, it is that we all have more information to deal with and less time in which to deal with it. The same is true for our coworkers, managers, employees, and customers. In this rushed, competitive atmosphere, the packaging of ideas for efficient delivery is becoming as important as the ideas themselves.

There is no medium that combines the ideals of high information density, easy and inexpensive delivery, and image-enhancing power as well as video. One of multimedia's most exciting benefits is the spread of video capabilities from the exclusive domain of Madison Avenue types and pricey video production houses to the hands of general business users. Computers are speeding that movement by lowering costs and hiding the complexity of video technology.

A milestone was passed about two years ago when Newtek introduced the amazing Video Toaster (see "Newtek's Video Toaster Makes Professional Video Affordable," March 1991 BYTE). It established standards for value, output quality, and ease of use that stand today. Now, an exciting new product from Matrox Electronic Systems called Studio promises to raise these standards, putting professional video production power in the hands of corporate communicators, businesspeople, and all those whose livelihoods depend on having their ideas and products understood and adopted.

The abridged description of Studio calls it a PC-based video-editing system. What makes Studio unique is its incredible completeness. In one package comes all the hardware, software, cables, and connectors you need to create your own professional-quality videos; all you have to add are VCRs. You can blend computer-generated graphics and titles with your video, add broadcast-quality digital video effects, and use the automated, computer-controlled audio mixer to manage the audio portion of your production. All this power comes together under an unimimidating Windows user interface; you can literally go from a blank screen to your first professional edit in 10 minutes.

I have to place some emphasis on the word professional. Studio's price tag of $14,000 may strike some as extravagant, but anyone who has looked into the costs of the components of an in-house video production system knows that Studio, while no drop-dead bargain, is a good deal. For $14,000, Studio gives you an eight-input video switcher with digital effects; a six-channel computer-controlled stereo audio mixer with DSP (digital signal processor) digital audio; a 32-bit frame buffer for computer graphics; three channels of time-base correction for video synchronization and quality enhancement; and VCR control for up to four decks. (Studio can be purchased in less expensive configurations, including a $9995 version without the audio mixer and time-base correction.) You needn't invest in costly additional components, and Studio doesn't require you to have the kind of expertise typically needed to purchase and set up a video production system from scratch. All you need is a little creativity and the desire to take control of your own presentations.

I tested Studio using a Media Resources/PC Craft 486-50 EISA system equipped with 8 MB of memory. I used two Panasonic AG-7650 Super-VHS playback decks as sources, one AG-7750 recorder, and a BT-M1310Y professional video monitor. I also used a Truevision AVista graphics board and software from AT&T Graphics Software Labs to create some of the graphics and animation sequences used in these tests. Studio requires Windows 3.1; its drivers install under the Multimedia Extensions, and the editing software is a native Windows application.

Call 1-800-Cable-Me

Studio's hardware side consists of five PC boards (four ISA and one EISA), three of which are tied together with a rigid bus connector (see the photo). You'll also find an astonishingly complete collection of cables, connectors, and adapters. Having configured video systems with makeshift cables many times, I cannot overemphasize the value of having everything included, complete with labels.

Studio's video inputs are versatile. The cable set has four S-Video (most often associated with the higher-resolution Super-VHS and Hi-8 video formats) inputs. One or more of these can be converted, using...
MATROX STUDIO

Studio's hardware consists of five boards (four ISA and one EISA). The first three (working from left to right) handle video, and they communicate with each other via a set of bus sockets along the top of the boards. The fourth is the DSP-based audio processing board. The smaller board below the others is the four-port RS-422 VCR controller.

supplied adapters, to transform a single S-Video connection into two composite video connections. In that way, Studio supports four to eight inputs; you can mix S-Video and composite inputs however you like. It's most beneficial to use S-Video inputs for those devices that support it and to run your entire system on S-Video if possible, since that improves the overall quality. Four external S-Video sources are enough for the most demanding projects.

The VCR control runs through a four-port RS-422 serial card. You don't have the option of using a camcorder or an inexpensive consumer deck; Studio requires high-quality editing decks, but with the cost of this gear declining, it's hardly a heavy burden. Besides, you wouldn't want to hobble Studio with consumer video equipment; you can only expect professional results if all your components measure up.

Studio's Triplecast

Studio takes advantage of brand-new application-specific-IC technology, developed at Matrox, Philips, and elsewhere, to create something that's never existed in a PC before. This technology gives you three independent channels of video that you can combine virtually any way you like. You can switch any of the eight video inputs into this three-channel virtual bus, and you can also use Studio's internal graphics frame buffer as a video source.

Obviously, you can't just throw three video signals onto a screen at once. Each channel has its own digital processing unit. Each unit operates independently of the others, contributing to your output in the way you define. Video can be resized in real time. Making video smaller creates window or picture-in-picture effects, while making video larger than full-screen creates a zoom effect. A video channel can be positioned anywhere, regardless of its size—even completely off the screen.

To get to the screen, the video must pass through Studio's effects unit. This decides which of the three channels actually shows on the screen, and how. For transition between two full-screen video sources, you can wipe, dissolve, or slide one source over another. Video windows can be transitioned in and out without disturbing the underlying video. Among the most intriguing of the effects are those that apply the digital keyer.

Studio's keyer lets you "stack" video channels, with the content of the image in selected channels determining what the output will look like. For a simple example, let's say you wanted to add a quick title to some video. You'd create a simple title graphic: white characters on a black background. You would then switch Studio's keyer into luminance (brightness) mode. A luminance keyer analyzes a video signal and turns everything within a certain brightness range transparent. With a little adjusting, the black background would become transparent, leaving the white title characters in the foreground, "floating" above the video underneath. You just created a video overlay.

If you wanted to use a graphic that had more color, you might use Studio's chroma (color) keyer. This lets you choose a range of colors (instead of brightnesses) that will become transparent. Alpha keying works with still graphics created in software that uses Studio's 8-bit alpha channel. This allows portions of a still image to take on any of 255 degrees of transparency, from opaque to filmy to invisible.

Studio's Ultimatte key mode uses the blue component of a graphic to determine transparency, useful for creating semi-transparent graphical effects in software that doesn't support the alpha channel. While I used still images as examples, most of Studio's key modes can be used with moving video as well.

Finally, a quick note or two on the audio board (referred to as the Virtuoso board),
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MATROX STUDIO

It's an MPC-compliant board, capable of digitizing and playing back audio at up to 44.1 kHz in 16-bit stereo. It also has an on-board music synthesizer and supports external MIDI devices. Virtuoso's mixer controls up to six stereo audio sources, with volume, balance, bass, and treble controls for each channel. Matrox used a general-purpose DSP, which will later bring digital audio effects to Studio.

The Soft Side

For all Studio can do, Matrox's programmers have done a marvelous job of wrapping that complexity in a friendly but not condescending application.

The main interface is the now-familiar collection/storyboard combo. Video segments, graphical images, and digital audio files are organized into "clips" and added to a collection by built-in Studio tools. The video clip editor (see the screen) puts up a comfortable interface on your VGA monitor that includes VCR controls, video and audio adjustment controls, audio Vu (volume unit) meters, and a live video window. Creating a video clip is as simple as using the graphical VCR controls to find the segment you want and marking its beginning and end. Studio digitizes a frame of the video and turns it into an icon, displaying it in the collection.

Once you have clips in your collection, you create your video by dragging and dropping the clips onto the storyboard's time line. A graphic depicts the start, end, and duration of each clip. There are separate time lines for graphics, audio, and multiple video channels. Two special time lines—Audio M/E (mix/effects) and Video M/E—are automatically filled in as you drop clips onto the storyboard. You double-click on the icons on the M/E lines to change the default audio or video mixing. In the case of video, it's the Video M/E time line that controls the type and duration of transitional effects and determines which video channels get displayed.

You can take minute control over each video channel's processing unit through Studio's keyframe effects. These allow you to set starting and ending attributes and then have the software interpolate between them automatically. You could, for example, have a one-quarter-screen video window appear and then gradually grow to occupy the entire screen. You would only have to set keyframes for the size and position of the one-quarter-screen window and the full screen that followed it. Studio would determine the intermediate size and position changes needed to make the window grow as you requested.

The only unpleasant part of Studio for me was that the keyframe effects weren't more automated. For example, you can create the effect of a video frame tumbling end-over-end into oblivion by using the keyframer, but it's an ordeal. A library of common keyframe effects, along with the ability to load and save new ones (a feature presently lacking), needs to be added.

Rewind and Eject

Studio is not the Video Toaster killer some might have been expecting. The Toaster still has the advantage of being usable in a live environment; Studio (its software, that is) can only deal with videotape and still images. The Toaster also includes 3-D animation, and its library of transitional effects is much larger than Studio's.

On the other hand, Studio has some things the Toaster doesn't: S-Video input and output, built-in time-base correctors, audio processing, VCR control, editing software, and video scaling top the list. Some of these can be added to the Toaster at no cost (about $9000). Prior to Studio's introduction, I did just that, and I'm very pleased with the results. Studio does not obsolete the Toaster; in the BYTE Multimedia Lab, they complement each other nicely. But of the two, Studio is clearly the better editing system, requiring less external gear, fewer connections, and fewer steps to a finished video.

If you're serious about doing your own video production, and you care about the quality of the results, Matrox Studio stands out as a well-engineered, well-executed video-editing solution. Software vendors are seeing this, too, since graphics packages like AT&T Graphics Software Labs' Topas and Rio and Autodesk's 3D Studio are being updated to include Studio support. I have no trouble giving Studio my most enthusiastic recommendation.

Tom Yager is director of the BYTE Multimedia Lab and author of The Multimedia Producer's Handbook (Academic Press, forthcoming). He can be reached on BIX as "tyager" and on the Internet at tyager@bytepb.byte.com.
LAN administrators sometimes need to handle problems that require knowing more than just the contents or destination of packets flying over the wire. Application-layer management involves topics that are so high-level they hardly seem to involve the network at all: tracking workstation hardware configuration, determining how many (or which) users are running certain limited-license application, and making changes to system and Windows configuration files at selected workstations, to name a few.

All of these are tasks that can best be carried out by an administrator working from a central management console—the same network administrator who handles low-level cable management. But while there are a host of management packages that will give you all the physical-layer information you require, there are relatively few that provide the high-level (i.e., transport layer through application layer) data required for configuration and asset management.

Microcom’s LANlord 1.0 is the newest of these packages for NetWare 2.15, 2.2, and 3.11 LANs, and it’s probably the most complete. In a single bundle, it gives you a software-metering module, a workstation-hardware-inventory module, a program-activity module, an alert-generating module, an alert-viewing module, and a remote-configuration module. In addition, Microcom promises to send you a virus detection and repair utility when you send in your registration card.

LANlord provides critical information, central management, and remote-editing capabilities, but unfortunately not without a little pain along the way. There are numerous configuration requirements and restrictions that make LANlord more difficult and less complete than such a package needs to be.

LANlord Architecture
LANlord is a client/server design. The server is an OS/2 machine that maintains a MIB (management information base) of over 200 objects detailing configuration and software-use information for each of its network clients. If the OS/2 server has to manage fewer than 20 or 30 clients and has enough horsepower, the LANlord server module can run as a nondedicated task under OS/2. However, the OS/2 machine must be dedicated to LANlord on busy networks.

The server’s clients are LANlord agents that run on DOS and Windows PCs. These agents are the components that determine hardware configurations and monitor software usage. Clients communicate configuration information to the LANlord server at timed intervals over SNMP protocols.

The last component is the administrative module (LANlord Manager), which can run on any Windows 3.0a client on the network (see the screen). LANlord Manager is the administrator’s “front end” to the LANlord server; it’s where the administrator can monitor configuration information or perform administrative tasks.

Because of LANlord’s structure, you need an interesting mix of hardware and software to get it up and running. The server requires a system running OS/2 1.21 or higher (I used OS/2 2.0). At least one workstation must run Windows 3.0a or higher (I used version 3.1). DOS workstations that you want to monitor must run a 19-KB agent TSR program, and Windows clients must also run a WindAgent program for monitoring Windows activity.

What LANlord Can Do
LANlord can track software usage, maintain an inventory of installed hardware and software, and give the administrator remote access to configuration files on each workstation. You access all these capabilities through LANlord Manager at your Windows management console; the information you work with is constantly updated by the clients in real time.

Software tracking meters software for licensing purposes and maintains a history of program usage for each workstation. After you tell LANlord about the software licenses in effect for your site, LANlord monitors the number of concurrent users of that software. You give LANlord the title of the software, the drive letter and path, the number of licenses, and the time interval (in minutes). LANlord should use for recording concurrent access. LANlord generates an alert when someone on the LAN exceeds the license limit. If you don’t specify the drive letter and path, LANlord tracks the usage of all copies of the specified application.

Besides showing usage statistics in numeric form, LANlord can display a graph of software usage. You can see at a glance if you need to buy additional licenses or, conversely, if you’ve bought software that no one uses. LANlord also shows the network administrator a history of programs run on each workstation. You can see this information for all workstations (sorted by workstation or by application) or for a single workstation; you can also specify a single application to keep track of where and when that application has been run.

LANlord’s detection of installed hardware and software is thorough and provides useful information. You get the sort of information at the management console that you would see if you ran a utility such as Norton’s SysInfo at the workstation. A Summary screen shows the workstation’s basic hardware configuration. A Volumes screen gives information about the workstation’s hard drives. The System Files screen lets you view configuration files. The Versions screen tells you whether the workstation’s DOS and network software are up to date. You also get detailed...
LANLORD EVICTS LAN PROBLEMS

pictures of Windows activity (if appropriate), memory utilization, DOS open files and environment information, adapters (including I/O-port, interrupt-request, and DMA-channel assignments), and IPX/SPX network statistics.

Finally, the administrator can remotely edit a workstation's AUTOEXEC.BAT, CONFIG.SYS, WIN.INI, SYSTEM.INI, and SHELL.CFG files. In addition, the administrator can, at his or her discretion, reboot the workstation after making these changes.

Alerts
LANlord provides configuration and usage information whenever you ask for it, but it can also generate alerts when certain conditions occur. A LANlord alert (Microcom calls them traps) can be critical, a warning, or just a notice. You can customize the category of each event and the color scheme LANlord uses for each category.

Alerts include a workstation joining or leaving the LAN, an unknown or incorrect workstation ID, a change in a workstation's configuration files, a workstation accessing a particular file, a workstation exceeding software license limits, the execution of a particular program, a user signaling for help, the detection of a virus, or the exceeding of a threshold you’ve set for that workstation. You can set threshold limits on quantities, including free disk space; available Windows GDI (graphics device interface) Heap or User Heap; or IPX or SPX errors.

LANlord in Action
Installing LANlord can be quick and easy if you already have OS/2 and Windows workstations on your LAN. As you set up LANlord, you can assign workstations to various logical groups; these groups may match the network's physical layout (e.g., the third-floor group) or more intangible organizational quantities (e.g., authorized Excel users). You can establish different monitoring parameters for each LANlord group.

I exercised LANlord on my LAN at home and at the office. Both networks are NetWare 3.11 environments with a mix of OS/2, pure DOS, and DOS-and-Windows workstations—both perfect matches for LANlord. I put all my applications, even shareware registrations, under the scrutiny of LANlord's software metering. I was able to verify over the course of several days that I'm not using unlicensed software. Before I updated the licensed-software list, LANlord dutifully alerted me to the supposed transgressions as I used each unlisted software product.

I found the hardware and software inventory supplied by LANlord complete and accurate. LANlord supplies a wealth of information, including even such things as CMOS configuration. I kept a log to check LANlord's program-monitoring functions; LANlord's history of programs run at each workstation echoed my handwritten list exactly. I also found LANlord's remote configuration and alert features very convenient.

Early Quirks
This is LANlord's initial release; the first version of any software product is bound to suffer from restrictions and limitations that disappear in later versions. But LANlord imposes some restrictions on your LAN that you may not be willing to live with. To Microcom's credit, the developers know about these drawbacks; the README file mentions many of them.

LANlord uses a SAP (service access point) provided by the Novell OS/2 Network Requester. The current OS/2 Network Requester doesn't support multiple SAPs, so you can't run any other SAP application on your LANlord server. In particular, the OS/2 machine can't be both a named pipe server and a LANlord server.

If you have an intelligent hub, bridge, or router on your network that filters NetWare SAP packets, the LANlord packets will fall into the bit bucket. You need to configure such devices to pass NetWare SAP packets, if the device can be so configured.

Microcom says LANlord may fail in the presence of Novell's NMS (Network Management System). The problem seems to be one of missdirected packets between the two management systems. Microcom also says it is working closely with Novell to fix the incompatibility.

Restrictions aren't limited to the LANlord server. The workstation on which you run LANlord Manager needs at least 8 MB of RAM. You can't run SHARE.EXE on a 286 DOS workstation and also run LANlord Manager on that workstation. Unfortunately, SHARE enables file sharing on a LAN, and many applications, such as Paradox for Windows, require that SHARE be loaded.

Agents, too, show a few quirks. The agent TSR program sometimes fails to respond to server requests when enhanced-mode Windows is running on top of the agent TSR and a DOS session is active. And the LANlord Windows Agent, which monitors Windows program activity, runs in standard or enhanced mode but not in real mode.

LANlord loads agent functions into memory from the disk as necessary to keep the size of the resident agent down to about 19 KB. Floppy drive-based computers will feel the slowdown as agent functions swap in and out of RAM. Finally, LANlord agents are compatible with the EMM386.EXE memory manager that comes with DOS 5.0, but not with the version of EMM386.EXE shipped with Windows.

The LANlord Verdict
I found that LANlord did a good job of living up to its promise. The information it displays makes network configuration and control easy. Basically, LANlord keeps a network administrator from having to continually walk around the office fixing things, noting workstation hardware and software configurations, and watching who runs what software.

I recommend LANlord for medium and
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LANLORD EVICTS LAN PROBLEMS

large LANs whose hardware and software configuration is already close to what LANLord needs to run. You can compare the cost of LANLord, at about $100 per node, with the cost of a network administrator's time spent walking around the office; LANLord will pay for itself over the course of a few months if you have an active administrator.

