486SX vs. Am386-40
Lab analysis reveals a surprise winner

State of the Art in
Desktop Multiprocessing
Understanding HP’s PCL
8 Leading SX Notebooks
Three Free Utilities
Zenith’s 386SL-Based MastersPort

PLUS
Borland’s C++ and Turbo Pascal/Windows
HP’s PA Unix Workstation
ATM, FaceLift, and Intellifont
Mac and PC 24-bit Paint Software
NCR WaveLAN
Nextstation
If we've said it once, we've said it ten times. You can get a custom-configured Dell® computer with better service for up to thousands less than a similarly configured Compaq system! Everything from the award-winning 386 SX laptop PCs to workgroup-sized i486* network servers. With a virtually limitless number of choices of monitors, hard drives, RAM sizes and peripherals.

But if you're still not convinced, go to a Compaq dealer and compare what's there with what's here.

You make the call, then we make the computer. And because we actually manufacture the desktop computers we sell, each one is custom configured to your exact specifications when you order.

Then we run a configured systems check, and ship it to you via two-day air standard. With a 30-day money back guarantee and a one-year limited warranty.

Support that wins awards, and your confidence.

The Dell service and support package has won PC Week's Corporate Satisfaction Poll for PCs, laptops and servers an unprecedented 8 times. Maybe because the company that supports Dell computers is the same one that designs Dell computers. Which means you get a technical support staff that can solve 90% of all problems over the phone. Usually in 6 minutes or less. You also get an electronic bulletin board that lets you see other users' questions about Dell systems. And more importantly, Dell's answers.
THE DELL SYSTEM 320LX.
ONLY $2,599
Lease $97/month
*Intel 80386SX microprocessor running at 20 MHz.
40 MB VGA Color Plus System $2,599
Option includes 2 MB of RAM* 80, 100, 190, 330 and 650 MB hard drive configurations also available.

THE DELL SYSTEM 316SX.
ONLY $2,099
Lease $79/month
*Intel 80386SX microprocessor running at 16 MHz.
40 MB VGA Color Plus System $2,099
Option includes 1 MB of RAM* 20, 80, 100 and 190 MB hard drive configurations also available.

THE DELL SYSTEM 316LT.
ONLY $2,899
Lease $127/month
*Intel 80386SX microprocessor running at 16 MHz.
20 MB, 1 MB RAM* $2,899
40 and 120 MB hard drive configurations also available.
16 MB systems also available starting at $1,499.

THE DELL SYSTEM 32XN.
ONLY $3,399
Lease $127/month
*Intel 80386SX microprocessor running at 20 MHz.
30 MB, 1 MB RAM* $3,399
60 MB configurations also available.
The Dell 212N 12 MHz: S86 also available starting at $1,399.

THE DELL SYSTEM 21C.
ONLY $1,499
Lease $56/month
*80286 microprocessor running at 12.5 MHz.
20 MB VGA Monochrome System $1,499
Price listed includes 1 MB of RAM* 60, 60 and 120 MB hard drive configurations also available.

You even have anytime, any day access to Dell's innovative automated toll-free, 24-hour TechFax line. Just dial-up, and get detailed information from the Dell technical library faxed back to you. On the spot.

And if your problem can't be solved over the phone, a trained service technician will come to you with a solution. Usually by the next business day.

And best of all, you don't have to worry about budgeting for all of this. Because the system price includes on-site service for a year, and phone support forever.

But you don't need to worry too much about that. Those Customer Satisfaction Rolls consistently rank Dell tops in reliability as well.

The right hardware for hard times.

A down economy is not the time for Compaq dealer mark-ups.

Which makes Dell computers look even better these days. And, to loosen those tight budgets even more, you can take advantage of a wide variety of credit, lease and lease-to-buy programs.

For instance, you can lease Dell computers for as little as $56 a month. Or use the lease-to-buy plans and own the computer at the end of the lease term. There's even a Dell Direct Advantage MasterCard with up to a $15,000 credit limit and a way to earn points toward Dell products with everything you buy. Either way, you'll get all the credit you deserve.

So if you were planning to buy a Compaq PC, take a deep breath, count to ten and call Dell.

TO ORDER, CALL PLEASE REFERENCE #11EI
800-365-9977
HOURS: 7AM-9PM CT MON-FRI 8AM-4PM CT SAT
IN CANADA 800-367-3752, IN MEXICO 95-800-000-0064.
ROAD WARRIOR.

There you are, doing battle far from home. Armed with your powerful new notebook computer. As you prep for the next day's conquest, something unexpected happens.

Suddenly you find yourself stranded in some strange hotel room, with your computer down. And no one will come service it.

You wake up in a pool of sweat.

Dreams like this make it very easy to choose Dell's 20 MHz 386SX notebook computer over the remarkably overpriced and underserviced Compaq LTE 386s/20.