There are a few gaps, however: Since an OS/2 system is required for the server, I wondered why the developers decided to release the product with a Windows interface. For LANLord, a Presentation Manager interface would make more sense. Macintosh and OS/2 agents will be a welcome addition in a future version of LANLord. And I'd like to see LANLord incorporate a software-distribution facility to help manage the dissemination of new files and updates.

Most critically, LANLord is only a partial solution; I'd like to see it expanded or included in a more complete network management tool. If LANLord included lower-layer diagnostics as well as the top-layer features, I'd buy it in a heartbeat. As it is, I'm currently extending the functionality of our homegrown management solution to include a wider range of monitors—from Token Ring beacon detection to available server disk space—because my office needs soup-to-nuts tools. I could buy LANLord, Madge's Ring Manager, and maybe another product, but, considering all the licenses, the complete solution is just too expensive.

Barry Nance, a programmer for the past 20 years and a BYTE contributing editor, is the author of Using OS/2 2 (Que, 1992), Network Programming in C (Que, 1990), and Introduction to Networking (Que, 1992). He is the editor for the IBM Exchange on BIX, where you can reach him as “barryn.”
A modem is a modem, but a shared network modem is more like three devices in one: It can act as a connection point for remote users who need LAN access, a shareable resource for LAN clients that need to reach dial-up services, or a LAN-to-LAN router.

In merging these three functions, the network modem combines many capabilities of communications servers and routers into a single, easily configured box. Naturally, a network modem won't replace a dedicated router or communication server; what you gain in ease of setup and configurability you'll pay for in power and scalability. But for many smaller businesses, or workgroups within large organizations, a network modem provides an attractive, all-around solution to dial-up communications requirements.

In this review, we'll look at two LAN-based modems, the Microtest Lan modem and the Shiva Net modem (see photos 1 and 2). Both are high-speed V.32bis modems that connect directly to Ethernet networks. Both will carry out all the tasks listed above, but the Net modem runs both AppleTalk and NetWare protocols, while the Lan modem works exclusively on NetWare LANs.

On the Wire
Network modems sit directly on the wire, communicating with clients via LAN protocols. Both of the devices we tested are designed for Ethernet connections, but Microtest and Shiva offer versions for other physical topologies, including Token Ring and LocalTalk.

The Lan modem is a dedicated NetWare device—it communicates via SPX/IPX, requires a NetWare server to maintain its boot files, and routes NetWare packets. The more versatile Net modem runs on both NetWare and AppleTalk LANs and in mixed-network installations.

Both the Lan modem and Net modem are V.32bis modems, handling communication rates of up to 14.4 Kbps. Both support V.42 error correction and V.42bis data compression, which can yield speed gains of up to 4 to 1 when communicating with other V.42bis modems. The Lan modem also includes a serial port to which you can connect a second modem for sharing on the network.

These products provide dial-out and dial-in capability through client software bundled with each product. Dial-out client software takes three forms, depending on environment. Under DOS, it consists of an INT14 or other standard communications protocol redirector. Windows clients get a new communications driver that replaces COMM.DRV. Finally, Macintosh clients get a communications driver that can be activated through the Chooser. Dial-in software is similarly dependent on environment, but in every case each remote client requires some software in order to connect to the host LAN.

In addition to the dial-in and dial-out utilities, the Lan modem and Net modem also provide software for administering configuration and security. Typically, these utilities let administrators assign access permissions and configure the modems for LAN-to-LAN connection. One nice feature that both modems support is dial-back, which provides an extra level of security and the convenience of billing your office directly for the connect charges you accrue while working at home.

Microtest Lan modem
Lan modem's Novell-only orientation restricts the networks on which it can be installed, but it makes setup, administration, and use conceptually simple. However, the eccentricities of the user interface common to all the Lan modem's utilities can cause a little frustration.

Once the Lan modem is running, the network administrator sets up communication parameters and user-access privileges. You can set configurations for both...
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Network Modems

Internal and external modems, if an external modem is connected to the serial port. External and internal modems are completely independent, so you can make one available for dial-in and the other available for dial-out, if you wish. You set user-access parameters (e.g., dial-in, dial-out, and dial-back) by checking a box for each NetWare user or NetWare group. Because Lanmodem reads the NetWare bindery directly, you don't have to key in any user names or maintain another group of users—a handy administrative feature.

All the tools for Lanmodem, both administrative and user, run under a GUI created using Zinc Software's interface library. Microtest's GUI was a little hard to work with, because it doesn't quite follow familiar Windows and Mac conventions.

Dialing out with the Lanmodem provided stable, reliable connections, and at 9600 bps it was hard to tell we were using a redirected modem at all. As with all network communications devices, you need to load a DOS redirector in order to access the Lanmodem. You also need a communications program (e.g., the networked version of Procomm Plus) that supports INT14 or NASI (Novell Asynchronous Services Interface) redirectors. Dial-out communications seemed a little hard to use at first, as the documentation didn't make it clear that you could load the redirector without running the graphical shell. However, Microtest's knowledgeable technical-support staff set us straight, and we were able to include loading and unloading the redirector in a batch file that launched Procomm Plus.

On the other hand, dial-in access to NetWare could hardly be easier. Microtest provides a dial-in package called FastLink that includes a full remote IPX stack. When you launch FastLink, it dials up the host you specify in a configuration file. Once the modems negotiate a connection, FastLink loads a packet driver, IPX, and NETX (a total of 69 KB), leaving you at a DOS prompt attached to a remote server—just as if you had loaded a local shell. Note that the packet driver you get with Lanmodem is not generic; you can't run other protocols (e.g., TCP/IP— —we tried) through FastLink's packet driver. The only connection problems we had during dial-in were when using the dial-back feature, and those we solved by tweaking remote modem parameters.

When connecting with 2400-bps modems, we found dial-in access was just too slow to be practical. However, connections of 9600 bps and up were perfectly reasonable and gave a pretty good illusion of local access. That illusion dissolves the instant you try to run a remote program, which requires loading the entire executable file into memory across the wire. FastLink traps remote execution attempts and asks you whether you want to continue or whether FastLink should instead download the file to a local disk for faster future access. FastLink also handles unexpected disconnects, attempting to redial lost connections.

With dial-in, you cannot be a client on both the remote LAN and the local LAN simultaneously. For that kind of access, you need to configure Lanmodem as a router. In its routing mode, Lanmodem routes IPX packets from the local LAN to another Lanmodem or Novell Asynchronous Router on a second network.
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In the 20th Century the first CAD programs were very slow and extremely difficult to use, not to mention the expense of buying them.

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Every client on one LAN then has access to resources on the other, given sufficient NetWare access rights. We tested out the Lammodem routing between our LAN and Microtest’s demonstration network, which ran a second Lammodem router. The connection was very quick, robust, and easy to set up.

**Shiva NetModem/E**

The NetModem/E offers connection services to both AppleTalk and NetWare LANs. Mac users can run NetModem/E software on System 6.x and System 7.0 Macs. As with the Lammodem, you can use the NetModem/E for 14.4-Kbps dial-out, dial-in, or routing.

For Mac dial-out, you use the Shiva Config Control Panel to select what serial port (either modem or printer) gets redirected via the AppleTalk driver to the NetModem/E. You also set time-out intervals here; if no I/O activity takes place on the redirected port for a certain amount of time, the software automatically disconnects the modem. This is handy for occasions when you might leave the Mac unattended during a lengthy download, yet you want the long-distance connection broken after the transfer completes.

You select the NetModem/E from the Chooser, as you would with printers or file servers. One nice interface feature: If the selected NetModem/E is being used by another user—whether it’s a Mac or a Windows PC—you get an alert that tells you who’s tying it up. You can opt to cancel the connection attempt or try to connect later. In the latter case, you’ll get another alert when the NetModem/E becomes available.

You can dial out from a NetWare LAN using either a DOS INT14 redirector or a Windows COMM.DRV replacement. Shiva provides a Mac-like “Chooser” for Windows and DOS that scans for NetModem/E units and pools and attaches them to COM ports. As in the Mac version, a simulated modem display appears on-screen when you launch a communications program. Under DOS we ran the INT14 version of Procomm, and under Windows we used Terminal and Dynamcomm. The modem display, naturally, is much nicer in Windows than in DOS. Yet Shiva’s trademark digitized modem sounds work only in DOS—oddly, there’s no sound support for Windows.

The NetModem/E administrator can establish a list of authorized users but must manually synchronize that list with NetWare and AppleShare servers. We used the NetModem/E to call a variety of services from both DOS and Windows at speeds up to its peak 14.4 Kbps.

Dial-in also supports remote Mac and PC clients. From a Mac, you make a remote connection by double-clicking on an icon in the Network Control Panel. You can also set up dial-in names, phone numbers, and baud rates. Once connected, you appear as a node on the remote network. PowerBook users will recognize this as the same capability provided by Apple’s AppleTalk Remote Access software. While ARA comes bundled with PowerBooks, it isn’t provided with desktop Macs; so Shiva’s Dial-In Access software will be handy for those connecting from home desktop Macs to the office network.

We tested Dial-In Access from a PowerBook 170 using a Global Village PowerPort/Gold 14.4-Kbps modem. We were able to make reliable connections only at 9600 bps. Dial-In Access doesn’t use Apple’s CCL (Command Connection Language) files. CCL files let you select a
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modem by name instead of dealing with AT commands and S-register settings. Shiva’s LanRover/L uses CCL files, but Dial-In Access users must use a Shiva application to configure new modems; we had to do this for the PowerPort/Gold.

For Dial-in access to NetWare LANs, Shiva provides an ODI (Open Data-Link Interface) driver that sends Ethernet packets from your remote PC through a phone line to a NetModem/E sitting on the LAN. You build connection scripts interactively or by editing the sample Shiva provides. Once connected, you load the NetWare shell (IPX and NETX) and log in. You can just call the NetModem/E or arrange to have it turn around and call you back.

You can, and should, also load the optional LaunchGuard TSR program. Like Microtest’s FastLink, LaunchGuard keeps you from accidentally running remote programs. The idea, of course, is to maintain copies of all your programs on the remote PC and use the asynchronous connection to link those programs to LAN-resident data and services. This setup is perfect for client/server applications like Shiva’s own ShivaNet Manager.

However, even with LaunchGuard you can find yourself in an unintentional file transfer. When we fired up the Epsilon text editor from the C drive, for instance, it began loading the first copy of its 70-KB configuration file that it found on the path—which happened to be on the remote network. Fortunately, Shiva provides an escape mechanism—Ctrl-Alt-E—so you don’t have to wait out the transfer or reboot.

Dial-in and dial-out are nifty features, but network-to-network routing is simply stunning. Using ShivaNet Manager, we told the NetModem/E on BYTE’s LAN to call its counterpart on Shiva’s technical-support LAN. Once IPX routing was under way, we could fire up File Manager and literally drag files between Cambridge, Massachusetts, and Peterborough, New Hampshire. With matched NetModem/E’s in the circuit, transfers were really fast. After breaking down the connection, we repeated the same experiment from a Mac. The NetModem/E obligingly set up AppleTalk routing between the two LANs. It worked so seamlessly that we dialed out to MCI using another NetModem/E attached to the remote LAN. (Don’t worry, Shiva, we used MCT’s 800 number.)

Excellent Choices
Network modems are excellent choices for smaller networks that don’t require a full-fledged router or communications server. The most significant problems we had with both the Lanmode and NetModem/E were in configuring remote modems for consistently negotiating high-speed connections.

Selecting between the two will depend mainly on your network. The Lanmode is more expensive than the NetModem, but it offers a second port for easy expansion. If you run AppleTalk or a mixed environment, the NetModem/E is your only option. For NetWare-only LANs, the NetModem/E is also a good choice, but we found that the Lanmode’s tight integration with NetWare made it easier to work with, despite its quirky interface.
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The BYTE Lab, Behind the Scenes

ALAN JOCH

The forward march of processing power combined with dropping prices continues to have a dizzying effect on PCs and workstations. This month, the BYTE Lab is filled with 486 systems that rank near the top of the performance curve. That so many systems meet this classification indicates that high-performance hardware lies within the reach of more people than ever. As the BYTE Lab Product Report makes clear, you can spend less than $3500 today and walk away with a 486 that runs everything from basic word processing programs to Unix. The Solutions Focus, which heads up the reviews section, shows that the PC environment stands head-to-head for price and performance with leading RISC-based workstations.

This doesn't mean that PCs can do it all, of course, but 10 years after the XT legitimized the microcomputer, the platform continues to flourish.

The bottom line is that the development of more-sophisticated hardware and software products is stronger than ever. So, too, are the challenges for those in the BYTE Lab who must learn new technologies and develop appropriate test methodologies to gauge a product's usefulness.

The significance of this hit home recently when we spent an afternoon with representatives of BYTE Brasil, the Sao Paulo-based computer magazine that publishes original material along with editorial from the flagship BYTE. This year's lifting of local trade restrictions will mean a legal flood of computers into that country. For BYTE Brasil, product evaluations will become an important service to its readers. How we built a testing facility and conduct evaluations on an ongoing basis became the foundation for many of the questions that afternoon.

Our Benchmarks
We're proud to have been the first computer magazine to develop benchmarks to rate computer performance. Our benchmark development continues: We've just finished expanding our Windows benchmarks, and we're working on new versions of Macintosh, Unix, NetWare, and DOS test suites. Over the next few months, we'll unveil these upgrades in evaluations that appear in these pages. We'll continue to publicly distribute the benchmarks, and we invite you to use them when you make buying decisions. We'd also like to hear your ideas for how we can improve our next generation of tests.

But while we believe in indexes and charts to quickly show how, for example, one 50-MHz 486 system ranks in performance against a competitor, readers demand more than simple numbers to understand the products we write about. Our testing editors have the technical expertise of some of the most talented programmers and engineers in the computer publishing field. They're also communicators. The same people who conduct BYTE Lab evaluations write the reviews that you see every month. That's the only way to get the hands-on insights that add power to benchmark numbers. This may sound obvious, but until recently, few magazine testing labs used the approach the BYTE Lab has been using all along.

Application-level tests have always been important in our testing, and in the future we'll emphasize them even more. The venerable BYTE Lab application-level benchmarks use commercial software to test how effective a particular product is for database applications, graphics, or word processing. We'll also spend more time doing field work, learning how professionals use a particular genre of products and what questions they'd like answered.

Looking at the BYTE Lab
This month's installment of Reviewer's Notebook launches a new format designed to keep you up to date with the BYTE Lab as it evolves. We'll take you behind the scenes as we develop new testing methods and discuss important technological issues.

The reason for this new format is three-fold. Through phone calls, E-mail, and letters, many readers have expressed the desire to look over the shoulders of BYTE Lab editors. Usually, these questions center on two important areas: how to decide if a particular product is right for your needs, and how to use the product most productively. Each month, those are the two primary issues we address as we develop a Solutions Focus, a roundup, and stand-alone reviews. This new format does not change the other way you have to get answers from the BYTE Lab: Ask BYTE, which has been addressing product and productivity problems for many years, will continue to field your specific questions.

By using this page to invite you into the BYTE Lab each month, we'll address specific issues relating to hardware and software testing. We also hope that you'll come to understand who we are and how we do our jobs, and develop greater trust in our recommendations. Finally, we'll provide a window to the future as we look at the latest technologies hitting the market.

Of course, this will work best if it's interactive: Let us know your questions, concerns, and insights about the subjects we deal with each month. Together, we'll advance the art of product evaluations.

Alan Joch is senior editor and director of the BYTE Lab. You can reach him on BIX as "ajoch."
PC-based circuit analysis just became faster. More powerful. And a lot easier. Because MICRO-CAP IV is here. And it continues a 12-year tradition of setting CAE price/performance standards.

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Now sample MICRO-CAP IV power. It comes, for example, from SPICE 2G.6 models plus extensions. Comprehensive analog behavioral modeling capabilities. A massive model library. Instant feedback plotting from real-time waveform displays. Direct schematic waveform probing. Support for both Super and Extended VGA.

And the best is still less. At $2495, MICRO-CAP outperforms comparable PC-based analog simulators — even those $5000 + packages — with power to spare. Further, it's available for Macintosh as well as for IBM PCs. Write or call for a brochure and demo disk. And experience firsthand added SPICE and higher speed — on larger circuits.
sequence to ponder: 1876 ("Mr. Watson, come here; I want you"), and then 1878 ("First teenage males flung off phone system by enraged authorities"). The teenagers were Bell's first telephone operators, and the litany of their misdeeds resounds down the decades. They talked back to subscribers, took Saint Patrick's Day off without getting permission, but worst of all, "played clever tricks with the switchboard plugs, disconnecting calls, crossing lines so that customers found themselves talking to strangers."

"This combination of power, technical mastery, and effective anonymity seemed to act like catnip on teenage boys." In The Hacker Crackdown: Law and Disorder on the Electronic Frontier, Bruce Sterling next adduces the hacker culture of the 1990s. Verily, some things never change.

Sterling was coauthor, with William Gibson, of last year’s novel The Difference Engine, about a Victorian England in which Babbage’s machine has succeeded (and John Keats lives, a wizard programmer). Gibson, in 1982, had coined the word cyberspace, the sort of word that can annoy in the absence of firm agreement about its scope. Here’s Sterling to the rescue: Cyberspace is “the ‘place’ where a telephone conversation appears to occur.” Not inside one phone or another; no, “the place between the phones. The indefinite place out there, where the two of you, two human beings, actually meet and communicate.”

For decades, cyberspace was a darkness defined by sound. Today, awash in light from computer screens, it’s routinely inhabited by “quite normal people,” even civil servants. "We do not really understand how to live in cyberspace yet," and The Hacker Crackdown is about “certain strange events in the year 1990,” when cops carried seized computers out of dozens of doors and some owners never did find out what, if anything, they were charged with.

There’s a surreal interlude when a registered Republican (and Grateful Dead lyricist) finds himself, on his ranch in Wyoming, explaining "the very nature of computer crime to a head-scratching local FBI man who specialized in cattle rustling." And there’s a wry subliminal when a young man is on trial for stealing from Southern Bell a document valued at $79,449, and after pages of skillful narrative foreplay, our author spreads before us nothing less than the radioactive document itself: mere grim lists of who’s responsible for what in the 911 number system. And for this, jail impends? (Moreover, there was nothing to steal. The document was in the public domain.)