Because when you buy the Compaq system, this isn't just a bad dream. It's a real possibility.

**Can you afford not to buy the Dell® 320N?** At a time when everybody is cutting budgets, can anyone afford to spend extra money?

More importantly, can you afford to go on the road counting on service from a Compaq dealer you've never heard of?

Especially when every Dell system comes with a full gamut of road services. Like a toll-free technical support line that helps users solve 90% of their problems over the phone.

And if you need help in the middle of the night, just call Dell's innovative TechFax line. It automatically faxes back detailed information on your Dell computer. Even to your hotel.

If that doesn't solve it, call for road service. A trained

TO ORDER, CALL PLEASE REFERENCE #18F1
800-365-9977  HOURS: 7AM-9PM CT M-F 8AM-4PM CT SAT
IN CANADA, CALL 800-365-9977
IN MEXICO 95-800-010-0664.

**DELL SYSTEM™ 320N 386™SX 20 MHz SYSTEM INCLUDES VGA LCD, 30 MB HARD DRIVE, 2 MB RAM.**

- Intel® 80386SX microprocessor running at 20 MHz (320N) and the Intel® 80C286 microprocessor running at 12 MHz (212N).
- Standard 1 MB of RAM, expandable to 5 MB (on the system board using 1 MB or 2 MB memory modules).
- 640 x 480 VGA LCD with edgelight.
- One expansion slot for Dell Data/FAX modem.
- 6.4 lbs. with battery, dimensions are 8.5"D x 11"W x 2"H.
- 3.5" 1.44 MB diskette drive.
- 85-key keyboard with embedded numeric keyboard.
- 1 serial port and external VGA monitor port.
- Selectable parallel printer or external 5.25" disk drive/tape back-up port.
- Connector for numeric keypad or 101-key keyboard.
- Mouse port.
- Removable and rechargeable battery pack utilizing Dell's "Continuous Power Battery System" (patent pending).

**THE DELL SYSTEM 320N 20 MHz 386SX AND THE DELL SYSTEM 212N 12 MHz 286.**

- 320N: 30 MB, 1 MB RAM, 52.399
- 212N: 20 MB, 1 MB RAM, 320N: 30 MB, 1 MB RAM, $3.399
- 40 MB hard drive configuration also available for the 212N.
- 40 MB and 60 MB hard drive configurations also available for the 320N.
The display is a high quality VGA LCD. There's an optional, built-in Data/FAX modem. And a sliding door that lets you easily insert a math coprocessor, RAM modules or the modem without major surgery. (Dell also has the 212N, 12 MHz 286 with a 20 or 40 MB hard drive.)

Even the keyboard shows touches of brilliance. It's a complete 85-key layout. Including the special screen navigation keys (Home, End, Page Up, Page Down and separate Cursor keys in the familiar inverted “T” layout) that let you easily navigate even the most spread-out spreadsheet. And every key is engineered for extended travel, to provide the familiar touch of a top-of-the-line desktop system.

Don't worry. Be happy. One more thing to consider.

When you buy from Dell, you're dealing directly with a company that has won PC Week's Corporate Satisfaction Poll for PCs, servers and laptops. Not just once. An unprecedented eight times.

A company that will custom configure any system to meet your needs. And then work with you to custom configure a finance or leasing plan.

And we back it all with a 30-day no questions asked satisfaction guarantee.

Call today for either of our new notebook computers. And hit the road, equipped with a Dell.

That'll really give the guys with the Compaqs something to worry about.
“Now all of my customers can afford to put a 486ASX on every desk.” Richard D. Darrell, President, Direct Computer Corporation

Upgrades

- PowerFlex 486ASX
- BusinessStation 486ASX

ALR's modular system architecture allows you to inexpensively Just Upgrade the CPU! whenever you need more processing power.

All Of Our Customers Think They Can Afford a 486. They're Right.

ALR's VEISA 33-MHz 486 CPU Module
ALR VEISA 33-MHz 486 CPU Module
ALR VEISA System Board

Upgrade 2 ways using ALR's SuperCharged 486 CPU/Math Coprocessor Chip. Increase performance up to 25% instantly or simply add a math coprocessor.

ALR VENTURE/16 Notebook and the grand prize of one new ALR BusinessVEISA 486ASX with Microsoft MS-DOS 4.01 & Windows 3.0

Come by the ALR booth, #3034, and enter to win giveaways of Nintendo Gameboys™, our ALR Venture/16 Notebook and the grand prize of one new ALR BusinessVEISA 486ASX with Microsoft MS-DOS 4.01 & Windows 3.0.
You've got that insatiable craving for performance that only the power of an i486™ can satisfy. Now, with ALR's complete family of advanced i486SX™ systems, you can get the full strength of a 20-MHz i486SX processor at a price that will revolutionize the way you view i486 technology —

$1995!

The flagship of this family is the powerful new BusinessVEISA 486ASX™. With its i486SX processor, this system is truly "32-bit ready" - it's completely compatible with 32-bit versions of UNIX™, OS/2™, and 386 mode of Windows™ 3.0. And as a member of ALR's award-winning VEISA™ family, the BusinessVEISA 486ASX surrounds this innovative processor with a full assortment of cutting-edge technology.

From its true 32-bit EISA bus to its trail-blazing "Just Upgrade the CPU!™" processor upgrade technology, the BusinessVEISA 486ASX is designed to take you comfortably into the future.

Suppose a year or two down the road you need more processing power. The BusinessVEISA 486ASX gives you two ways to upgrade. The first, and most inexpensive method, utilizes ALR's SuperCharged 486™ CPU/Math Coprocessor Socket. Just plug an ALR SuperCharged 486™ CPU/Math Chip into the socket found on your system's 486ASX CPU module. You'll instantly get all the performance (and the integrated math coprocessor) of a true 25-MHz Intel i486 processor. That's enough power to take on advanced database and statistical applications, even CAD/CAM.

MIPS Benchmarks

BusinessVEISA 486ASX: 8.8
BusinessVEISA 486ASX with SuperCharged 486 CPU/Math Chip: 11.1

And when you need even more processing power you can add 64-KB of optional cache memory or replace the 486ASX CPU module with one of ALR's 33-MHz (or faster) i486 modules. There's no reason to deny your craving for power any longer. Call: 1-800-444-4ALR

Available at these selected resellers:

<table>
<thead>
<tr>
<th>Model</th>
<th>ALR PowerFlex 486ASX</th>
<th>ALR BusinessVEISA 486ASX</th>
<th>ALR BusinessStation 486ASX</th>
<th>ALR MPS 486ASX</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>20-MHz i486SX</td>
<td>20-MHz i486SX</td>
<td>20-MHz i486SX</td>
<td>20-MHz i486SX</td>
</tr>
<tr>
<td>Bus Architecture</td>
<td>ISA</td>
<td>EISA</td>
<td>EISA</td>
<td>Micro Channel</td>
</tr>
<tr>
<td>RAM Standard</td>
<td>1-MB</td>
<td>1-MB</td>
<td>1-MB</td>
<td>1-MB</td>
</tr>
<tr>
<td>Floppy Standard</td>
<td>1.44-MB</td>
<td>1.2-MB</td>
<td>1.2-MB</td>
<td>1.44-MB</td>
</tr>
<tr>
<td>Storage Bays</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Total Slots</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Starting List Price</td>
<td>$1995</td>
<td>$2795</td>
<td>$3295</td>
<td>$2995</td>
</tr>
</tbody>
</table>

* BusinessVEISA 486ASX prices start at $2795. Prices and configurations subject to change without notice. Prices based on U.S. dollars. ALR is a registered trademark of Advanced Logic Research, Inc. All other brand and product names are trademarks or registered trademarks of their respective owners. ©1991 by Advanced Logic Research, Inc.
FIRST IMPRESSIONS

The 486SX Falls Short

PAGE 36

MICROBYTE

Is the Advanced Computing Environment the next coming of the PC?

FIRST IMPRESSIONS

Seven's a Success

A long-awaited Mac OS offers compatibility, new features, and a future growth path.

HP/Apollo 9000 Series 700, the fastest Unix system we've tested

Zenith's MastersPort 386SL and SupersPort 486, the first 386SL-based low-power notebook and a loaded 486 portable

Turbo Pascal for Windows, finally, an easy way to develop Windows applications

GUI Programming Facility, software that takes away some of the pain of developing PM applications

WHAT'S NEW

Desktop power for use on the road, working in DOS on your Mac, and more.

Window Wars

The leading graphical user interfaces go head to head.

Tools for Window Workers

Development systems make it easier to create GUI programs.

Resource Guide: Graphical User Interfaces

Embedded Systems in Control

The proliferation of, and new trends in, embedded systems.

Advanced Spreadsheets

MULTIPROCESSING

Introduction

Multiprocessor Surf's Up

A parallel technology that's gone from Real Soon Now to Here Now!

Cache as Cache Can

Cache coherency is a critical element of shared-memory multiprocessor systems.

Popular and Parallel

Various approaches to creating truly scalable shared-memory architectures.

Scaling Up: Get the Message?

Message-passing multicomputers bypass shared memory.

Symmetry, Thy Name Is Unix

Unix SVR4/MP: A new standard for multiprocessing with Unix?

Resource Guide: Multiprocessing Systems
PRODUCT FOCUS
Paint for the Pros
The BYTE Lab tests eight professional-level paint programs for Macs and PCs.

No-Compromise Notebooks with 386SX Power
From a torrent of SX notebook introductions, one clear winner emerges.