What makes the book work much better than such lurid details suggest is the third of its four parts, "Law and Order." There, Sterling spends time with the Bad Guys, those who seize the equipment of innocents and scare the guts out of bewildered teenagers. And they’re feisty, and they talk sense, and it’s not a black-and-white world. It’s riven by conflicting coordinate systems.

Gail Thackeray, "a trim blond Baby Boomer who favors Grand Canyon white-water rafting to kill some slow time, is one of the world’s most senior, most veteran hacker-trackers." She shares computer fever with her targets, longing for access to "an Amiga 2000 with IBM card and Mac emulation!" And four pages from the end, we are privy to a moving moment in San Francisco.

Ms. Thackeray is at the same party as the kid who was almost juggled over that Southern Bell document. She turns on him "the full lighthouse glare of her attention and begins a determined half-hour attempt to win the boy over." His future should be with her! His skills should be prosecuting Computer Crime! He’s listening with unfeigned attention, saying yes, ma’am.

Too soon yet for a symbiosis. But give both camps, say, another decade.

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. His recent books include Mazes and Historical Fictions. You can contact him on BIX as "hkenner."


Graphics File Formats won’t keep you glued to your seat, nor will it provide you with masterful insights into the inner workings of graphics applications. It will, however, come in handy if you ever need to decode or understand any of the common graphics file formats. The book helps developers decide which graphics standards are most appropriate for their applications. Each format description is accompanied by a section listing the format’s advantages and disadvantages.

CompuServe’s GIF, for example, can be used to exchange images between widely differing input and output devices. It’s widely supported on numerous platforms, and it supports 24-bit color and images of up to 65,536 by 65,536 pixels. On the downside, GIF can have only 256 24-bit colors and cannot store gray scales or color-correction data. Also, it does not store CMYK or HSI model data. Similar feature lists are provided for all formats.

Exploring the depths of graphics file formats is probably not on your daily task list. However, after reading this book, you’ll understand the appropriate uses of each format, and the detailed description is sufficient for you to rummage around inside many of the graphics files and determine how they operate. This is the type of voyage of discovery I enjoy.

—Raymond GA Côté
LITERATE LISTINGS


While you’re waiting for Donald Knuth’s fourth volume of *The Art of Computer Programming*, pass the time reading this new collection of Knuth classics. *Literate Programming* gathers an even dozen pearls, ranging from his 1974 Turing Award address titled “Computer Programming as an Art” to contemporary works on Web and Tex.

The title refers to Knuth’s current quest for readable programs. “All of the major problems associated with computer programming—issues of reliability, portability, learnability, maintainability, and efficiency—are ameliorated when programs and their dialogues with users become more literate.” In short, computers are fully capable of properly deciphering the most amazing mélange of uncommented, poorly spaced code with indecipherable variable names. If, however, the focus changes from writing code for the computer to writing code for other programmers, the result becomes like literature rather than programming.

While the first half of the book presents the whys and wherefores of Knuth’s move to literate programming (and includes one of my favorite Knuth essays, “Structured Programming with go to Statements”), the second half consists of views into Tex, a typesetting program, and Web, a literate programming environment in which Tex is written.

Reading others’ code is a learning experience. By doing it, you can increase your own repertoire of algorithms and solutions. The key is that the reading should be enjoyable as well as educational. Much less is learned from having to wade through turgid code than by sitting down with a good algorithm in front of a warm fire.

—Raymond GA Côté

MORE MAC SECRETS


Scott Knaster wrote the original *Macintosh Programming Secrets*, an enjoyable amalgam of loopy humor and little-known Mac programming techniques. Now he teams up with Keith Rollins to write a second edition. Most of the material is new. And it is the good stuff.

It includes sample code for a movable modal dialog box, a progress indicator (like that used by the Finder during a file copy), intelligent window redrawing using off-screen buffers, and a file copy program that illustrates use of the File Manager. There’s also a discussion of stand-alone code (the stuff of INITs, XCMDs, and WDEFS) with sample code, and a nifty Command-period abort dialog box that gives you control of the computer no matter what by sneaking a look at the Mac’s event queue. The Knaster humor is still there, making an esoteric subject interesting. This is a must for the Mac programmer’s bookshelf.

—Tom Thompson

DIAL SOS FOR SUPPORT

**Support on Site**, $1295 from Computer Library (1 Park Ave., New York, NY 10016, (212) 503-4400; fax (212) 503-3695).

Unless you have had firsthand experience as a technical-support professional, you can never imagine how wide-ranging, challenging, esoteric, and downright flaky some support requests can be. Supporting a large group of users requires a broad knowledge of applications and hardware, a shelf full of reference materials, and personality traits such as patience, persistence, and a sense of humor.

The new Support on Site series from Computer Library puts all the reference materials in one place. The first title to be released, SOS for Applications, packs a large reference set onto a single CD. Computer Library updates it monthly with material from software manuals, technical notes, newsletters, and even program code fixes and software drivers. An annual subscription sells for $1295 (single user) or $4995 for the LAN version (five concurrent users).

Computer Library is still building up the product’s content, but it has already covered many popular programs, including Windows 3.1 and OS/2; dBase for the PC; and the PC and Mac versions of Lotus 1-2-3, WordPerfect, and Excel. As of the August edition, coverage of PC applications far outnumbered Mac product references.

SOS is packed with valuable tips, fixes, and workarounds, but organizationally it appears as a hodgepodge of technical data from divergent sources. As such, it’s less accessible than other reference works. Although each document contains a header of descriptive fields, much of the information just doesn’t lend itself to simple classification.

Accessibility of information is crucial in support work, where you rarely look for a clearly defined subject. You usually research complex problems involving many hardware and software elements, and it’s hard to encapsulate such problems in a simple search.

The search-and-retrieval software starts with a field template to narrow your search to a particular application or publication. From there, you can use Boolean operators (i.e., AND, OR, and NOT) to create search expressions. You can also negotiate proximity searches, looking for *Windows* within 10 words of *network*, for instance. Anyone familiar with the interface of Computer Library’s Computer Select CD-ROM will feel right at home with SOS.

This is not a CD for browsers or nontechnical users. The structure and content are not accessible enough to accommodate casual use. However, technical-support professionals will find SOS useful as a comprehensive reference tool and a way to keep up with the steady stream of technical updates.

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The meeting with the famous Dr. Kruschel was two months ago, and you distinctly remember writing down an important idea and filing it under Kruschel. Or was it Kruchel? No, Kruchell. Can't find it. How about Kruchel? Oh, no, this idea is crucial now, and there are just too many spelling possibilities!

If the amount of data you have is small, you may be able to look everywhere (e.g., you can look at all names that start with K). But if you have megabytes' worth of text and the only way to find something is by searching for names, technical terms, or other keywords or patterns, a typo may be equivalent to dropping a folder behind the filing cabinets—it's virtually lost.

Searching text through pattern matching is a common operation in many applications, ranging from word processing to molecular biology. But sometimes the pattern does not appear in the text exactly, and errors in the text or in the query can result from problems like misspellings or transmission errors. Most text editors and search programs do not support approximate searches because of the complexity involved in implementing such a procedure. But some new algorithms may change that.

Below, we describe one such algorithm in sufficient detail to enable you to include it in your own programs. We also describe agrep, a Unix software tool for approximate pattern matching that we developed. Agrep includes many options that make searching powerful and convenient.

Imagine how nice it would be if you didn't have to write down the exact spelling of everything. Instead of guessing all the possibilities every time you need to spell Kruschel, you can just try something similar and let the program find out the right spelling. If you use agrep, you can search approximately for Kruchel in a whole directory (or even several directories), and instead of getting No match, you might get The best match has 1 error; there are 4 such matches; do you want to see them?

Think of a system that automatically suggests alternatives every time it sees a word it doesn't understand. If you typed cd personal/travel/Massachusetts/hotels, the system would not reply personal/travel/Massachusetts/hotels: No such file or directory. Instead, it might say, do you mean personal/travel/Massachusetts/hotels? Such systems can't come soon enough for those of us who can't type or spell well. Approximate matching is useful, fast, and not too hard to do.

**Exact String Matching**

The first thing you must do when designing an algorithm is define the problem precisely. Often, it's best to start with the simplest nontrivial variation of the problem and go from there. As Einstein once said, "Make it as simple
as you can, but not simpler than that.” So we’ll forget the word approximate for a moment and concentrate on exact string matching.

We represent the text and the pattern as sequences of characters. Think of the characters as English characters, but they can be any symbols, such as DNA base pairs, lines of source code, angles between edges in polygons, or music notes and tempo in a musical score.

We’ll denote the text by \( T = t_1, t_2, \ldots, t_n \) and the pattern by \( P = p_1, p_2, \ldots, p_m \). Generally, \( n \) is much greater than \( m \). The basic string-searching problem is to find all occurrences of \( P \) inside \( T \).

The straightforward solution to this problem is to start by comparing \( p_1 \) to \( t_1 \), and continue comparing \( p_i \) to \( t_i \), and so on, until we either complete the match or find a mismatch. In the latter case, we must go back to the place from which we started the match (at first), move on one character (to \( t_2 \)), and try again. This process is illustrated as shown at right. The pattern is \( \text{vivid} \), and the piece of text we are searching in is \( \text{vivi&dv&vivid} \).

We’ve indicated mismatches in bold type. The first four characters match, but the fifth does not. We cannot continue matching from \( \& \), because the third and fourth positions in the text (vi) match the beginning of the pattern and may be the start of a complete match. We have to try every beginning as shown.

\[
\text{vivi&dv&vivid} \\
\text{vivid} \\
\text{v} \\
\text{v} \\
\text{v} \\
\text{vivid}
\]

**Boyer-Moore Filtering**

There are many ways to improve on this straightforward solution. The two most famous ones are the Boyer-Moore algorithm and the Knuth-Morris-Pratt algorithm (see Gonnet in the bibliography).

The Boyer-Moore algorithm is usually the fastest algorithm for exact string matching. It has many variations, but the main idea is this: The first comparison is not between the first character in the pattern and the first character in the text, but between the last character of the pattern and the \( m \)th (fifth in our case) character in the text.

In our example, we would compare \( \& \) to \( \& \); we have a mismatch right away, so we can shift the pattern. The key idea is to look at the character in the text that caused the mismatch (in this case, \&) and see where this character can fit in the pattern. \& does not appear at all in our pattern; therefore, we can safely shift the whole pattern \( m \) positions to the right.

The next comparison is between the last character in the pattern and the tenth character in the text (moving \( m \) steps from the fifth position). The tenth character is \( i \), which does appear in the pattern in the second and fourth positions. The only safe shift is by one, because the \( i \) in the text may match the fourth position in the pattern; so now we look at the eleventh character in the text, \( v \), which appears in the pattern in positions 1 and 3.

The safe shift now is by two (which is the size of the pattern minus the last position of the text character in the pattern). That gets us to the thirteenth character, \( d \). Now we have a match of the ds, and we continue backward, to check whether the

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whole pattern matches (which it does, in this case). If there is a match of the last few characters and a mismatch in the middle, we can shift by one, as in the straightforward algorithm, or use other techniques for determining a better shift.

The main advantage of this method is that most of the time there will be mismatches that will lead to large shifts. In our example, only eight character comparisons are used, versus 20 comparisons for the straightforward method. We recently extended the Boyer-Moore approach to approximate matching, and it is used in some parts of the latest version of agrep. But other parts use a much more general and elegant algorithm, based on a remarkable algorithm by Baeza-Yates and Gonnet (see the bibliography).

The Shift-AND Algorithm

Assume for the moment that you’re looking not only for all matches of the pattern, but also for all matches of all prefixes of the pattern. This requires much more information; but, as is sometimes the case in algorithm design, more is easier to obtain.

In our example, we are looking for all occurrences of five patterns: \( v, vi, viv, vivi, \) and \( vivid \). We build a table that will indicate, for each position in the text, whether this position is the end of any of these five patterns. For each text position, we will have a bit array of size 5, such that the \( k \)th bit is 1 if this position is the end of a match to the \( k \)th prefix. Overall, the table will consist of \( m \) rows and \( n \) columns of bits:

\[
\begin{array}{cccccc}
\text{vivid} & \text{dv} & \text{vivid} \\
v & 1010001010100 \\
in & 0101000001010 \\
v & 0010000000100 \\
i & 0001000000001 \\
d & 0000000000001
\end{array}
\]

We are mainly interested in the last row, which indicates a match to the whole pattern, but the other rows will become important shortly.

Let’s formalize what we’ve done so far. We denote by \( R_j \) the \( j \)th column of the table. \( R_j \) is a bit array of size \( m \), such that

\[
R_j[k] = 1 \text{ if the first } i \text{ characters of the pattern exactly match the } k \text{ characters preceding and including } t_j \text{ in the text (i.e., if } p_1...p_i = t_j + i \text{).}
\]

The question is how to evaluate this table quickly. The first observation is that the \( j+1 \)st column depends only on the \( j \)th column, the pattern, and \( t_j+i \). For example, there is a match for \( viv \) at \( j+1 \) only if there was a match for \( v \) at \( j \) and \( t_j+i = v \). In other words,

\[
R_{j+1}[k] = \begin{cases} 
1 & \text{if } R_j[k-1] = 1 \\
\quad \text{and } p_i = t_{j+i} \\
0 & \text{otherwise}
\end{cases}
\]

Initially, \( R_0[k] = 0 \) for all \( k \), \( 1 \leq k \leq m \), and \( R_j[0] = 1 \) for all \( j \), \( 0 \leq j \leq n \).

The recurrence above can be translated directly into a program that requires one IF statement to compute each entry in the table. But we can do much better. If the pattern’s size is no more than 32, we can represent each column (which is just a bit array) as a one computer word. As we show next, a whole column can be computed quickly.

Look at columns 1 and 2 in the example above. There are two conditions to have 1s in column 2: (a) 1s can be only at positions where there is an \( i \) in the pattern (because \( t_i = 1 \) ), and (b) a 1 can be at a given position in column 2 only when the previous position in column 1 was a 1. Condition (a) ensures that the last character \( t_2 \) (in this case) matches, and condition (b)
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ensures that the previous characters match.

To check for condition b, we simply shift column 1 downward. To quickly check condition a, we prepare (ahead of time, when we first see the pattern) a characteristic vector of size m for each alphabet character. The characteristic vector for character i, for example, has a 1 in positions 2 and 4, which are the positions in the pattern where a 01010. The characteristic vector for i, in which case condition a, and a 0 for all other characters, is 00000.

To take care of condition a, we match the vector obtained by shifting column 1 downward (column 1 is 10000; after the shift, it is -1000) with the characteristic vector obtained by shifting column 1 upward (column 1 is 10000; after the shift, it is 01010). The characteristic vector for position 1, in which case condition a, and all other characters, is 00000.

Suppose that instead of vivid, you are looking for all words that have five characters and an i in the second and fourth positions (which is how we searched the dictionary to find vivid as an example). A common way to indicate this pattern is "i...", where "..." stands for any character.

The shift_AFD program in listing 1 can handle this pattern without any modifications. The only thing we need to do is to change the preprocessing slightly. We simply add 1s in the first, third, and fifth positions to the characteristic vectors of all characters. This indicates that the first, third, and fifth positions match all characters. To exclude digits, for example, we just set their characteristic vectors to 00000.

It gets even better. We discovered that you can extend this algorithm to support approximate pattern matching in a very general way. This discovery was the basis for the development of agrep (although agrep now uses several other algorithms as well) and the ability to provide general-purpose approximate pattern matching.

**Approximate String Matching**

Let’s try one substitution error. In our example, we want to search for all the occurrences of vivid with possibly one

---

**Listings**

**Listing 1: The shift-AND algorithm for exact string matching.**

```c
#define WORD_SIZE 32 /* the size of a computer word */
#define MAX_SYM 256 /* the size of the alphabet */
unsigned int CV[MAX_SYM]; /* the characteristic vector */
char pat[WORD_SIZE]; /* the pattern (bounded by WORD_SIZE) */
unsigned int m; /* length of the pattern */
unsigned int bit[WORD_SIZE]; /* bit[i] has a 1 in the ith bit only */

preprocessing(pat, CV) /* compute the characteristic vectors */
char *pat;
unsigned int *CV;
{
  int i, j;
  m = strlen(pat);
  for (j=0; j<WORD_SIZE; j++) bit[j] = (1 << (WORD_SIZE - j - 1));
  for (i=0; i<MAX_SYM; i++)
    CV[i] = 0;
  for (j=0; j<m; j++)
    if (pat[j] == i) CV[i] = CV[i] | bit[j];
}

shift_AND(text, textend, CV)
char *text, *textend;
unsigned int *CV; /* the characteristic vector table */

preprocessing(pat, CV) /* compute the characteristic vectors */
char *pat;
unsigned int *CV;
{
  int i, j;
  m = strlen(pat);
  for (j=0; j<WORD_SIZE; j++) bit[j] = (1 << (WORD_SIZE - j - 1));
  for (i=0; i<MAX_SYM; i++)
    CV[i] = 0;
  for (j=0; j<m; j++)
    if (pat[j] == i) CV[i] = CV[i] | bit[j];
}

Listing 2: The new main loop for dealing with one substitution error.

```
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character changed. We compute two tables. One table, $R$, is identical to our previous table, and it is computed in the same way. The other table, which we denote by $R^t$, is similar to the first table, except that it shows all matches that either are exact or have one substitution.

\[
\begin{align*}
&vivi\& dvivid \\
&v 1010001010100 \\
&i 0101000010100 \\
&v 0010000000001 \\
&i 0001000000100 \\
&d 0000000000001
\end{align*}
\]

Look first at the fifth column of $R^t$. This column differs from the fifth column of $R$ in the first, third, and fifth positions. Indeed, $vivi\&$ matches the pattern $vivid$ with one substitution, $v&$ matches $viv$ with one substitution, and $d$ matches $v$ (the first row of $R$ is always 1).

We can discover the match with one substitution of $vivi\&$ to $vivid$ by looking at the fourth column of $R$ and finding the exact match of $vivi$. If there is an exact match up to the last character, then there is always a match with at most one substitution (there may be an exact match, but we don't care, because $R$ will indicate it). So one way to add 1s to $R^t$ is by shifting down the previous column of $R$ without the AND.