WavelAN: A Network with No Strings Attached
NCR's product does away with LAN cabling—for a price.

The Nextstation: A High-Performance Graphical Workstation with a PC Price Tag
Can Next take on both Sun and Apple?

Borland C++ 2.0 Moves into Windows Territory
Borland's latest compiler produces DOS and Windows applications.

What-If CAD: Parametric Math Migrates to Windows
DesignView and Cedar offer CAD designers what-if analysis tools.

Windows Display Managers File Rough Edges from Text
How's your face? Windows font managers finally make true WYSIWYG a reality.

SOME ASSEMBLY REQUIRED
The Big Index
Create an efficient keyword index for all the files on your disk.

UNDER THE HOOD
The Evolution of PCL
Version 5 of Hewlett-Packard's PCL beefs up the standard office printer.

SOFTWARE CORNER
Just for Checking Up
Three free utilities for DOS, Mac, and Unix systems.

ASK BYTE
Floppy disk drives, drivers, photography, and more.

NETWORKS
The AIX Alternative, Part 2
by Barry Nance
The search for the right network-support software.

BEYOND DOS:
Windows Meets AI
by Martin Heller
AI applications come to Windows.

MACINATIONS
System 7.0—Apple Defines Its Future
by Don Crabb
The Mac moves into the 1990s with a new operating system.

THE UNIX /bin
Networking Unix
by David Fiedler
Networking on LANs and the Internet.

USER'S COLUMN
DOS Decisions
by Jerry Pourmelle
Jerry works with the Arche Legacy 486/33 and Digital Research's DOS 5.0.

BUSINESS CONNECTION
A LAN Away from Home
by Wayne Rash Jr.
Your LAN: You can take it with you.

ROUNDTABLE
Who Needs GUis?
The pros and cons of graphical user interfaces.

PRINT QUEUE
A Passage from India
An intriguing biography of an Indian genius.

STOP BIT
Windows of Vulnerability
What will the coming of the GUI mean to the blind and the learning-disabled?

EDITORIAL
Here We Go Again...

LETTERS
Unreliable software continues to strike a nerve.

READER SERVICE
Editorial Index by Company
Alphabetical Index to Advertisers
Index to Advertisers
Inquiry Reply Cards: after 408

PROGRAM LISTINGS
From BIX: Call (800) 227-2983
From Demolink: See ad on page 373
On disk: See card after 392

INSIDE BYTE

REGIONAL SECTION
begins after page 88
### BYTE Topic Index and Author Guide

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 402), you can identify articles by type, subject, title, author, or product discussed.

#### C
- 18, 301

#### DATA COMPRESSION
- 18

#### EDI
- 18

#### ELECTRONIC MAIL
- 18, 107, 294, 341, 343, 363

#### IDE
- 18

#### MACINTOSH
- 42, 66, 124, 258, 357

#### DATA COMPRESSION
- 18

#### ETHERNET
- 294

#### FONTS
- 311

#### 40-MHZ CHIPS
- 36

#### 486SX
- 25, 36

#### GRAPHICS
- 139, 258

#### GUI
- 52, 117, 124, 139, 151, 416

#### IDE
- 18

#### IDE
- 18

#### MACINTOSH
- 42, 66, 124, 258, 357

#### MATHMATICS
- 414

#### MULTIPROCESSING
- 196, 199, 209, 219, 231, 245

#### NETWORKING
- 18, 107, 294, 341, 343, 363

#### NOTEBOOKS
- 52, 282

#### OBJECT-ORIENTED PROGRAMMING
- 301

#### PASCAL
- 52

#### PCL
- 325

#### PORTABLES
- 66, 107

#### PRESENTATION MANAGER
- 52

#### SPREADSHEETS
- 171

#### 386SX
- 18, 282

#### UNIX
- 52, 66, 245, 297, 363

#### WINDOWS
- 52, 66, 124, 139, 305, 351, 416

#### WORKSTATIONS
- 52, 89, 297

#### AUTHORS

<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alford, Roger C.</td>
<td>325</td>
</tr>
<tr>
<td>Andrews, Dave</td>
<td>66</td>
</tr>
<tr>
<td>Barker, D.</td>
<td>25</td>
</tr>
<tr>
<td>Barron, Janet J.</td>
<td>124</td>
</tr>
<tr>
<td>Bissell, Don</td>
<td>305</td>
</tr>
<tr>
<td>Carpenter, Steve</td>
<td>127, 144, 297</td>
</tr>
<tr>
<td>Cook, Rick</td>
<td>153</td>
</tr>
<tr>
<td>Crabb, Don</td>
<td>117, 357</td>
</tr>
<tr>
<td>Eglowstein, Howard</td>
<td>311</td>
</tr>
<tr>
<td>Fiedler, David</td>
<td>363</td>
</tr>
<tr>
<td>Goode, Roger</td>
<td>262</td>
</tr>
<tr>
<td>Grehan, Rick</td>
<td>258</td>
</tr>
<tr>
<td>Heller, Martin</td>
<td>52, 117, 139, 351</td>
</tr>
<tr>
<td>Joch, Alan</td>
<td>36</td>
</tr>
<tr>
<td>Kearns, Steven</td>
<td>301</td>
</tr>
<tr>
<td>Kenner, Hugh</td>
<td>414</td>
</tr>
<tr>
<td>Langa, Fred</td>
<td>10, 117</td>
</tr>
<tr>
<td>Lazzaro, Joseph J.</td>
<td>416</td>
</tr>
<tr>
<td>Linderholm, Owen</td>
<td>42, 52</td>
</tr>
<tr>
<td>Loeb, Larry</td>
<td>117</td>
</tr>
<tr>
<td>Malloy, Rich</td>
<td>158</td>
</tr>
<tr>
<td>Miastkowski, Stan</td>
<td>52, 117</td>
</tr>
<tr>
<td>Minchillo, Vinny</td>
<td>156</td>
</tr>
<tr>
<td>Nadeau, Mike</td>
<td>36</td>
</tr>
<tr>
<td>Nance, Barry</td>
<td>341, 343</td>
</tr>
<tr>
<td>Nudelman, Mark</td>
<td>245</td>
</tr>
<tr>
<td>Pournelle, Jerry</td>
<td>89</td>
</tr>
<tr>
<td>Rash, Wayne Jr.</td>
<td>107, 294</td>
</tr>
<tr>
<td>Robinson, Mike</td>
<td>219</td>
</tr>
<tr>
<td>Ryan, Bob</td>
<td>117, 199, 261</td>
</tr>
<tr>
<td>Sheldon, Ken</td>
<td>117, 124</td>
</tr>
<tr>
<td>Smith, Ben</td>
<td>52, 124, 139</td>
</tr>
<tr>
<td>Stein, Richard Marlon</td>
<td>231</td>
</tr>
<tr>
<td>Swartz, Carol</td>
<td>66</td>
</tr>
<tr>
<td>Tazelaar, Jane Morrill</td>
<td>196</td>
</tr>
<tr>
<td>Thompson, Tom</td>
<td>42, 117, 258</td>
</tr>
<tr>
<td>Udell, Jon</td>
<td>117</td>
</tr>
<tr>
<td>Vaughan-Nichols, Steven J.</td>
<td>209, 282</td>
</tr>
<tr>
<td>Vornberger, Cal</td>
<td>270</td>
</tr>
<tr>
<td>Wayner, Peter</td>
<td>139, 317</td>
</tr>
</tbody>
</table>
Tri-Star's 486/25 rates honorable mention for its thoughtful design touches, two year warranty and excellent service program.

"Tri-Star's edge is its good documentation and excellent service policy."

PC Sources 486/33 Lead Review, February 1991

Flash Cache 486 Computers

- Intel 80486 Processor
- 8MB RAM (Expandable to 16MB On Board)
- 64K High Speed Static RAM Cache
- 210MB 15ms Hard Disk Drive
- 1.2MB 5.25-inch Floppy Drive
- 1.44MB 3.5-inch Floppy Drive
- 1024 x 768 SVGA Adapter w/1MB RAM
- 14" Non-interlaced SVGA Color Display
- High Res 400 DPI Three Button Mouse
- Quality 101-Key Tactile Keyboard
- Two Serial Ports and 1 Parallel Port
- Fully DOS, UNIX & Novell Compatible
- Circle 332 on Inquiry Card.

FC425
$3755

FC433
$3995

Upgrades:

- 16" Color Display $695
- 20" Color Display $1695

Flash Cache 33MHz 386 as above with 4MB RAM & 125MB Hard Drive—Only $2655

ALL Flash Cache Computer Systems Include:

- 2 Year Parts & Labor Warranty
- 60 Day Money Back Guarantee
- 12 Month On-Site Service
- Overnight Parts Replacement
- Lifetime Toll-Free Technical Support

Product names and specifications subject to change without notice. We accept MasterCard & Visa. All sales subject to change without notice. All models have been verified to meet or exceed specifications. For more information, call 1-800-678-2799. Product names mentioned herein may be trademarks and registered trademarks of their respective companies.

1.800.678-2799
707 West Geneva, Tempe, Arizona 85282

Tech Support 1.800.688-TECH
Telephone 602.829-0584
Fax 602.345-0110
Monday - Friday 7:00am-7:00pm MST
Saturday 9:00am-4:00pm MST

Flash Cache 486

"Tri-Star is king of the 33MHz 486 Mountain."
PC WEEK Analyst's Choice, February 18, 1991

PC Magazine Editor's Choice Honorable Mention, September 11, 1990

"Tri-Star is king of the 33MHz 486 Mountain."
When you build a better mouse

Microsoft Mouse devotees number over 6 million, and counting. Just what kind of mouse inspires people this way? Well, the kind with a patented ergonomic design and high resolution, 400-points-per-inch tracking.