Now look at column 10. In $R^t$, column 10 is 11010. The second row is 1 because of an exact match (vi), which is covered by the shift. The fourth row corresponds to the match of vasi against viv, in which the substitution occurred earlier. We can discover that match by looking at the third column of $R^t$, checking that there is a match (with one substitution) of vavv, and verifying that the last character (i) matches.

Overall, all possibilities can be handled with just two additional arithmetic operations. If the substitution is for the current text character or there is an exact match, then shifting the previous column of $R$ will discover the match. If the substitution occurred earlier, then shifting (with 1-filling) the previous column of $R$ and performing an AND on it with the characteristic vector will discover the match. Listing 2 shows the new main loop that checks for one substitution error.

Now we will deal with insertions and deletions. An insertion or deletion that happened earlier is already indicated by the previous column of $R^t$; it can be detected by the exact same shift and AND operation that detected an earlier substitution. An insertion at the end can be detected by copying the previous column of $R$ (without a shift). And a deletion can be detected by shifting the current (new) column of $R$.

For example, the third column of an $R^t$ that covers substitutions, insertions, and deletions would be 111110; the fourth column comes from a match of vivi to viv by deleting the last i, and we detect it by shifting the third column of $R$. The second 1 can be obtained in two ways: We can match vivi to viv by inserting the last i (which we detect by copying the second column of $R$), or we can match vi to vii by deleting the character i.

\[
\begin{align*}
&vivi\& dvivid \\
&v 1111111111111 \\
&i 0101001001010 \\
&v 0010100010101 \\
&i 0001000001010 \\
&d 0000100000001
\end{align*}
\]
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the i. Overall, substitutions, insertions, and deletions can be handled with four arithmetic operations.

Furthermore, if you want to allow more than one error, it’s no big deal. You simply maintain one additional table for each error and use similar transitions from one table to another. This algorithm supports arbitrary wild cards, range of characters (e.g., all digits), complements of characters (e.g., anything but blank), and a whole host of other options. In fact, you can even extend it to search for any regular expression, even with errors.

Agrep
Motivated by this algorithm, we developed agrep for approximate or exact pattern matching in Unix. It’s as fast as any other grep that we know of for exact string matching (it takes about 0.1 second of user time to search a simple string in a 1-MB file on a Sparcstation II), and it can do much more.

A typical use of agrep is to search for patterns in text files as follows:

```
agrep [ -OPTIONS ] pattern
[ -f patternfile ]
filename(s)
```

The file or files are typically scanned line by line (but not always; see below), and all lines containing the pattern are output. Agrep has three significant features not supported by other greps. The first is the ability to search for approximate patterns. For example, agrep -2 Krushell ideas-file will find Krushal, Kruchel, Krusche/, and any other word that can be obtained from Krushell with at most two substitutions, insertions, or deletions, or any combination of these. (This search took 1.3 seconds of user time in a 2-MB text file on a Sparcstation II.) If you don’t want to, you don’t have to specify the number of errors: agrep -B breacracy /usr/dict/words scans the dictionary for the best match to breacracy, which is great for someone who doesn’t know (and maybe doesn’t want to know) how to spell bureaucracy.

It is even possible to assign different costs to insertions, deletions, or substitutions. For example, agrep -1 -T2 -d555-3217 address-file will output all lines containing numbers that differ from 555-3217 by at most one digit. The -1 option sets the cost of insertions (-0 sets the cost of deletions); in this case, setting it to 2 prevents insertions and deletions.

Agrep’s second advantage is that it’s record-oriented rather than just line-oriented. A record is, by default, a line, but it can be user-defined; for example, agrep -d "^From -l Kruschel mail- file outputs all mail messages containing "Kruschel" at most one error (mail messages in Unix start with "From", and the -d option defines records separated by the given delimiter).

Agrep’s third major advantage is that it supports Boolean queries. For example, agrep -d "XXX/ "Kruschel;[8-9]/#92/ ideas-file outputs all ideas (which we assume are separated by XXX) containing "Kruschel" and a date that starts with either 8 or 9 and ends in 92 (that meeting was about two months ago, right?). The symbol # stands for arbitrary wild cards—that is, anything, of any length, can replace it.