The kind of mouse that wins the PC Magazine Editors' Choice Award and Technical Excellence Award. Not to mention the Innovation in America Design Award from Business Week, the Industrial...
Design Award from *Industrie Forum* and others.

And incidentally, no mouse works better with another innovation of ours, Microsoft Windows' graphical environment version 3.0.

To track down America's number one mouse, call (800) 541-1261, Department P98.

We'll be happy to point you in the right direction.

*Microsoft*

Making it all make sense®
HERE WE GO AGAIN...

I admire Intel. The company does a spectacular job of advancing technologies and delivering successful products based on those technologies. No matter where you stand in any of the CPU religious wars—segmented versus flat, big-endian versus little-endian—one undeniable fact remains: More people use Intel-based PCs than any other type. There’s not even a close second. Time after time, Intel has set the de facto standard for what is acceptable on the desktop.

When Intel competes on technological grounds, I’m one of the company’s biggest fans. Anytime Intel rolls out new computing technology, our options increase, we can do more with our computers, and the prices of older technologies go down. More computing horsepower gets into the hands of more people.

But sometimes, Intel competes by creating artificial distinctions among chips—distinctions not based on technological advances. In fact, the 386SX was technologically backward: a 32-bit chip stuffed into a 16-bit package. Intel could have served the low end by letting prices of true 32-bit 386DX chips fall, but instead it chose to prop up DX pricing and tried to kill off low-end competition from non-Intel 286 chips. When Intel ran ads that said “No 286, it really meant “No Advanced Micro Devices,” and “No Fujitsu,” and “No Harris.” The ads also really meant “No competition.”

Well, the competition struck back anyway, and AMD is now shipping a very nice, perfectly legal clone 386 chip. Other companies have clone 386 chips in the works, and Intel is feeling threatened.

Enter the i486SX. While the original i486 was a genuine technological advance, the i486SX is retro: a slowed-down i486 with its built-in FPU deliberately disabled. While the rest of the industry differentiates products through value added, Intel has chosen to differentiate this product through value subtracted. It’s like an auto maker taking a perfectly good V-8 engine, disabling two cylinders, and selling it as a V-8SX.

So, like the 386SX before it, the i486SX is another chip with no technological reason for existence, but one that will have a huge market impact because of massive ad campaigns (watch for them soon) and knee-jerk responses from tub-thumping publications.

This kind of marketing game might be amusing if it didn’t hit us in our wallets. Consider: If Intel can take a fully functional i486, perform extra work on it to turn off some of the functions, and sell it to you at a low price, Intel could sell you the fully functional i486 at that same price—or less, because the original chip doesn’t require the extra step of disabling functions.

Once you get past the marketing games, what’s left is the issue of price/performance. It’s not a question of the i486SX being nonfunctional: Of course it works. Without the FPU and with a slower clock, what’s left of the chip (which still does have the i486’s improved instruction set and on-board cache memory) falls between garden-variety 386 chips and fully functional i486 chips. And that’s what Intel wanted.

The first systems we’ve seen that are built around the i486SX perform about as you’d expect, but they cost much more than alternative systems that deliver equivalent performance.

This price/performance gap is much wider than I’d expected. I’d thought that—CPU pricing aside—the other parts for a 40-MHz 386 system would be substantially more expensive than the parts for a 20-MHz 486SX system. We’d gone into this 486SX versus AMD 386/40 expecting price/performance parity. But the system designers we’ve talked to said the parts-pricing differences aren’t significant, and the fruits of their labors seem to bear this out.

In this month’s cover story, you’ll see how a Club American Technologies system built around AMD’s new 40-MHz 386 clone chip easily matches and/or exceeds the CPU performance of i486SX-based systems from ALR and AST. But the Club system costs one-third to one-half less than the ALR and AST systems.

Other manufacturers have signed up for the AMD chip or for some of the other 386 clone chips that are in the works. Some of these will offer performance boosts and extra features that will leave the i486SX in the dust. The price/performance gap will widen.

The i486SX will have its day, and systems with good price/performance will emerge. But for now, if you feel yourself succumbing to 486SX fever, consider the alternatives before you reach for your wallet.

I’m waiting for Intel to return to technological leadership, with this summer’s expected announcement of the 586 and higher-clock-speed i486 chips—real advances that are worth getting excited about.