These options can be combined with other new options to form powerful queries. Two examples follow:

```
agrep -i -d "===" -l <bytes>;
Manb;matching;<199(1-2)> bib- file outputs all records (separated by
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Low Radiation models are available for additional protection against electromagnetic radiation emitted by all CRT's during normal use.

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<table>
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<th>Name</th>
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<td>$\Gamma(z) = \int_0^\infty t^{z-1}e^{-t} , dt$</td>
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<tr>
<td>Sine</td>
<td>$\sin(z) = \frac{1}{2i} (e^{iz} - e^{-iz})$</td>
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<tr>
<td>Zeta</td>
<td>$\zeta(s) = \sum_{k=1}^{\infty} k^{-s}$ (Re $s &gt; 1$)</td>
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(==>) referencing articles in BYTE (the -i makes it case-insensitive) in 1991 or 1992 by Manber (or something like that—one error is allowed) and dealing with matching. The error cannot be in either BYTE or the year (the angle brackets forbid errors in the pattern between them).

Agrep -p -5 abcdefghij /usr/dict/words outputs all words in the Unix dictionary that have at least five of the first 10 letters of the alphabet in order. The -p option makes insertions free everywhere, so, for example, it can be used to give acronyms and find the full name. Since we don’t pay for insertions, only deletions make sense, which is why the query has the meaning it has. The reply to this query (at least on our machine) starts with academia and ends with sacrilegious. We’ll tell that to Dr. Kruschel the next time we see him.

Editor’s note: The source code for agrep is available on the Internet by anonymous ftp to cs.arizona.edu. You’ll also find it on B!X in the frombyte92 listings area.

BIBLIOGRAPHY


Udi Manber is a professor of computer science at the University of Arizona. He won the Presidential Young Investigator award in 1985 and is the author of Introduction to Algorithms—A Creative Approach (Addison-Wesley, 1989). Sun Wu is a member of the technical staff at Bell Laboratories in Murray Hill, New Jersey. Both authors won the best paper award at the 1992 Usenix Winter Technical Conference for their work on agrep. You can reach them on B!X c/o “editors” or on the Internet at udi@cs.washington.edu and sw@cs.arizona.edu, respectively.
A Call to ARM

Apple's decision to use the U.K.-designed ARM610 CPU chip in its Newton PDA (Personal Digital Assistant)—and in future PDAs—may have come as a surprise to many people. Before Apple's announcement (see "The PC Gets More Personal," July BYTE), Advanced RISC Machines' ARM architecture was not at all well known in the U.S.

What's the attraction of the ARM610? This 32-bit RISC CPU combines fast processor speed and low power consumption in a small package. For hand-held systems such as Apple's Newton, this is an ideal combination.

The basic ARM design has been around longer than any other commercial RISC processor. I first wrote about it in the January 1986 BYTE (see "The Acorn RISC Machine"). At that time, ARM stood for Acorn RISC Machine, a computer from U.K. PC manufacturer Acorn Computers. Acorn designed the original ARM in 1983 (see the text box "Origins of the ARM" on page 296). Then in 1989, Olivetti bought Acorn, and in 1991 it spun off all ARM development into ARM, Ltd., a research, design, and marketing venture jointly owned by Olivetti, VLSI Technology, and Apple Computer. ARM's chips are manufactured under license by VLSI Technology in the U.S. and by GEC Plessey in the U.K.

An ARM6 Overview

ARM's commercial strategy is to design custom ASICs (application-specific ICs) based on the ARM6, a macro-cell implementation of the original ARM CPU architecture with 32-bit addressing. A macro cell is the VLSI CAD equivalent of a subroutine; it's a complete predesigned (and debugged) circuit element that you can drop into a new design without modification.

The ARM6 is so simple that its CMOS implementation uses only about 33,500 transistors and occupies very little silicon area when compared to rival CPU designs; Intel's 486 requires 1,200,000 transistors. The ARM CPU element consumes less than one-quarter of a small silicon die, leaving room for other components that a customer chooses for specific jobs. For example, in the embedded controller market, a customer might specify some on-chip ROM to hold the control software, and a UART (universal asynchronous receiver/transmitter) for serial communications.

The ARM610 is one such specific ASIC design, intended especially for advanced hand-held, battery-powered computers. In addition to an ARM6 CPU core, the ARM610 contains a 4-KB instruction and data cache, a write buffer, and an innovative MMU (memory management unit) that's optimized for the needs of an object-oriented operating system (see figure 1). The instruction set is small, as you'd expect of a RISC design, and all instructions are conditionally executed (see the text box "The ARM610 Instruction Set" on page 297).

Although the ARM610 is a custom design for Apple,
The ARM610 RISC CPU contains a 4-KB instruction and data cache, a write buffer, and an innovative MMU that's optimized for the needs of an object-oriented operating system.

When you're designing a hand-held, battery-operated computer, raw speed is not the sole CPU performance criterion. Pen-based computers running handwriting-recognition software need plenty of processing power, but power consumption and physical package size are more important. The ARM CPU, capable of 20 to 25 MIPS, isn't a performance leader when compared to newer RISC designs like Sun's SuperSparc, the Mips R4000, and DEC's Alpha, but it offers the best combination of speed, size, and power consumption for hand-held systems.

The ARM610 yields a speed-to-power ratio of about 0.35 MIPS per milliampere, five times better than the SparcLite's and 10 times better than the Motorola 68030's.

The ARM610 is thrifty because it's implemented as a fully static CMOS device; you can stop and restart the system clock at any point in the instruction cycle with no loss of state information. Other low-power designs, like Intel's 386SL, are fussier about when you stop the clock, and they require extra logic to restart safely. The ARM610 also contains other tricks to minimize power usage—especially by the potentially power-hungry cache and MMU.

Good manufacturing yields, a consequence of its small (22-mm) die size, make the ARM610 competitive in dollars per MIPS as well. The ARM610 comes in a 144-pin plastic surface-mount thin-quad flat package, which is the size of a postage stamp and only 1.4 mm thick. In order to squeeze the 22-mm-square die into this tiny package, the manufacturers grind down the backs of the finished silicon wafers to a thickness of less than a millimeter before cutting them up.

Core Architecture
The ARM610's CPU core is a 32-bit microprocessor of classic RISC design, with full 32-bit data and address buses (see "RISC Basics," April 1991 BYTE, page 298). All ARM instructions are 32 bits long, are decoded directly by hard-wired control logic, and use no microcode. The CPU has only 10 types of instructions, most of which execute in a single cycle. It has a three-stage execution pipeline, so one instruction can execute while the CPU decodes its successor and fetches a third from memory.

ARM's pipeline is shallow and simple compared to recent radical designs such as the Mips R4000 and DEC's Alpha; there are no instructions that manipulate pipeline sequencing explicitly. As a result, the ARM610 cannot equal those processors for sheer burst speed, but it's straightforward to program in assembly language (you don't have to worry about complex pipeline dependencies) and presents an easy target for compiler writers.

ARM's 32-bit data path contains a 32-bit hardware multiplier and, as an unusual touch, a barrel shifter that is closely coupled to the ALU. Most ARM arithmetic and logic instructions contain a bit field
that can specify a shift of their second operand register so that you can combine, say, an add and a shift (or a rotate) into one instruction. The CPU uses the barrel shifter internally to align data and to extract bytes from whole words during byte-addressing operations.

As is usual for a RISC processor, the ARM610 employs a load/store architecture where data-processing operations take place only between register contents; they never take place directly between a register and memory (or between memory and memory). The ARM610 has 37 32-bit registers, of which 31 are general-purpose data registers and six are status registers (see figure 2).

However, only 16 of these data registers (R0 through R15) and only two of the status registers are ever visible to the programmer and to user programs. Of these, register R15 is reserved as the program counter. The other 15 data registers, called banked registers, get switched in whenever any sort of exception is processed for the ARM610's own internal use. In this way, the ARM610 preserves the contents of the user registers without writing them to an external memory stack. This is how the ARM610 gets its quick response to interrupts, exceptions, and context switches, which makes it a suitable processor for real-time systems.

The ARM610 processor operates in six different modes that can be switched by software or by external hardware signals. User and supervisor modes are for normal program and protected operating-system use. FIQ (fast interrupt request) and IRQ (interrupt request) modes are for interrupt handling. FIQ mode has a minimum interrupt latency of just four processor cycles and a worst case of 26 cycles, which is less than 5 microseconds in a 25-MHz system. Abort mode is for handling address exceptions from the MMU in virtual memory systems. The ARM610 enters undefined mode whenever an undefined instruction is executed. It uses this mode to trap coprocessor instructions issued when the required coprocessor is not present and to vector out to a suitable software-emulation routine.

The ARM6 core is basically an integer CPU with no floating-point hardware, but it has an on-chip coprocessor interface that it can use to access up to 16 external coprocessors. Three of the 10 ARM6 instruction types are reserved for coprocessor instructions, so off-chip functions look completely consistent with internal functions from the programmer's view.

The ARM610 design ignores this external coprocessor interface (i.e., it's not brought out to the chip's pins), so you can't
Origins of the ARM

Acorn, designer of the ARM (Advanced RISC machine) architecture, was founded in 1979 by Chris Curry and Herman Hauser, both of whom had previously worked with Sir Clive Sinclair, inventor of the legendary Sinclair Research ZX80. The firm shot to success by winning a BBC design competition for an advanced personal computer to accompany an educational TV series. The BBC Computer (which users nicknamed the “Beeb”) used Motorola’s 8-bit 6802 processor. The Beeb was advanced for its time; it had higher-resolution color graphics than the Apple II and a fast (2-MHz) processor.

By 1983, Acorn was looking for a successor to the 8-bit 6502, which had reached an evolutionary dead end. Acorn’s designers were unimpressed by Motorola’s 68000 and Intel’s 8086. The BBC system software depended heavily on the excellent interrupt response of the 6502, and adopting the comparatively sluggish 68000 would have meant adding lots of DMA and other hardware complications. Instead, Acorn bravely—some say foolishly—designed its own CPU, the true heir to the 6502. A 32-bit CPU, the ARM CPU skipped a whole generation. Acorn’s third-generation chip, the ARM3, furthered the ARM’s designs.

The most radical aspect of the ARM610 is its MMU, which combines a sophisticated conventional virtual memory controller with a novel scheme for partitioning memory along object-oriented lines. This aspect of the chip’s design is the subject of a patent held by Apple Computer and licensed to ARM.

Virtual memory is the use of secondary storage (typically a hard disk) to extend the amount of available RAM by transparently swapping blocks between disk and memory. Instead of accessing physical RAM locations directly, all application programs work through virtual addresses.

The virtual address space is much larger (often measuring gigabytes) than the actual amount of RAM present, and it is divided into units, called pages, that get swapped between disk and memory. The MMU keeps in memory a set of tables that map the virtual page addresses into physical RAM locations.

When a program tries to access an object whose virtual address falls in a page that’s not in memory, the MMU raises a special kind of exception called a page fault. The CPU traps this fault and then jumps into an operating-system routine called the virtual memory manager, which swaps in the required page (and in so doing may swap out another page to make room). The MMU then updates its page tables, the suspended task restarts, and the memory access succeeds as the MMU translates the virtual address into a real memory address.

The ARM610 MMU maps both virtual addresses and memory-access rights. Every address is protected by permissions, in much the same way as files are protected under Unix. When a task attempts access, there are two considerations: whether the address is actually in RAM, and whether the requester has permission to access it. Attempting to access an address without permission results in a permission fault exception. The novelty of the MMU is that it maps virtual memory and permissions as separate, orthogonal concepts.
The ARM610 Instruction Set

The ARM610's instruction set is small and regular, as you would expect from a true RISC processor. The most unusual fact about ARM (Advanced RISC machine) instructions is that they are all conditionally executed. The 4 most significant bits (28 through 31) of every instruction code form a condition field that is compared with the contents of the N, Z, C, and V flags in the PSR (program status register) before execution. Only if this test succeeds will the CPU execute the instruction.

Unexecuted instructions don't cause an abort, but instead proceed through the pipeline, acting like a NOP (no operation). Conditional instructions let you avoid writing explicit branch instructions in many cases, and since a skipped instruction is less costly than the pipeline break caused by a branch, this greatly improves the processor's throughput. RISC processors with deeper pipelines, like the Sun SuperSparc and Mips R4000, have adopted more complex schemes such as "delayed branch with annulment on branch not taken." This approach may be faster, but it lacks the elegant simplicity of the ARM scheme.

In truly object-oriented systems, objects are protected entities; only those tasks that are methods of the class of which an object is an instance can legally access it data. Enforcing this protection in software is a slow process, since it requires that all data be accessed indirectly via a class table. The ARM610 supports this protection efficiently in hardware. By combining address and permission mapping, the chip can divide the virtual address space into a fine-grained, protected object store.

Three major components of an object-oriented operating system can benefit from this hardware support. The virtual memory manager uses address mapping to control disk swapping. A persistent object store uses both address and permission mapping to bring objects transparently into memory when they are referenced. And a concurrent garbage collector can use permission mapping to deny all programs access to the region of memory that it is currently "sweeping."

Persistent object storage erases the distinction between the concepts of "in memory" and "on disk" from the user's viewpoint. There are no files—just a catalog of objects that you can activate without knowing their storage location. Any system that uses dynamically created objects needs a garbage collector to stop the memory from clogging up with redundant objects.

Current systems use garbage collectors that periodically take over the whole machine. This behavior is responsible for that noticeable pause familiar to any Smalltalk or Lisp programmer. The ARM610 MMU lets you implement an efficient concurrent garbage collector as a permanent background task. Any other task can call upon the garbage collector, which protects each page of the task's memory in turn, copies any live objects (i.e., ones that have valid pointers) into an active page, and disposes of all other objects.

Put more formally, the ARM610 MMU maps permissions via the concept of domains, 16 contiguous and disjoint regions of virtual memory that are distinct from pages. All tasks run in an environment consisting of a set of permission maps for one or more domains. The environment is said to be a client of these domains. An environment might have a different permission map for each domain of which it's a client, but all clients of a domain share the same virtual address mapping.

An object-oriented operating system assigns a software manager to each domain, and these managers dole out permissions to application tasks. Object-oriented programming systems map their classes onto domains, using the MMU to protect each object's integrity.

Virtual Memory

The ARM610's MMU keeps its translation tables in physical memory, but the
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Table entries are cached in an on-chip TLB (translation look-aside buffer) that has room for 32 addresses. The virtual address space can be mapped either in 1-MB sections, which require only a one-level table lookup, or in pages, which need a second lookup level. The MMU supports small (4-KB) or large (64-KB) pages. Large pages allow single table entries to map large data objects. This helps to keep the translation tables small.

When the CPU requests a memory access, the MMU’s access-control logic first looks in the TLB for a translation of the virtual address. If it’s there, the access-control logic checks to see whether the access is permitted. If so, the MMU outputs the physical address immediately. If the TLB misses, then the MMU computes an index into the external translation table, which is offset from an address held in the on-chip translation-table base register.

If this translation-table entry is for a section, it will contain the actual base address of the section. This is combined with an index contained in the virtual address to give the physical address. If the translation-table entry is for a page, then it contains the base address of another table, the page table, and a second lookup is required to get the physical address. In both cases, the MMU checks permission before the access proceeds, and it updates the TLB by overwriting the existing entry with the resulting physical address.

A Compact CPU

If the Sun SuperSparc and the DEC Alpha were top-fuel dragsters, the ARM610 would be a European sports car. It’s small and economical, but it still outperforms popular PC CPUs like the 486 and 68030. And its MMU contains the key to the next generation of system software.

Although ARM isn’t yet a mainstream architecture in the U.S., Apple will benefit from its many available language compilers and programming tools. That would not have been the case if Apple had used a totally new processor in the Newton. Also, ARM’s lack of mainstream status is unimportant, because few people will want to port old PC or Mac software to such a radically different computer.

Newton created one of those rare conceptual breaks in computer evolution that opens up a brief window of time in which a new, more suitable processor can be adopted, free from compatibility constraints. I’m glad Apple had the courage to grasp the opportunity.

Dick Pountain is a BYTE consulting editor based in London. You can reach him on BIX as “dickp.”

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Ever since AT&T's Korn shell (developed by David Korn) appeared, the Unix community has been looking for a freely distributed version of this excellent shell. The Free Software Foundation's BASH (the Bourne Again Shell) fulfills that requirement. A Unix shell is the program that interprets user commands and script programs—essentially, it's the user interface. Prior to the Korn shell (and now BASH), the two most popular Unix command interpreters were the Bourne shell (i.e., /bin/sh, the old AT&T standard) and the Berkeley C shell (i.e., /bin/csh).

The features that the commercial Korn shell and the free BASH both offer are fast performance; functions and command-line aliases; tilde expansion to home directory paths; many set options for configuration, control, and debugging complex scripts; a dynamic shell variable that keeps track of the working directory; and an easy-to-edit command history—while maintaining the basic syntax of the standard Bourne shell. BASH includes the best features of the Berkeley C shell, including job control and an embedded arithmetic interpreter.

A free Korn-shell replacement from the Free Software Foundation

One feature that makes the Korn shell so popular is the command-line editor, which BASH includes. As with the VMS command interpreter, you can scroll through previous commands, edit them, and issue the edited version. Unix shell command editors can look like either vi or emacs, depending on your preference. With the appropriate commands, you can use all the line-editing operations you're used to, including cut and paste.

The most obvious difference between the Korn shell and BASH (besides the license) is in the command-history expansion syntax. The Korn shell uses the syntax command-abbreviation, where command-abbreviation can be a command number or the first few characters of a recently issued command. The Korn shell's r is actually an alias for fc-s, the Korn shell's fix-command program.

BASH, on the other hand, uses a syntax that is nearly identical to that of the Berkeley C shell, a "bang" character followed immediately by an abbreviation. The only difficulty with using the bang character for history is in issuing E-mail and UUCP commands, which use bangs to separate network address elements. To prevent the shell from interpreting the bang as a history command, you have to prefix it with a backslash, as in uunet!bytepb!ben.

BASH has been ported to a huge list of machines. It is professionally supported by a team of programmers that can be reached at bash-maintainers@ai.mit.edu. Brian Fox is the primary author.

The source code for BASH (BASH.SRC) is available on BIX as well as on a great number of anonymous FTP sites. BYTE is now posting the source code for Software Corner and Some Assembly Required on the UUNET system, under the directory path/published/byte. UUNET is the most connected computer in the world. By placing our files on UUNET, we are making them available to 11 million computer users. For more information about UUNET, send E-mail to info@uunet.uu.net or retrieve the file uunet:/published/byte/README."

Viewing JPEGs with JPEGView

JPEG is an up-and-coming standard for compressing image data. That's good, because JPEG can trim the size of large 24-bit images, thus conserving hard disk space. But it's bad if a JPEG-encoded file lands on your Mac and you don't have an application that understands this format. Enter Aaron Giles's JPEGView 1.1, a freeware utility that lets you view almost any flavor of JPEG file on the Mac.

JPEGView can read PICT images, JPEG-encoded PICT images (courtesy of QuickTime's compressor/decompressor software), and JFIF (JPEG File Interchange Format) files. JPEGView works reliably, too. I've used it to read JPEG-encoded images produced by Adobe Photoshop. You can then save the image in standard PICT format for use in your graphics application. If you think your work with graphics might involve JPEG-encoded files, keep JPEGView handy.

Easy-Open Windows Files

Opening and reopening Windows application files can be tedious, especially if the data files for a single application live in many different directories. Open Axess 1.4 (i.e., Axess104.exe) is a $10 shareware utility by Steven Gutz and Randy Westman that remembers the last few filenames, file types, and directories that you've accessed, sparing you the trouble of navigating the same directory tree access after access.

Open Axess takes advantage of the Windows 3.1 Common Dialogs. When you launch Open Axess, it hooks into the common File Open dialog box. Thereafter, any time you choose File/Open from an application that uses Common Dialogs, you get a dialog box with its control menu augmented by several Open Axess menu choices. The menu choices let you instantly choose from among the last few files, types, and directories you've opened. You can also specify a list of permanent files.

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Externally, Windows NT looks like Windows 3.x. But internally, Windows NT is as similar to Windows 3.x as CP/M is to VAX/VMS. It took Microsoft over three years to design and build NT. Why? What is so different? The answer lies not so much in describing preemptive multitasking or symmetric multiprocessing, but in the overall system model itself.

Windows NT is different because every component is woven from the same material into a smooth, consistent fabric. While earlier versions of Windows resemble a patchwork quilt of components, Windows NT is more like a long, continuous piece of cloth.

The new operating system gets its smooth uniformity from a design that is completely object-based. Virtually everything in the operating system is defined as an object, and an important component of NT, called the object manager, is dedicated solely to overseeing the creation, usage, and destruction of these objects.

The Object Rationale
Windows NT is among the first of a new generation of operating systems that use an object-based model. Most operating-system manufacturers are switching to this model to leverage the advantages offered by OOP (object-oriented programming). OOP lets programmers think in terms that more closely model the real world. Instead of writing procedures that manipulate data as a separate entity, OOP lets you define objects of different types that combine attributes (i.e., data) and behavior (i.e., procedures) into a single package.

OOP also allows a more natural way of achieving abstraction, which lets programmers deal with higher-level components without having to deal much with the lower levels of the system. Thus, objects can be treated like "black boxes"—the manufacturer (in this case, the programmer) of the black box simply describes what it can do and how to use it.

Besides the greater power available to programmers, basing everything on objects usually leads to a simpler and more elegant design. If everything is defined as an object, you can manage all system elements in a single, consistent manner rather than using a different mechanism for each type of element. This makes the system much easier to modify or extend.

Note, however, that Windows NT is not a true object-oriented operating system. Most of it is written in C, not C++. Some of the advantages of C++ (e.g., inheritance and polymorphism) were therefore not available to the NT designers. But contrary to popular belief, C++ or any other OOP language is not a prerequisite for achieving an object-based design. PenPoint appears to the user (and programmer) to be object-oriented in every respect, but it too is written mostly in C. Thus, I use the term object-based instead of object-oriented, which is a stricter definition.

NT Objects Defined
Virtually everything handled by Windows NT is an object. Files, processes, threads, RAM sections, drivers, and devices are all examples of objects. All NT objects follow a generic template that is divided into two parts: header and body. An object header contains fields of data such as the object's name, a security descriptor, and its temporary or permanent status. The body contains a set of data values (or attributes) that are relevant to the type of object and a set of functions (or services) that operate on that particular object.

All objects have the same kind of information in their header, but the body is specific to each type of object. Thus, a process object has different attributes and services than a file object, but both have the same header structure. For example, a file object has a size attribute and a write service, neither of which is relevant to a process object. Likewise, a process object has attributes and services that would not be used by a file object. The figure illustrates the generic object template and a specific object type (i.e., a process) that follows the template.

The primary benefit of having a standard object template is the ability to handle a wide range of system elements in a consistent manner. For example, all objects in the system have a quota-charges attribute that records the resource cost of using that object. Thus, a resource accounting program that monitors system resource usage can be built easily because there is no reason to write different code to handle each type of system element differently.

The Object Manager
Because objects are such a pervasive part of the Windows NT operating system, it
makes sense to have a software module dedicated solely to the management of objects. The NT object manager performs this role. The object manager provides a set of basic object management services to processes that want to manipulate objects. These basic services include object creation, location, and destruction.

However, the object manager oversees only the lowest common denominator of object operations; it is not responsible for performing object-specific operations because it knows nothing about the internal structure of an object or what it might be used for. For example, if a thread tries to write to a file, the object manager becomes involved in security considerations (an operation common to all objects); but when data must actually be written to the file, the object manager calls upon the I/O subsystem to perform the operation.

Every manipulation of an object must pass through the object manager at one level or another, and this has many desirable consequences, especially in the area of security. A central idea behind Windows NT security is to create a gate through which every use of system resources must pass. Because every resource is an object, the object manager becomes this gate.

The Key to Security

Security is a perfect way to illustrate the benefits of NT’s object-based operating-system model. In many operating systems, the security system consists of some loosely associated modules, each of which is responsible for a certain type of resource (e.g., files, memory, or processes). Although this works, there are disadvantages to the design. The primary downside is complexity. It is difficult for system programmers to implement different security systems for different system resources, and adding new security systems for new resources is not straightforward.

In contrast, Windows NT offers a centralized security system that works hand in hand with the object manager to provide a uniform security system for virtually all system resources. Because all resources are represented by objects, and all objects have a well-defined format, the security system acts upon resource objects in a consistent manner. The result is a much cleaner design that is easily extensible when new object types are introduced.

When a user logs onto an NT system, the user’s credentials (i.e., ID and password) are authenticated by the LSA (local security authority) process. Note that log-on now means local log-on to an NT workstation on your desktop as well as remote log-on to an NT server across a network. Thus, the operating system now secures both the desktop and all network servers, instead of just network servers.

If the LSA finds the user’s credits in the server’s encrypted security database, NT creates a user process and permanently attaches it to an object known as an access token. An access token is like a security pass that is checked when the user’s process tries to access a system resource.

On the other side of the equation, all system resources (i.e., objects) have a security descriptor, which states the access rights to that resource. The security system therefore compares access tokens to security descriptors to approve or deny access. For example, when a user process tries to open a file for write access, the object manager sends the process’s access token to the security system, which checks the file’s security descriptor to see if the privileges in the access token are sufficient to write to the file.

Each security descriptor contains, as its main component, an ACL (access control list), which is a list of users and privileges that apply to that object. An object’s ACL can be modified only by the owner of the object. Thus, access to resources is completely at the discretion of the resource owner and is applicable to any system resource, providing an extremely fine level of security granularity. If desired, ACLs can specify groups of users or all users, which makes resource access easier to set up and administer.

The Programmer’s Perspective

Although objects are an important part of NT, most Windows programmers will never see them directly. This is because virtually all programming for the Windows NT operating system is done through the Win32 subsystem, which provides a 32-bit superset of the Windows 3.x APIs. An application running on Win32 doesn’t need to know that it is running on NT at all, and you don’t need to know anything about NT objects to write applications for NT.

However, programmers creating system-oriented programs such as backup utilities or desktop extensions need to access objects directly. In this case, objects are handled much like files are handled in traditional programming. Programmers can easily deal with objects because they are already familiar with manipulating files.

If Windows NT looks like Windows 3.1 to the user, was it worth the effort to build such a sophisticated object model? The answer is most definitely yes. In addition to the benefits I’ve outlined, the existence of an object-based infrastructure indicates that Windows NT was designed to be the foundation of future operating environments that Microsoft will deliver.

Although the object model is completely internal and not visible to the user, expect future versions of Windows to externalize an object model in the user interface. This externalized object model will probably use Windows NT object services for infrastructure and include major extensions for object management through OLE 2.0 and other object services. When this happens, computing will change dramatically, and users will interact with computers in a completely natural manner.

ACKNOWLEDGMENT

Thanks to Helen Custer, author of Inside Windows NT (Microsoft Press, 1992), for providing much of the reference material for this article.

Bruce D. Schatzman is an independent systems consultant in Bellevue, Washington. You can reach him on BIX c/o "editors."
ASK BYTE

Lean, Mean Windows

Is there a run-time version of Windows that I can use to run a low-end Windows desktop publishing package in standard mode without dealing with the intricacies of Windows itself? If not, which Windows program files do I need to absolutely run this software in standard mode?

Charles Izevbige
Tallahassee, FL

Some vendors included a run-time version of Windows with their applications before the advent of Windows 3.0. Unfortunately, run-time versions are no longer available.

The Windows 3.1 installation program lets you load the minimum files required to run in standard mode. The minimum configuration requires between 5 and 6 MB of disk space. If you want to pare Windows down even more, use the Windows Setup Option menu to remove nonessential files from your Windows subdirectory. Target the READ ME, .BMP, and .WAV files; accessory applications; games; and screen-saver files. If you decide you need a file again, simply repeat the process to add it back into your Windows subdirectory.

—Stan Wszola

Tracks and Sectors

Is there a reason why I shouldn't format a 3½-inch high-density floppy disk to 720 KB in a 1.44-MB drive using the Format command's /f:720 or /s:9 switches? Why can't I use Diskcopy to duplicate a 720-KB floppy disk to a new, unformatted 1.44-MB floppy disk?

Christopher Bedford
Lansdowne, CP, South Africa

It's physically possible to format a 1.44-MB floppy disk to 720 KB, but I wouldn't do it. There are differences in the magnetic media for the various types of densities, and the head current to write to the different media varies proportionately. A 1.44-MB disk requires higher write currents than a 720-KB disk. Your 1.44-MB/720-KB drive will switch to the lower write current when you format to 720 KB. Using the lower write current on a disk that requires the higher one will make your disk unreliable. This same reasoning applies in reverse: You cannot reliably format a 720-KB disk to 1.44 MB (and you should never use those disk hole punchers that let you do so).

As for your Diskcopy question, the answer becomes obvious when you consider the sector differences. All the 3½-inch disk formats use 80-track sectors, but a 720-KB floppy disk has nine sectors per track, while a 1.44-MB floppy disk uses 18 (a 2.88-MB floppy disk uses 36). If you try to run Diskcopy, the program doesn't know which 720 KB of the 1.44-MB disk you want to use. The reverse situation is more obvious, because it's physically impossible to cram 1.44 MB of data onto a 720-KB disk. Diskcopy will simply read the two disks and refuse to copy unless they're identical.

—Stan Wszola

CP/M Conversion Artist

I want to move my WordStar book manuscripts from a Morrow Designs MD-3 CP/M system to a 386 machine and convert them for use with Microsoft Word for Windows. Are there any programs that can read WordStar files on CP/M floppy disks? Is there a service that will convert them? Unfortunately, I don't have OCR (optical character recognition) hardware and software to read the printed pages.

Wayne Irwin
Northridge, CA

Media Master from Intersecting Concepts (30851 Agoura Rd., Suite 200, Agoura Hills, CA 91301, (818) 879-0086; fax (818) 879-0623) is a universal disk-conversion program that reads about 200 foreign disk formats, including the 40-track MD-3 disks. To use it, run the software, insert the CP/M disk, and simply copy the files to your 386 hard drive. Once the files are on your new machine, Word for Windows should be able to convert them from WordStar format.

Media Master has one drawback: It hasn't been updated for DOS 5.0. Under DOS 5.0, your 80-track, 1.2-MB floppy drive won't be able to read the 40-track format. If you run DOS 5.0, you'll need to get a 360-KB floppy drive or boot up from a DOS 3.x or 4.x boot floppy disk.

—Howard Eglowstein

Video Control

I have a Sony camcorder with the Control-L port that Tom Yager mentioned in his article "Practical Desktop Video, Part 2: Raw Material" (May BYTE). I want to build an editing controller for my camera, but my dealer doesn't have access to any documentation for this port. Where can I get it?

David Annett
Upper Hutt, New Zealand

Sony publishes the Control-L specification in a document called "Protocol of Control-L," publication #997245311. In the U.S., it's available from Sony Publications (P.O. Box 20407, Kansas City, MO 64195, (816) 891-7550 ext. 33). The U.S. office isn't equipped to send copies overseas, so you should ask your local dealer to order it for you, or have a friend in the U.S. order a copy and mail it to you. —Howard Eglowstein

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For years, BYTE has offered electronic copies of each month's featured programs through BIX. Now we're also posting these files on UUNET. If you have access to any machine on the Internet, you can retrieve files from UUNET for free. The most common method for retrieving files is to use FTP utilities. A version of FTP exists for nearly every popular operating system today. Here's what to do.

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ASK BYTE

Once you're on the Internet, type ftp uunet.uu.net.
FTP should respond with

Connected to uunet.uu.net
220 uunet.uu.net FTP server (Version 4.1 8/1/91) ready

followed by

Name (uunet.uu.net:ben):

Enter your user account name or press the Return key to use the default. At the ftp> prompt, type help to see a list of all the commands. Commands can be abbreviated.
Go to the BYTE files by changing your working directory to the top of the BYTE file tree (i.e., cd/published/byte) and list the files. The file lines that begin with d represent subdirectories with files that pertain to the issue date indicated. Here's a sample session:

ftp> dir
drwxr-xr-x 7 cas 0005 other 112 Aug 16 13:45 oct92
drwxr-xr-x 8 cas 0005 other 134 Sep 12 13:02 nov92
226 Transfer complete.
ftp> cd nov92
250 CWD command successful.
ftp> dir
-rw-r--r-- 7 cas 0005 other 12999 Aug 16 13:45 bash.tar.Z
-rw-r--r-- 8 cas 0005 other 45231 Sep 12 13:02 whisk.Z
226 Transfer complete.

To retrieve whisk.Z, enter

get whisk.Z
local: whisk.Z remote: whisk.Z
200 PORT command successful.
150 Opening BINARY mode data connection for whisk.Z (45231 bytes).
226 Transfer complete.
45231 bytes received in 21.74 seconds (2.03 Kbytes/s)
ftp> quit
221 Goodbye.

If you want to use filename globbing to retrieve more than one file, use FTP's mget command. FTP has many other options that speed up multife transfer.

This file-retrieval process is equally as simple from Singapore as it is from the University of California. We look forward to seeing more international readers accessing the software that we publish in BYTE.—Ben Smith

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<th>Model</th>
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<td>386-SX/25</td>
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<td>• 2MB RAM expandable to 32MB&lt;br&gt;• 8MB IDE hard drive w/ cache&lt;br&gt;• 1:1 Interleave 3/2 IDE controller&lt;br&gt;• 1.2MB 5.25&quot; &amp; 1.44MB 3.5&quot; floppy drives&lt;br&gt;• 16-bit 1024x768 SVGA card w/ 1MB RAM&lt;br&gt;• 14&quot; 1024x768 0.28mm dot pitch SVGA color monitor&lt;br&gt;• 2 serial, 1 parallel &amp; 1 game port&lt;br&gt;• MS DOS 5.0 &amp; MS Windows 3.1&lt;br&gt;• Enhanced 101-key keyboard&lt;br&gt;• High resolution serial mouse&lt;br&gt;• Mini-vertical case</td>
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<td>• 4MB RAM expandable to 32MB&lt;br&gt;• 130MB 15ms IDE hard drive w/ 64K cache&lt;br&gt;• 1:1 Interleave 3/2 IDE controller&lt;br&gt;• 1.2MB 5.25&quot; &amp; 1.44MB 3.5&quot; floppy drives&lt;br&gt;• 16-bit 1024x768 SVGA card w/ 1MB RAM&lt;br&gt;• 14&quot; 1024x768 0.28mm dot pitch SVGA monitor&lt;br&gt;• 2 serial, 1 parallel &amp; 1 game port&lt;br&gt;• MS DOS 5.0 &amp; MS Windows 3.1&lt;br&gt;• Enhanced 101-key keyboard&lt;br&gt;• High resolution serial mouse&lt;br&gt;• Desktop or mini-vertical case</td>
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### StarFlex 3/486C

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<td>• CPU upgradable to 386DX, 486SX, 486DX, 486DX2. Up to 66MHz&lt;br&gt;• 486 fast RAM expandable to 32MB&lt;br&gt;• 130MB 15ms IDE hard drive w/ 64K cache&lt;br&gt;• 1.2MB 5.25&quot; &amp; 1.44MB 3.5&quot; floppy drives&lt;br&gt;• 1MB SVGA non-interlaced color card&lt;br&gt;• 17&quot; 1024x768 non-interlaced 0.28mm dot pitch SVGA monitor&lt;br&gt;• VESA 72Hz flicker-free display&lt;br&gt;• 2 serial, 1 parallel &amp; 1 game port&lt;br&gt;• MS DOS 5.0, Windows 3.1 &amp; mouse&lt;br&gt;• Enhanced 101-key keyboard&lt;br&gt;• Desktop or mini-vertical case</td>
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**Buy Smart...Buy RMB Upgradable Motherboards**

<table>
<thead>
<tr>
<th>Model</th>
<th>No Memory</th>
<th>2 Mb</th>
<th>4 Mb</th>
<th>8 Mb</th>
<th>16 Mb</th>
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<td>386 SX-25</td>
<td>149</td>
<td>123</td>
<td>901</td>
<td>453</td>
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<td>386 SX-33 16k</td>
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<td>132</td>
<td>1473</td>
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<td>386 DX-33</td>
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<td>407</td>
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<td>835</td>
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<tr>
<td>486 SX-25</td>
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<td>NA</td>
<td>427</td>
<td>1579</td>
<td>855</td>
<td>1435</td>
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<tr>
<td>486 SX-25 Local Bus Slot</td>
<td>349</td>
<td>NA</td>
<td>501</td>
<td>1635</td>
<td>929</td>
<td>1509</td>
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<td>486 DX-33 Upgradable</td>
<td>599</td>
<td>NA</td>
<td>751</td>
<td>1903</td>
<td>1179</td>
<td>1759</td>
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<tr>
<td>486 DX-33 Local Bus Slot</td>
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<td>1265</td>
<td>1845</td>
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<td>486 DX-50 Local Bus Slot</td>
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<td>1063</td>
<td>1427</td>
<td>1479</td>
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<td>486 DX-50 ElSA Upgradable</td>
<td>1150</td>
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<td>1314</td>
<td>1647</td>
<td>1730</td>
<td>2310</td>
</tr>
</tbody>
</table>

Future Upgradability: 486-DX-33 to 25MHz or 486 DX-50 to 66MHz

**486DX-50 MHz ElSA only $1150**

Overdrive socket for easy 486DX-2 100 MHz upgrade. Local Bus Slot

- SIS ATQ chipset
- AMI BIOS
- Intel CPU

**VIDEO PRODUCTS**

### 14" Super VGA Displays (interlaced)
- Magnavox CM8489GX SVGA w/0.39 dot pitch $213.00
- Aamazing CM8489GX SVGA w/0.39 dot pitch $213.00
- CTX CV-5439A SVGA w/0.39 dot pitch $229.00
- Magnavox CM9097 SVGA w/0.28 dot pitch $289.00
- Aamazing CM8482BX SVGA w/0.28 dot pitch $266.00
- CTX CV-5468A SVGA w/0.28 dot pitch $269.00

### 14" Super VGA Displays (non-interlaced)
- Aamazing CM8482MX SVGA w/0.28 dot pitch $298.00
- CTX CV-5468N1 SVGA w/0.28 dot pitch $306.00

### 15" Display (Ballin's choice for Windows users)
- CTX CPS-1560 Flat Square Tube SVGA w/0.28 $475.00

### 17" Display (for the serious Windows user)
- CTX CPS-1740 Flat Square Tube 1280 x 1024 w/0.28 $665.00

### 20" Display
- Magnavox 20CM64 1280 x 1024 w/0.31 dot pitch $1275.00

**VIDE O Cards**

- RMB Trident 8900C w/1Mb up to 1024 x 768 $75.00
- Non-interlaced $75.00
- RMB Windows Accelerator $75.00

**DRIVES**

### Floppy Drives
- Epson* 1.2Mb 5.25" half height drive $69.00
- Epson* 1.44Mb 3.5" in a 5.25" frame $69.00
- Teac* 1.44Mb 3.5" drive $59.00
- EPSON* 2.88Mb 3.5" in a 5.25" frame with controller card $169.00

### Hard Drives
- Conner* CP-3000 40 Meg IDE with 28ms access time $165.00
- Maxtor* 7040A 80 Meg IDE with 17ms access time $229.00
- Maxtor* 7214A 120 Meg IDE with 15ms access time $285.00
- Maxtor* 7213A 213 Meg IDE with 15ms access time $415.00
- Maxtor* LXT-340A 340 Meg IDE with 13ms access time $769.00

### Tape Backups
- Colorado® DJ-10 Jumbo 120 Mb QIC-40 Internal $197.00
- Colorado® DJ-20 Jumbo 250 Mb QIC-80 Internal $257.00

**C ASES**

### Desktop Case
- 5-bays (3) 5.25" (2) 3.5" 16.3"w x 16"d x 7"h $87.00
- 200 watt power supply $75.00

### Mini Tower
- 4-bays (2) 5.25" (2) 3.5" 7"w x 16"d x 13.6"h $139.00
- 200 watt power supply $115.00

### Full Tower
- 9-bays (6) 5.25" (3) 3.5" Digital Display, 230 watt power supply $139.00

### Mid Tower Version
- 5.25" 3.5" 2.88M 3.5" in a 5.25" frame with controller card $75.00

The RMB Advantage

MIS managers from across the country are discovering the advantages of upgrading with RMB Motherboards:

- Save hundreds or even thousands of dollars by avoiding replacement costs with upgrades.
- Every RMB Motherboard with SIMM memory comes with the memory completely installed, burned-in and fully tested to assure quality performance.
- Take the RMB challenge! If you have an entire department to upgrade, try one RMB Motherboard for 30 days. If you're not completely satisfied, return it for a full refund.*

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Zoom Telephonics

Zoom modems rate at the top of their class for compatibility and performance. The recipient of numerous Editors’ Choice awards, Zoom modems offer the quality and dependability that you require at a price that makes them a true value. All Zoom modems are backed by a 7 year warranty and are made in the USA.

2400 bps w/ v.42bis and MNP 2-5

(AMC) internal $49.00
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9600 send & 4800 receive Fax

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(AF) external $79.95

2400 bps w/ 9600 bps send/receive Fax

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(FX 9624) external $95.00

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(VX-V32) external $199.00

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(VVF-V32bis*) external $269.00

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*WINFAX software option available for $15 if purchased with VPF-V32bis or VFX-V32bis modem.

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Magnavox® CDD-461MM $319.00
Combination external MPC CD-ROM drive and CD-audio player.

CDD-461GY $399.00
Includes: Grolier's Encyclopedia (MPC version), PC Glade/USA/ Geo Jigsaw, Microsoft Bookshelf, PC SIG Library

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CM 205XRS $379.00
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Sound Blaster Pro Package $179.00
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MATH CO-PROCESSORS

Cyrix® S25 for 386 SX-16, 20 or 25 MHz $69.00
Cyrix® D33 for 386 DX-16, 20, 25 or 33 MHz $87.00
Cyrix® D40 for 386 DX-16, 20, 25, 33 or 40 MHz $110.00

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  - SLP - 8 parallel and 2 serial ports.

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- **Rapid Data Transfer:**
  The SL Series software allows PCs to transmit up to 8,000 characters per second parallel and up to 115,200 bits per second serial, much faster than the DOS serial limit.

- **Automatic Switching:**
  SL Series Buffalo boxes will automatically buffer data, convert between parallel and serial, and route data from your PC to the device of your choice. No commands are needed when sharing only one printer.