—Fred Langa
Editor in Chief
(BIX name “flanga”)
### Consoled Statement of Cash Flow

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash flows from operating activities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Income (loss)</td>
<td>902</td>
<td>676</td>
<td>453</td>
</tr>
<tr>
<td>Operating Activities Adjustments:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation and Amortization</td>
<td>1,456</td>
<td>1,368</td>
<td>1,298</td>
</tr>
<tr>
<td>Changes in assets and liabilities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts Receivable</td>
<td>(359)</td>
<td>264</td>
<td>(462)</td>
</tr>
<tr>
<td>Inventories</td>
<td>265</td>
<td>201</td>
<td>220</td>
</tr>
<tr>
<td>Uncollectible Accounts</td>
<td>(326)</td>
<td>252</td>
<td>(97)</td>
</tr>
<tr>
<td>Other</td>
<td>238</td>
<td>201</td>
<td>220</td>
</tr>
<tr>
<td>Changes in cash and equivalents (in thousands)</td>
<td>3,365</td>
<td>2,364</td>
<td>1,823</td>
</tr>
</tbody>
</table>

#### Quattro Pro 3.0

Quattro Pro is the hottest spreadsheet on the market. Consistently delivering the best power features: Multiple worksheet consolidation, advanced publishing and 1-2-3 compatibility.

Now Quattro Pro 3.0 adds WYSIWYG, plus a theatre full of graphics, publishing and presentation features that will dazzle even the most demanding audience. And, unlike 1-2-3 r3.1, all of Quattro Pro's features, including WYSIWYG, are seamlessly integrated into one set of menus, greatly enhancing ease-of-use. Just another example of how Quattro Pro's advanced technology is built in... not tacked on.

**Quattro Pro 3.0 beats 1-2-3. Again.**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Quattro Pro</th>
<th>1-2-3 r3.1</th>
<th>1-2-3 r2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Live&quot; editable WYSIWYG spreadsheet</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>WYSIWYG page preview</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Banner (sideways-oriented) printing</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Print-To-Fit automatically on a page</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Backsolver technology built-in</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3-D graphs (ribbon, step, bar, area, pie)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Worksheet zoom</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Draw package built-in</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Clip art library</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**1-2-3 Users!**
Upgrade now for only $129.95 Join the more than 3/4 million people who have already switched! And for an additional $49.95, you can get ProView*, the ultimate presentation toolkit.

60-day, money-back guarantee. Order today! See your dealer or CALL NOW 1-800-331-0877

**Borland**
Makers of Paradox, Quattro Pro, ObjectVision, Borland C++, Turbo C++, Turbo Pascal and Sidekick.*

*PRICE INCLUDES 100 additional CD-ROM clip art images, 3D professionally designed chart styles, a full color "how to" presentation guide, additional fonts and sounds, plus $100 worth of 35mm slide service processing from Brilliant Images. Upgrade pricing in U.S. dollars and good in U.S. and Canada only. Dealer prices may vary. Copyright © 1991 Borland. BI 1421A

Circle 49 on Inquiry Card (RESELLERS: 50).
All the monitors you’ll need for

What you see is the remarkable MultiSync® 3D color monitor from NEC. What you don’t see is how this one 14” monitor can accommodate not only the broadest range of current mainstream standards, but also the next standards to become mainstream—8514/A and XGA, with brilliant color resolution of 1024 x 768.

Built around our award-winning multiple frequency technology, this one monitor automatically adjusts to frequencies from CGA all the way up to 8514/A and XGA. Which means even if you haven’t moved up to 8514/A or XGA yet, you have the opportunity to purchase a monitor through foresight, rather than hindsight.

Get a $50 to $200 rebate on a MultiSync color monitor when you buy selected NEC desktop or portable PCs, now through June 30, 1991. For details, call 1-800-NEC-INF1.

MultiSync is a registered trademark of NEC Technologies, Inc.

Computers and Communications

*Other restrictions apply.*
all the resolutions you’ll need.

Especially since the MultiSync 3D also has a microprocessor-based digital control system that provides automatic screen configuration, lets you select the ideal resolution for your software, and even has a memory that recalls your preferred screen settings. And it’s also compatible with the IBM PC/XT/AT, PS/2 and the Macintosh computer systems.

Now, since NEC is ready to accommodate even the newest graphics standards to emerge, maybe the real question is: Are you?

For literature call NEC at 1-800-826-2255. For details, call 1-800-FONE-NEC. And in Canada, call 1-800-268-3997.

NEC
We'll help you keep your business rolling. With our 4 megabyte diskettes and 3M Magnus™ 1.35 data cartridges you have a whole new generation of data storage media for high capacity systems. So, whatever format or capacity your data is stored in, we're ready when you are.

That's why more business protects important information on 3M brand diskettes and data cartridges than any other brand in the world. Call 1-800-888-1889 ext.4 to find out more.