- **User Upgradable Memory:**
  SL units are available with installed buffer memory from 256KB to 4MB. Buffer modules can be added later to expand any unit to the full 4MB.

- **Easy Installation & Use:**
  Connect one cable for each PC or output device to the SL Series box. Run the SETUP program to configure the Buffalo box and to install the pop-up menu. Then, simply select your printer and print as you did before you installed the box.

- **Pop-up Menu Option:**
  Select printers, macros, and other control functions using the cursor or a mouse. The pop-up menu appears over other applications and desktop publishing.

- **Network Server Support:**
  Connected to a network server port, the SL Series can direct data to a variety of shared output devices.

- **Windows Support:**
  Buffalo hardware and menu software are Windows compatible.

- **Toll-Free Technical Support:**
  Skilled technicians will answer your call and help you achieve the best performance from your system.

- **Cost-Effective Solutions:**
  Prices for the SLmkII and the SLP range from just $595 with 256KB of memory to $995 with a full 4MB installed.

- **Smaller Alternatives:**
  The Buffalo H Series is also available priced from $245 for the HXP with 4 parallel ports and 256KB of buffer. The H Series buffers offer expandability to 16MB of buffer and parallel data transfer at up to 180,000 characters per second.

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Circle 399 on Inquiry Card.
The Fantasy Combinations/VGA & IDE Caching

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- 1MB, Super VGA Card
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- Min. 200W Noiseless Power Supply
- 8 Expansion Slot
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- 66, 50 and 33MHZ available now!
- 486-66MHZ, 256K Cache, w/Local Bus......Call Price
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- 486-50MHZ, 256K Cache, w/ISA Bus $1,499.00
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- 486-33MHZ, 256K Cache, w/ISA Bus $1,259.00
- 386-40MHZ, 64K Cache, AMI BIOS
- Upgradeable to 486-66MHZ $998.00

**OPTION:**
- NonInterlaced DynamicScan 72 SPVGA Monitor.
- 1024 x 768, .28 DOT, 72HZ, Add $49.00

**HARD DRIVES:**
- Call For Best Price

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
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<tbody>
<tr>
<td>80MB</td>
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<tr>
<td>600MB</td>
<td></td>
</tr>
<tr>
<td>1.2GB</td>
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</tbody>
</table>

**The Fastest P.C. Configurations:**
- 486-66MHZ Motherboard
- 256k external Cache
- 16MB RAM Installed
- 300MB IDE Hard Drive plus 32Bit Local Bus
- Comes with 4MB RAM Write Back Cache
- Speed Up Windows or AutoCAD
- 32Bit Local Bus
- 16MB RAM INSTALLED
- 256K Write Back S.RAM Cache
- Dual local Buses

**Syste**m

**IDE 32BIT Synchronous Local Bus**
- 4MB RAM Cache
- Less than .3MS

**Dual Synchronous 32Bit Local Buses**
- The Fantasy Combinations/VGA & IDE Caching

**$3,789.00**

**DynamicScan**

- 15" Flat Screen Flicker Free
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**The Best Application for File Server, CAD Station, Graphic Art, Data Base**

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32MB SIMM (8M X 36) $ 1699.00
COMPAQ SystemPro - 32MB MODULE $ 1299.00
DELL 486's - 16MB KIT (2 SIMMS) $ 538.00
32MB KIT (2 SIMMS) $ 1078.00
MAC IIfx - 64MB KIT (4 SIMMS) $ 1956.00
MAC QUADRA 950 - 64MB KIT (4 SIMMS) $ 1956.00
MAC IIci, IIcx, QUADRA 900 - 64MB KIT (4 SIMMS) $ 1956.00
MAC QUADRA 700 - 64MB KIT (4 SIMMS) $ 2156.00
SUN IPX, ELC - 16MB SIMM $ 499.00

OTHER MEMORIES AVAILABLE...

IBM
PS/1 - 2MB $ 68
4MB $ 149
M30 - 2MB $ 92
M30Z, M30z, M30 nx, 2MB $ 149
M40 - 2MB $ 199
M50 - 2MB $ 300
M80 - 4MB $ 300
M80-111, 121, 131 - 2MB $ 99
M80-A21, A31 - 4MB $ 195
16-bit OK Exp Board $ 128
32-bit OK Exp Board $ 155

AST
PREM. 386/20C - 1MB KIT $ 65
PREM. 386/25 - 1MB $ 45
PREM. 486/20 - 1MB $ 45
PREM. II 486 - 1MB $ 45
PREM. II 8MB KIT $ 310
PREM. II 1MB Exp Board $ 469

COMPAQ
DP 386/20, 20E, 25 - 1MB $ 66
4MB $ 106
DP 386/16 - 1MB $ 66
4MB $ 106
DP 286N/386N, S/20 - 4MB $ 149
8MB $ 299
M-SYSTEMS - 4MB $ 149
8MB $ 299
DP 386/33, 486/25 - 2MB SystemPro - 8MB $ 315
OK Exp Board $ 315
DP 386/16/1MB Exp Board $ 105
DP 386/20E/25/2E $ 105

DELL
325D/P, 333D/P, 1MB $ 45
4MB $ 90
420, 425, 433 - 2MB KIT $ 178
4MB KIT $ 298
450D/E, 460E, 4MB KIT $ 70
8MB KIT $ 298

HP
Vectra GS16 - 2MB KIT $ 129
4MB KIT $ 229
Vectra 486 - 2MB $ 149
8MB $ 299
X-Station 700, 2MB $ 149
4MB $ 299
9000/400, A25 - 8MB KIT $ 99
16MB KIT $ 428
9000/425, A26 - 8MB KIT $ 828
16MB KIT $ 828

APPLE
II SE, SE/30 - 1MB $ 32
Classic - 1MB Exp. Board $ 44
4MB $ 90
420, 425, 433 - 2MB KIT $ 178
4MB KIT $ 298
450D/E, 460E, 4MB KIT $ 70
8MB KIT $ 298

LAPTOPS
AST EXEC. NB - 4MB $ 135
COMPAG NTE386 - 4MB $ 229
DELL 312, 320 LT - 2MB $ 99
EVEREX TEMPO - 2MB $ 129
IBM L40sx - 4MB $ 168
MAC POWERBOOK - 2MB $ 404
NEC P.S. 268-36 - 4MB $ 200
P.S. 386 - 8MB $ 429
P.S. S/20 - 4MB $ 200
PANASONIC CI770 - 1MB $ 155
T.I. TROL-LMT 3000 - 2MB $ 80
TOSIBHA 1000 - 2MB $ 108
3000SXE - 8MB $ 388
3000SX - 4MB $ 160
5200 - 8MB $ 315

PRINTERS
EPSON 6000 - 4MB $ 229
HP 8125, 8125D, 2MB $ 135
IBM 4012/4022e - 3.5MB $ 140
4029 - 4MB $ 135
OKIDA 400 - 2MB $ 129

OTHER MEMORIES FOR:
ACER, ALTIMA,APPLE, AST, CHAPLET, COMPAQ, DELL, EPSON, EVEREX, HP,
LEADING EDGE, IBM, NEC, NCR, OKIDATA, PACKARD-BELL, PANASONIC, PHILIP,
SAMPO, SHARP, SILICON GRAPHICS, SUN MICROSYSTEMS, TANDON, TI, TOSHIBA,
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Options: External Floppy Drive, SRAM Memory Cards, 9624 IC Card
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- PCMCIA 2.0/JEIDA standard port for memory card and I/O card
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- 1 parallel (bi-directional)/ 1 serial
- External PDD port for optional Floppy Drive
- DR-DOS 6.0, File Transfer Software & Serial Download Cable
- Built-in Personal Data Manager software
- Built-in Programmable Power Management Software
- Universal AC/DC adaptor
- Carrying Case

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IBM users vote BEST's UPS number ONE for second straight year

For the second year in a row, BEST has been named the top UPS by 50,000 owners, users, and buyers of IBM AS/400, RS/6000, and Systems/3X computing products. The FD series FERRUPS® was selected for the coveted 1992 Midrange Systems Buyers Choice Award.

The award recognizes the most innovative and reliable products and services in the IBM midrange computing industry. Winners are chosen by Midrange Systems subscribers. "Being selected as a Buyers Choice Award winner by the market's most influential buyers is a significant honor," according to the magazine's Associate Publisher, John Curran. "This recognition is a tribute to your entire organization, from R&D to marketing and sales. There's no better endorsement than a satisfied customer."

FERRUPS is BEST's line of advanced, on-line, line-interactive UPS. Products feature Artificial Intelligence, automatic battery and inverter checks, alarm and inverter logs, five indicator lights, 16 audio alarms, RS232 communications, and more than 100 operational parameters that may be monitored or programmed by the user.

FERRUPS also features:
- Sine-wave output
- 2000-to-1 spike attenuation
- Complete galvanic isolation (including output neutral-to-ground bonding)
- 120 dB of common-mode noise rejection
- True no-break power

BEST won the Buyers Choice Award over manufacturers in both the single- and three-phase UPS markets. Competitors included American Power Conversion, Sola, Tripp-Lite, Liebert, and Minuteman.

BEST wins top honors in all five UPS categories in Computerworld study

The top honors in all five Uninterruptible Power System (UPS) categories in the 1992 Computerworld 1/5 Brand Preference Study went to Best Power Technology, Inc.

In the study, which focused on

Local Area Network products, 515 Computerworld subscribers were asked which manufacturer they most closely associated with five areas of product excellence. BEST got highest consumer ratings in the categories of Best Technology, Best Price/Performance, Best Service/Support, Best Documentation, and Prefer to do Business With. BEST won with fairly wide margins — as much as 32 percentage points higher than its closest competitor.

Circle 391 on Inquiry Card.
Fortress leads the pack in LAN Technology review

BEST's newest Uninterruptible Power System, Fortress®, has received the coveted "Network Specialist Preferred" rating from LAN Technology. Fortress showed the best performance of the seven leading UPS products tested.

"Aptly named, the Fortress produced rock-solid, stable power under all test conditions," the magazine stated in its April 1992 issue. "On the strength of its electrical performance, the Fortress topped the seven products in our review."

In fact, the Fortress was the only product that provided uninterruptible, no-break power in every test. Other products tested had power breaks lasting as long as nine milliseconds. Some gave square-wave output with as much as 33 percent total harmonic distortion.

Other products tested included "UPS" from American Power Conversion, Tripp Lite, Sola, and Para Systems.

LAN Technology's editors were impressed at what they found. "The LI 660 shined in our tests," they wrote. "It did not follow the over-voltage condition, and instead delivered a constant 115 Volts rms to the load. The unit's output had less than three percent total harmonic distortion for all conditions. In both the one-cycle dropout and power outage tests, the LI 660 provided smooth, sinusoidal power to the test load.

"The LI 660 ... was a fine piece of equipment, and we picked it as the top performer in the review," the editors concluded.

Other products tested did not fare as well, however. For instance, APC advertises a maximum three milliseconds transfer time for its Smart UPS 600 standby system. But in the LAN Technology one-cycle dropout test, the Smart UPS broke power for a full 4.5 milliseconds — hardly an "uninterruptible" performance. As the editors noted, the Fortress "was not measurably affected by the one-cycle dropout."

The applause for Fortress, the world's smallest, smartest, true no-break UPS, continues to roll in!

The latest comes from John McCormick, who writes the "Power User" column for Government Computer News. In his March 16, 1992 column, "In the Dark About Emergency Power Supplies," he shares his insights on UPS.

"Washington is a real power city, but recent power- and water-related incidents in Washington have brought a new meaning to the term 'power user,'" McCormick wrote in the column. "I have a lot of sophisticated computer equipment here. Without reliable power, I would have nothing when the lights go out."

A stickler for quality and long runtimes, McCormick relies on BEST technology. "A Fortress LI 2K from BEST is my main UPS," he writes.

"The control and display capabilities of the Fortress are impressive, starting with a countdown of the time left when operating on the battery.

The reviewer was also impressed by the fact that Fortress "will run equipment beyond its rated capacity, and audibly warn you to shut something off. Line, output, and battery voltages can all be displayed, as well as a percentage of load reading."

As a power user, McCormick appreciates the flexibility that Fortress' digital display and keypad give him. "There are so many options that one important setup step is to decide on what is important for your installation and reset those features from factory defaults."

Government Computer News editor: "Fortress is my main UPS"

The applause for Fortress, the world's smallest, smartest, true no-break UPS, continues to roll in!

The latest comes from John McCormick, who writes the "Power User" column for Government Computer News. In his March 16, 1992 column, "In the Dark About Emergency Power Supplies," he shares his insights on UPS.

"Washington is a real power city, but recent power- and water-related incidents in Washington have brought a new meaning to the term 'power user,'" McCormick wrote in the column. "I have a lot of sophisticated computer equipment here. Without reliable power, I would have nothing when the lights go out."

A stickler for quality and long runtimes, McCormick relies on BEST technology. "A Fortress LI 2K from BEST is my main UPS," he writes.

"The control and display capabilities of the Fortress are impressive, starting with a countdown of the time left when operating on the battery."

The reviewer was also impressed by the fact that Fortress "will run equipment beyond its rated capacity, and audibly warn you to shut something off. Line, output, and battery voltages can all be displayed, as well as a percentage of load reading."

As a power user, McCormick appreciates the flexibility that Fortress' digital display and keypad give him. "There are so many options that one important setup step is to decide on what is important for your installation and reset those features from factory defaults."

Circle 391 on Inquiry Card.
Disaster avoidance and recovery is growing business priority

Computing and telecommunications disasters are increasingly headline news. One of the most recent occurred when AT&T lost a major switching center in downtown New York City for seven hours due to a power failure on September 17, 1991. The crash blocked 5.5 million calls, closed New York’s airports, and disrupted more than 1,000 flights.

More recently, Chicago’s thriving “Loop” district was completely shut down in mid-April of this year, when the Chicago River flowed through a hole in an old freight tunnel, flooding the basements of scores of high-rise office buildings. Commonwealth Edison shut off electrical power to the entire area to protect its transmission equipment, forcing the closure of the Mercantile Exchange and the Chicago Board of Trade. Worldwide stock and commodities trading was disrupted, and business losses were estimated at as much as $50 million per day.

With nightmares like these in the news, it’s little wonder that businesses across the country are scrambling to develop ways to avoid major power disasters. AT&T is actively recommending this type of planning to its customers.

The concern is justified. The Enterprise Technology Center recently reported a number of terrifying statistics:

- On average, a company loses as much as three percent of its gross sales within eight days of a sustained computer outage.
- The average company struck by a computer outage lasting more than 10 days will never fully recover. Half of these companies will be out of business entirely within five years of the outage.
- Your chances of experiencing a disaster are one in 100.
- Power outages were one of the three most common causes of disaster in 1989 and 1990.

Morser recommends the use of an Uninterruptible Power System (UPS) to avoid short-term power failures, and a UPS backed by a generator for avoiding longer ones. But he admits that traditional approaches to long-term power protection aren’t always cost-effective.

Moreover, generators and battery banks used for power support need careful tending, Morser notes. “My personal view as a former diesel engineer is that operating life and reliability are far better if the [generator] is run for sustained periods . . . on a regular basis,” he writes.

**UBS® — A cost-effective approach to disaster avoidance**

Fortunately, there is an affordable, reliable solution to the threat of computer and telecommunications failures — BEST’s “Infinite” Battery System (UBS®).

This revolutionary, cost-effective approach to extend Battery Reserve Time is the perfect solution to provide Hours, Days, or even Weeks of...
“Infinite Battery” solves disaster avoidance problems

Continued from page 3

Traditional solutions to extend a facility’s battery reserve time require the addition of parallel ranks of batteries, or the replacement of the existing battery plant with one having a larger ampere-hour capacity. Simply adding batteries to the system requires additional floor space, increases the maintenance required for the system, and often requires additional battery charging equipment. These additions are expensive, add to the complexity of the power system, and reduce the system’s overall reliability.

BEST’s “Infinite” Battery System (UBS®) is unique in providing DC power for extended Battery Reserve Time. It does so without the problems associated with battery plant additions, or those associated with AC phase control and transfer switch operation. The AC generator output waveform ceases to be a concern, and frequency stability problems vanish.

To ensure reliability, the microprocessor-controlled UBS® has an automatic self-diagnostic test system. It automatically monitors parameters such as fuel, oil, and cranking battery power and sounds an alarm if the UBS® fails any system check. A total of 55 system parameters can be monitored, controlled, and forwarded to remote central maintenance facilities. The UBS® also allows for remote control and monitoring using a password-protected system. A keypad and display allow for local monitoring and control of the UBS® unit.

The UBS® is automatically cycled to run for 20 minutes every two weeks to ensure reliable automatic starting when needed.

UBS® by BEST is the first power source designed specifically to provide high-quality, reliable DC power for essential UPS and communication systems.

BEST leads industry with Double Lifetime Warranty

Competitors rush to “clone” innovative program

Best Power Technology has once again demonstrated its leadership in the UPS industry by announcing a first in the power protection industry; a limited Double Lifetime Warranty on all its power protection products.

The Double Lifetime Warranty applies to the transient surge suppression circuitry in each FERRUPS®, Fortress®, Patriot™, Citadel™, or SpikeFree™ sold by BEST for installation in the United States and Canada.

Not surprisingly, competitive manufacturers have scrambled to imrove “me-too” warranties. But BEST’s leadership in this area is driven by its proven track record of product reliability and performance. Subject to certain terms and conditions, this bonus warranty extends BEST’s basic manufacturer’s warranty to offer repair or replacement of transient surge suppressor circuitry in the event of defective material or workmanship or circuitry damage through normal use during the life of the product. Also, this expanded coverage includes reimbursement of up to $25,000 per occurrence of physical damage to specified computer equipment damaged as a result of defective surge suppression circuitry.

Full details of this warranty coverage can be obtained from a BEST dealer or by calling BEST at 800-356-5794.

BEST, the world’s largest manufacturer of single-phase UPS, is the first in the power protection industry to offer this type of warranty on UPS, SPS, and power conditioners, as well as surge suppressors.

According to Best Power Technology Sales Corporation President Bill Paul, “The new Double Lifetime Warranty demonstrates our confidence that BEST products will protect computers and other sensitive electrical equipment from lightning and surges. Each power protection solution BEST offers has advanced surge suppression capabilities. And we’re willing to stand behind our products with the best warranty in the business.”

Paul isn’t troubled by the crowd of clone warranties hastily introduced after BEST announced its program on January 1, 1992. “It’s not the first time we’ve led the way in power protection,” he said. “Besides, given the marginal field performance of some of these competitive units, it’s questionable how long their manufacturers can afford to provide this kind of coverage.”

For more information on Best Power Technology’s products and services, and how they can benefit you, contact:

BEST
Best Power Technology, Inc.
P.O. Box 280
Necedah, WI 54646 - U.S.A.
Toll-Free: 800-356-5794, ext. 4229
(U.S.A. and Canada)
Telephone: (608) 565-7200, ext. 4229
Fax: (608) 565-2221
Telex: 701934
(Best Power UD)
Windows, Netware, Unix and other high-end applications need a SCSI controller that delivers top disk I/O performance and a growth path. Only SmartCache Plus delivers both — and costs no more than less advanced controllers!

As the industry's fastest SCSI controller, SmartCache Plus is the easy choice. It's the smart choice, too — because if your system needs a performance boost, you can transform it from a non-caching host adapter into the world's fastest caching controller! Expandability is so simple: plug-on modules add caching, up to a total of 16MB of cache memory, and disk mirroring!

SmartCache Plus is supported by all major operating systems and applications, and provides connectivity to hundreds of SCSI devices. Reliable, scalable and simple to install, SmartCache Plus breaks your system's disk I/O bottleneck without breaking your budget!
CyberResearch System of the Month Features RTI® DAS from Analog Devices

Guarantee Valid Data with Signal Conditioning Modules
Signal conditioning modules serve several purposes; they protect your computer, isolate your signal of interest from noise, amplify low-level signals, and provide power and excitation to transducers.

One name is virtually synonymous with signal conditioning: Analog Devices. And CyberResearch is your Analog Devices distributor carrying every signal conditioning line: the versatile 3B series, the low-cost 5B series, and the new, intelligent 6B series with on-board A/D conversion.

Call 800-394-3300 to receive additional information.

New PC Products for PC Systems Handbook for Scientists & Engineers

This Combination Tutorial/Catalog Includes Many Examples of PC-based Scientific & Engineering Systems

Have you wanted to enjoy the many benefits of configuring your own PC-based Data Acquisition or Instrumentation system, but didn't know where to begin? The PC Systems Handbook will lead you every step of the way, explaining all aspects of systems configuration with easy-to-understand text and clearly documented diagrams. A detailed glossary and two dozen "Tech Notes" help you understand the terminology. Our new 1993 Edition will be expanded to 196 pages with a hard spine, making it suitable as a permanent addition to your bookshelf. And there is absolutely no charge for this invaluable reference book delivered within the United States. A handling charge is required for Handbooks sent overseas. Please call or Fax for information.

Topics Covered Include:
- Industrial Rack-Mount PCs — 80386, 80486 Models
- Real-Time Data Acquisition, Analysis, & Process Control Software
- PC Plug-in Boards for Analog/Digital, Digital/Analog, & Digital I/O
- Connect your PC to Test Instrumentation with IEEE-488, RS-232, RS-422
- Stepping and Servo Motor Control with your Personal Computer

Op/0/2 Isolated RS-422 Converter Protects Your PC
Your computer can be protected at the power supply, but suffer a devastating shock from power surges picked up over long data lines. The Model 262 converter from Telebyte Technology serves double-duty, providing both high-speed RS-232 to RS-422 conversion and optical isolation.
- Optical isolation exceeds 10,000 Volts
- Earth ground connection
- Switch selection of DCE or DTE
- LED status indicators on data lines
- Wall transformer powers the unit
- Data Rates to 19k baud over 2 miles
- RS-232 Connector: DB-25 (select Male/Female)
- RS-422 Connector: 4 screw terminals + ground

Circle 396 on Inquiry Card.

Package includes LABTECH NOTEBOOK
The RTI series of data acquisition boards were designed by Analog Devices with industrial users in mind. With the lowest failure rate in the industry, these are the boards to choose when reliability is critical. Designed from the outset to be compatible with the full line of Analog Devices’ signal conditioning modules, RTI boards can be used for the broadest possible range of data acquisition applications.

CyberResearch has now made this top-of-the-line product affordable for everyone. By bundling an RTI 815A together with LABTECH NOTEBOOK software at one low price, we’ve saved over $500 and made it possible for you to afford the very best.

Each combination package includes:
- RTI 815A data acquisition board configured for 32 Single-Ended or 16 Differential analog input channels with a 50KHz A/D conversion rate, 2 analog output (D/A) channels, 16 Digital I/O lines, and 3 Counter/Timer I/O channels.
- LABTECH NOTEBOOK menu-driven software with new IconView diagramming user interface and drivers for controlling the RTI 815A board.

Order #RTI 815N RTI DAS Combination Package $1895

New A/D Board perfect for Portable Systems
Designed specifically for use in portable PCs, the PC 126 from United Electronic Industries packs a lot of power into a small package. Unlike many A/D boards, the PC 126 operates entirely on +5V power, usually the only power available in a portable. It’s features include:
- 50kHz A/D sampling @ 12-bit resolution
- 16 Analog Inputs and 2 Analog Outputs
- Free: Driver software with source code in C, menu-driven Status-30 software, and data streaming-to-disk software.
- Consumes 190mA+5V (less than 1 Watt)
- 8 Digital Inputs & 8 TTL Digital Outputs
- PC 126 16-Channel 50KHz Data Acquisition Board with software...
- #INST 347 50-Terminal Screw Terminal Block with 2-Meter Cable to PC 126...

Circle 396 on Inquiry Card.

VGA to Video Converter — VGA to your VCR
Redlake’s TapeCaster converts VGA screen output to video for applications such as recording animation and creating training tapes. The TapeCaster is extremely easy to use: no base addresses, no interrupts, no software required — just plug and play.
• True, precise NTSC/PAL video timing.
• Simultaneous VGA & video display.
• Composite Video & Y-C (SuperVHS)
• Data Rates to 19K baud over 2 miles

#NTSC 209 TapeCaster - NTSC Video Output (for use with VCR's in the U.S.A.)...
#PAL 208 TapeCaster - PAL Composite Video Output...

Circle 393 on Inquiry Card.

New A/D Board perfect for Portable Systems
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- Earth ground connection
- Switch selection of DCE or DTE
- LED status indicators on data lines
- Wall transformer powers the unit
- Data Rates to 19K baud over 2 miles
- RS-232 Connector: DB-25 (select Male/Female)
- RS-422 Connector: 4 screw terminals + ground

#COMH 252 Optically-Isolated RS-232 to RS-422 Converter Module...

Circle 394 on Inquiry Card.
High-Performance Rack-Mount PC's at Economical Desktop Prices!

Now you don't have to pay a huge premium to enjoy the benefits of a 19" rack-mountable PC.

Rugged Chassis Saves Rack Space

Many manufacturers would require you to use 10.5" of height for a PC, 14" for a monitor, and 35" for a keyboard drawer (on which you are supposed to balance the keyboard while you type.) This comes to 28" (16 rack units) of rack height. Our new VRK models include all of these components in just 10.5" (6 rack spaces) tall. You can fit 2'/, PC's in the space of their system, or simply have a rack-mount PC where it was never possible before.

VRK Rack-Mount PC's come in heavy-duty metal cases for EMI/RFI protection.

The VRK line includes the following features:

- Your choice of 80386 or '486 microprocessor. From affordable 386sx models to Ultimate-Performance 50M Hz EISA-Bus Computers.
- 4 MB of RAM (2 MB on 386sx model).
- 10" VGA High-Resolution Color Monitor, with VGA Card included at no extra charge.
- Eight Expansion Slots.
- Industrial Keyboard pulls out and locks - does not move while typing. A protective door keeps keys safe from foreign materials when not in use.
- 1.2 MB (5.25") or 1.44MB (3.5") Floppy Drive.
- 3 Full-access Drive Bays for Floppy Drives, etc.
- Hold-Down keeps Expansion Cards Firmly Seated.
- Floppy & IDE Hard Disk Controller Included.
- Dual-Fan Cooling System w/Honeycomb Filter.
- Rack-Mounting Slide Rails Included FREE.

#VRK 386-208 Rack-Mount 20 MHz 80386sx PC w/VGA Monitor, Rack-Mount Keyboard, & 2 MB RAM ..........$3395
#VRK 386-33 Rack-Mount 33 MHz 80386 PC w/VGA Monitor, Rack-Mount Keyboard, & 4 MB RAM ..........$3795
#VRK 486-33 Rack-Mount 33 MHz 80486 PC w/VGA Monitor, Rack-Mount Keyboard, & 4 MB RAM ..........$4195
#VRK 486-50 Rack-Mount 50 MHz 80486 PC w/VGA Monitor, Rack-Mount Keyboard, & 4 MB RAM ..........$4495
#VRK 486-50E Rack-Mount 50 MHz ISA-Bus 80486 PC w/VGA Monitor, R-M Keyboard, & 16MB RAM ..........$5095

Prices subject to change (reduction) at any time Also available as chassis-only for installation of computer by others. Call or FAX for the latest pricing, quantity discounts, and more information on the entire VRK rack-mounting product line.

Circle 395 on Inquiry Card.

If you use a standard keyboard with your rack-mount system, you know what a nuisance and a hazard it can be. These industrial keyboards are designed to fit easily into any EIA 19" rack. Rugged and reliable, these keyboards are made in the U.S.A. by a Swiss electronics company & demonstrate classic Swiss craftsmanship.

- 101-key layout & full-travel construction with tactile feel for touch-typing
- #DIX 3010 drawer-mounted/#OIX 6010 (shown) slides out with locking door
- Occupies only 1 rack space (1.75" high)

#DIX 3010 Low-cost, Drawer-Mounted Rack-Mount Keyboard ...........$295
#OIX 6010 Slide-out, Rack-Mount Keyboard w/locking drawer ...........$395

Circle 395 on Inquiry Card.

The EASYTEMP System from Keithley/Metrabyte

Software New EASYEST LX software lets you start acquiring data immediately. Specialized start-up software is designed to provide powerful, application-specific solutions.

Manuals Detailed manuals facilitate speedy set-up of your EasyTemp system.

#KDAC 575 EasyTemp Temperature Monitoring System w/Software ...........$4450

100 MHz PC-Based Oscilloscope

CompuScope 250 from Gage Applied Sciences is a family of high quality 100 MHz PC/XT - compatible Data Acquisition Cards with advanced oscilloscope software. Features include:

- 100MHz sampling on 1 channel (10ns/sample) or 50MHz simultaneous sampling on 2 chan.
- 8-bit resolution
- 50MHz bandwidth
- 32 or 128-Kilobyte memory buffer
- Software programmable inputgains
- Store and load setups and signals
- Drivers available in C, Pascal and Basic.

#DSO 200 40MHz CompuScope Lite w/16K Buffer ...........$595
#DSO 250L 100MHz CompuScope 250 Lite ..........$795
#DSO 250-32 100MHz Scope w/32K Buffer ..........$3998
#DSO 250-128 100 MHz Scope w/128K Buffer ..........$8095

Circle 396 on Inquiry Card.
CONTROL UP TO 96 PC FILE SERVERS WITH 1 KEYBOARD AND MONITOR USING...

COMMANDER by cybex

- 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
- Shows PC power status

- PS/2 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

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Huntsville, Alabama 35805
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Fax (205) 534-0010

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The most complete and accurate bomber simulation ever produced, the B-17 Flying Fortress will have you negotiating 25 perilous daylight missions over Nazi-occupied Europe.

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Circle 267 on Inquiry Card.

For IBM PC compatibles!
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Due to a large OEM excess we are offering (lot 123 version 3.1)
with original manual, 3.5 disks in sealed bag with original
registration card

only $199

CD ROM Drives

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| All CD ROM's come complete with software interface and documentation.

Sound Cards

Sound Blaster Pro .............................................. 94
Sound Blaster Pro .............................................. 188

FONT CARTRIDGES FOR HP & COMPATIBLES

Action Set- 102 fonts, same as HP's Pro Collection, compatible with HP, Epson etc. $89
Super Set- 25 fonts, compatible to Pacific Drive 25 in 1, HP's Pro Collection and HP's Microsoft. $199
Jet Set- 118 fonts for HP 900, 300C, 5 to 30pt. $114
Jet Page- postscript for HP $199

MITSUBISHI Floppy Drives

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Maxtor Hard Drives

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CONNER Hard Drives

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<td>IDE</td>
<td>899</td>
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Cypress Coprocessors

- Plug compatible with Intel, three times faster than 5 year warranty.
- Cyrix 32-bit CPUs, 33 MHz X 586BX.SX $88
- Cyrix 32-bit CPUs, 200 MHz 386DX $78
- Cyrix 50 MHz 386SX $78
- AMD 286-40 10 MHz $58
- WEITEK 386DX-20 $89
- WEITEK 386DX-24 $89
- WEITEK 386DX-33 $89
- WEITEK 386DX-20 $89
- WEITEK 386DX-24 $89
- WEITEK 386DX-33 $89
- WEITEK 386DX-20 $89
- WEITEK 386DX-24 $89
- WEITEK 386DX-33 $89

Popular Hard Drives

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<td>QUAN US588A</td>
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<td>WC AC 280</td>
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<td>WC US 1010</td>
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<td>17MS</td>
<td>IDE</td>
<td>1699</td>
</tr>
</tbody>
</table>

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<th>Price</th>
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<td><strong>IBM</strong></td>
<td>PS/2 606, 585X</td>
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<td>PS/2 606/6, Expansion Board 150793</td>
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<td>PS/2 515X, 415X, 605X, 805X, X24, X24X, 30/286, X16, X16X</td>
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<td>IBM Expansion Board 320, 640, 240</td>
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<td>DeskJet 305C, DeskJet 305, 330A, 330AX</td>
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<th>Price</th>
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<tbody>
<tr>
<td>ProLinea 3/25s, 84 MB</td>
<td>$989</td>
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<td>ProLinea 4/25s, 240 MB</td>
<td>$1595</td>
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<tr>
<td>ProLinea 4/50, 240 MB</td>
<td>$2275</td>
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<tr>
<td>DESKPRO 3/25, 120 MB</td>
<td>$1695</td>
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<td>DESKPRO 4/25s, 120 MB</td>
<td>$1610</td>
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<td>DESKPRO 4/66, 210 MB</td>
<td>$2675</td>
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<tr>
<td>DESKPRO 386/33M, 120 MB</td>
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<td>DESKPRO 50M, 340 MB</td>
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<td>DESKPRO 65M, 510 MB</td>
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<td>$6278</td>
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<td>Laptop 486c (color), 210 MB</td>
<td>$8926</td>
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<tr>
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<td>$2259</td>
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<tr>
<td>Laptop Lite 25, 120 MB</td>
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### SystemPro/LT

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<tr>
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<tr>
<td>486DX/25, 1020 MB</td>
<td>$9350</td>
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### NoveLL Specials

Netware 386 V.3.11 Authorized Dealer

<table>
<thead>
<tr>
<th>Plan</th>
<th>Price</th>
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<tbody>
<tr>
<td>5 users</td>
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<tr>
<td>10 users</td>
<td>$1395</td>
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<td>20 users</td>
<td>$1695</td>
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<tr>
<td>100 users</td>
<td>$3795</td>
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<td>250 users</td>
<td>CALL</td>
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### Service

Netware 386 V.3.11 Authorized Dealer

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<td>100 users</td>
<td>$3795</td>
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<tr>
<td>250 users</td>
<td>CALL</td>
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Call for pricing on other brand name models

### We stock

<table>
<thead>
<tr>
<th>Brand</th>
<th>Available</th>
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<tr>
<td>Citizen</td>
<td>YES</td>
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<tr>
<td>OKI Data</td>
<td>YES</td>
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<tr>
<td>TALLGRASS</td>
<td>YES</td>
</tr>
<tr>
<td>NEC ALR</td>
<td>YES</td>
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<tr>
<td>WYSE</td>
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<tr>
<td>HITACHI</td>
<td>YES</td>
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<td>NEC Archive</td>
<td>YES</td>
</tr>
<tr>
<td>MicroSoft</td>
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<tr>
<td>Houston Inst.</td>
<td>YES</td>
</tr>
<tr>
<td>Intel PC Mouse</td>
<td>YES</td>
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<tr>
<td>CalComp</td>
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### LAN Boards

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<td>$75</td>
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<tr>
<td>16 bit Arcnet</td>
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<td>Novell NE 1000</td>
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<td>Novell NE 2000</td>
<td>$175</td>
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<td>8 port Active Hub</td>
<td>$325</td>
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<tr>
<td>Token Ring Card</td>
<td>$399</td>
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<td>Tokenhup 4-port</td>
<td>$355</td>
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Call for other LAN Accessories

### Printers

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<th>Model</th>
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<tr>
<td>EPSON LQ 570</td>
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<tr>
<td>EPSON LQ 1170</td>
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<tr>
<td>OKIDATA ML320</td>
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<td>OKIDATA ML390</td>
<td>$460</td>
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<tr>
<td>HP DeskJet 500</td>
<td>$399</td>
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<tr>
<td>HP PaintJet 705</td>
<td>$705</td>
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<tr>
<td>Citizen, Panasonic</td>
<td>CALL</td>
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### Hard Disks

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<td>QUANTUM</td>
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<td>MAXTOR, SEAEGE</td>
<td>CALL</td>
</tr>
<tr>
<td>MICROPOLIS, MICRONET</td>
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### Laser Printers

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<td>HP Laser III</td>
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<td>HP Laser IID</td>
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<td>HP Laser IIIP</td>
<td>CALL</td>
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<td>HP IIP Plus</td>
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<td>OKI OL 300, 800</td>
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<td>OKI OL 840 P.S.</td>
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<td>OKI Model 95</td>
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### Accessories

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<td>CP30104</td>
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<tr>
<td>CP3024F</td>
<td>CALL</td>
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</tbody>
</table>

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18. Hard Drives - 30-39 meg
19. Hard Drives - 30-39 meg
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21. Ext 900 Modems Pro or Nat
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23. Ext 900 Modems Pro or Nat
24. Ext 900 Modems Pro or Nat
25. Ext 900 Modems Pro or Nat
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<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>February</td>
<td>March</td>
<td>April</td>
<td>May</td>
</tr>
<tr>
<td>June</td>
<td>July</td>
<td>August</td>
<td>September</td>
<td>October</td>
</tr>
<tr>
<td>November</td>
<td>December</td>
<td>Special Issue</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HARDWARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ACCESSORIES/SUPPLIES</td>
<td>349</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ADD-IN BOARDS</td>
<td>174</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>BAR CODING</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>COMMUNICATIONS/NETWORKING</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>COMPUTER SYSTEMS</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>DISK &amp; OPTICAL DRIVES</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>DISKETTES/DISKUS</td>
<td>205</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>FAX BOARDS/MACHINES</td>
<td>398</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>GRAPHICS TABLETS/MICE/PEN INPUT</td>
<td>382</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>KEYBOARDS</td>
<td>197</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>LAPTOPS &amp; NOTEBOOKS</td>
<td>73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>MONITORS &amp; TERMINALS</td>
<td>183</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>MULTIMEDIA</td>
<td>274</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>PRINTERS/PLOTTERS</td>
<td>399</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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5. Engineer/Scientist

6. Other

B. What is your level of management responsibility?

7. Manager

8. Assistant Manager

9. Supervisor

10. Manager Level

11. Middle-level

12. Other

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

13. Yes

14. No

D. What operating systems are you currently using? (Check all that apply)

15. MS-DOS

16. OS/2

17. Unix

18. VMS

19. VAX/VMS

20. Other

E. For how many people do you currently use software?

1. 1-25

2. 26-50

3. 51-100

4. 101-200

5. 201-500

6. Over 500

F. What is your personal computer's make/size?

1. IBM/PS/2

2. Compaq/386

3. Apple/II

4. Tandy/1000

5. Other

G. Does this software influence the purchase of hardware or software?

1. Yes

2. No

H. How much will you influence the purchase of hardware or software?

1. Medium

2. Little

3. None

I. What are your special interests in software?

1. Business

2. File Management

3. Data Base Management

4. Multimedia

5. Database Management

6. Communications

7. Graphic Systems

8. Operating Systems

9. Programming/Programming Languages

10. Game Software

11. Educational

12. Productivity Software

13. Engineering/Scientific

14. Information Retrieval

15. Security

16. Miscellaneous

17. Other

J. Where do you currently receive software information?

1. BYTE Magazine

2. Computer Shopper

3. CompuServe

4. Other

K. What is your level of education? (Check one)

1. 7th grade or Less

2. 8th grade

3. High School Grad

4. College

5. Bachelor's Degree

6. Master's Degree

7. Doctoral Degree

8. Other

L. What is your income range?

1. Under $15,000

2. $15,000 - $24,999

3. $25,000 - $39,999

4. $40,000 - $54,999

5. $55,000 - $69,999

6. $70,000 or More

M. What is your annual software spending?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

N. What is your annual hardware spending?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

O. What is your annual computer training program spending?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

P. What is your annual hardware repair program spending?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

Q. What is your annual software repair program spending?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

R. In what way do you use software?

1. Programming

2. Management

3. Operating Systems

4. Geographic Information

5. Engineering

6. Scientific

7. Education

8. Business

9. Gaming

10. Entertainment

11. Miscellaneous

S. Will you be purchasing software in the next year?

1. Yes

2. No

T. How much will you spend on software in the next year?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

U. Will you be purchasing hardware in the next year?

1. Yes

2. No

V. How much will you spend on hardware in the next year?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

W. What is your method of software distribution of products you're interested in?

1. Direct Mail

2. Trade Shows

3. Dealers

4. Other

X. Will you purchase add-on boards (Sound/Modem cards) in the next year?

1. Yes

2. No

Y. What is your annual software spending?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

Z. What is your annual hardware spending?

1. Under $100

2. $101-$250

3. $251-$500

4. $501-$750

5. $751-$1,000

6. $1,001 or More

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<table>
<thead>
<tr>
<th>Category No.</th>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>103</td>
<td>34</td>
</tr>
<tr>
<td>43</td>
<td>107</td>
<td>34</td>
</tr>
<tr>
<td>51</td>
<td>109</td>
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<td>50</td>
<td>138</td>
<td>34</td>
</tr>
</tbody>
</table>

**GENERAL**

<table>
<thead>
<tr>
<th>Category No.</th>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>139</td>
<td>34</td>
</tr>
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<td>52</td>
<td>140</td>
<td>34</td>
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<td>141</td>
<td>34</td>
</tr>
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Artificial Life and Natural Markets

Artificial life is a hot topic right now for computer scientists, biologists, and philosophers. But it may hold special meaning for the new entrepreneurs of Central Europe and the former Soviet Union by providing a respectable scientific model for the behavior of seemingly chaotic competitive markets. In a world where capitalist economics is still suspect, artificial life makes it clear that competition is a creative force, not a destructive one.

The basic idea behind artificial life, or ALife, is to build electronic "creatures" that reproduce—but imperfectly. Sometimes there are slight changes between the original and its children; sometimes by combining features of two original creatures you can produce a best-of-both-sides (or worst-of-both-sides) copy. If you select the best of each successive generation as the starting point for the next generation, you'll see something awesome: evolution at a time scale humans can comprehend.

One of the most exciting experiments along these lines is Tierra, created by Tom Ray, now at the Santa Fe Institute for complex adaptive systems. Ray created a single electronic creature that reproduced itself, with slight mutations. Soon these creatures had filled up available memory, and imperfect copies started to do strange things—use each other's code, get more efficient at reproducing, and so on. These creatures were parasites, and they became new species competing for resources.

ALife gives biologists and computer scientists a way to experiment that isn't possible in the "real" world. Traditional experiments usually take years to create and test a generation so that the best ones can be selected for the next round. Most biologists have to work with incomplete, hard-to-assess fossil records instead of tidy, well-organized interactive computer graphics, where you can trace the exact progress of generations.

The ALife experiments illustrate the awesomely creative power of competition. Creatures evolve best when they coevolve, when one species spurs another to evolve, exploiting its weaknesses and enhancing its strengths. When different species compete, they find niches and evolve into specialists at competing with each another or cooperating with other species.

As it happens, you can see this same principle work in markets. I divide my time between places such as Silicon Valley and the emerging computer markets of Eastern Europe. Over and over, I see parallels between market processes and evolutionary processes, as illustrated by ALife. The major difference had been time scale, but now simulations let us look at both processes in real time.

In Eastern Europe, I can follow the stumbling, awkward process of market creation. The emergence of healthy competition is not automatic. The untrained notion of competition is that one side wins and the other loses. But as ALife illustrates, competition is a much more complex, self-organizing tool.

Slowly, the factors that made one side win get strengthened, while those that made the other side lose diminish. Competition fosters healthy diversity. Second-place finishers find other races to run, emphasizing different subsets of features. To compete successfully with Compaq, Dell didn't just do the same things better; it tried something different. The mathematics of how this happens are complex and can be observed in ALife simulations.

There's little coevolution in the new Russian markets, partly because competitors do not know enough about each other. Vendors don't have to compare their products to those of other vendors because everything is in such short supply. That will change.

As ALife shows, the way to evolve is by defining yourself against the other guy, by specializing. The market isn't only about sellers talking to buyers, who determine fitness; it is also about sellers talking to each other, so that they can find their proper specialization.

The former Soviets have been trained to think of markets as wicked and dirty—and, indeed, most of the markets they've seen so far fit this description. The Communist model depicted a cleanly run, scientific world where goods were produced and allocated according to just, scientific principles, and where prices reflected costs of production. But prices work better when they reflect customer demand—or fitness in evolutionary terms. Prices do not just allocate scarce goods; they influence design and investment in the production of future goods. By clarifying the scientific principles behind markets and market pricing, artificial life may help to make them respectable, even in the eyes of former Communists.

Esther Dyson is editor of Release 1.0, a newsletter that discusses exotic software, and of Rel-EAST, a newsletter about emerging computer markets in Central and Eastern Europe. You can reach her on BIX c/o "editors" or by MCI Mail at 511-3763.
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