Innovation working for you™

Diskettes and data cartridges require compatible drives. ©3M 1991. Magnus is a trademark of 3M.
The IBM RISC System/
The power you've been seeking

It's a never-ending quest for power seekers. You're always looking for ways to run your favorite applications faster. Well, search no more. The RISC System/6000 family of POWERstations and POWERservers gives you power that soars as high as 23 MFLOPS.

When it comes to porting, your ship has come in. Of course, all the speed in the world wouldn't mean much without the applications you need. So the RISC System/6000 family already has more than 2,500 of the most popular technical and commercial applications up, running and running fast. And if you think you know a good thing when you see it, so do software vendors. That's why you'll also be seeing more and more applications coming on board the RISC System/6000 platform all the time. And if you like to build your own solutions, there's a full arsenal of enablers and relational data bases from leading vendors, as well as CASE tools and a host of popular programming languages.

A smorgasbord of solutions. Applications already announced include the IBM engineering design packages CADAM, CAEDS, CBDS,

MFLOPS are the results of the double-precision, all FORTRAN Linpack test 100x100 array suite. The Dhrystone Version 1.1 test results are used to compute RISC System/6000 Integer MIPS value where 1.757 Dhrystones/second is 1 MIPS (Rev 11/78). SPECmark is a geometric mean of ten benchmark tests. All performance data are based on published benchmark information.

IBM is a registered trademark, and RISC System/6000 and CAEDS are trademarks of International Business Machines Corporation. SPECmark is a trademark of Standard Performance Evaluation Corporation. UNIX is a registered trademark of UNIX System Laboratories, Inc. CADAM is a trademark of CADAM Inc. CATIA is a trademark of Dassault Systems. CBDS is a trademark of Bell Northern Research Corporation. DECstation is a trademark of Digital Equipment Corporation. HADAD THE HORRIBLE Characters © 1990 King Features Syndicate, Inc. © IBM Corp. 1991. All rights reserved.
CATIA™ and AES. Also available are a broad spectrum of solutions from vendors like Valid Logic, MacNeal Schwendler, Swanson Analysis, SAS Institute, SPSS, Wavefront, Alias, Polygon, Cadence, Fluid Dynamics International, Western Atlas, ECL Petro and creare.X. Scientific and technical applications are available in areas like physics, structural analysis, chemistry, securities trading, mathematics, earth resources, operations research, visualization, graphics, technical publishing and more. There's also accounting software like FourGen and support for leading UNIX®-based office automation packages. And there are key industry applications for businesses in medical groups, retail stores, newspapers, pharmacies and many more.

Command enormous processing clout. The RISC System/6000 family is built to boost the performance of the software power seekers use most. It's got the best floating point processor in the business for numerically intensive applications, plus a new superscalar processor and incredible 3D graphics capabilities. To find out more, call your IBM marketing representative or IBM Business Partner. For literature, call 1 800 IBM-6676, ext. 990.

For the Power Seeker.
LETTERS

The Roundtable Continues

When I got my March issue, I turned straight to the new BYTE Roundtable discussion on why software doesn't work. As a programmer by profession, I was very curious to read what you had to say on the subject.

Many in the forum completely missed the boat as to the real reason why software doesn't work. They pointed to tight schedules, poor testing, and a lack of user uproar over bugs. These factors are important, but the real problem is software maintenance. Software maintenance encompasses a lot, including bug fixes, user-requested enhancements, enhancements designed to keep current with the market, and the like.

The degree of maintainability of a software package has a direct bearing on how quickly, and how correctly, a package can be upgraded or debugged and brought to market. If poor programming practices are put in place when the package is first written or if poor maintenance practices are used, an upgrade is bound to have problems.

Here's an example: Almost every major textbook on software maintenance stipulates that the key is to write software in the highest-level language possible. What are most packages written in today? C. My experience has been that debugging and validating chores are orders of magnitude greater than with such languages as Pascal or dBASE. This means that the chance a bug will slip through even rigorous testing is much higher.

In all fairness, the Roundtable participants' points are valid. However, because of its ripple effect on the next update of the product, maintenance cannot be overlooked. And I also believe that the world's fascination with C is a step in the wrong direction toward solving the software crisis.

Bill Jurasz Jr.
Applications Engineer
Texas Instruments
Dallas, TX

As the owner of two AST Premium 386SX/16 boxes, one fitted with a Conner 40-megabyte CP344 drive and the other with a Conner 10-MB CP3104 drive, I've been trying to figure out for over a year how to tell in advance whether software I need has any chance of surviving in this temperamental environment. My shelves are littered with highly rated software products that weren't worth the trouble created by system compatibility quirks.

Every time I have experienced a problem—and I have had a lot of them—it ends up being traced either to the IDE hard disk drive or to incompatibilities with the memory manager I am using (currently, Desqview 386 with QEMM). At this point, I must confess that, having been burned so many times by so-called state-of-the-art software and hardware, I am very reluctant to purchase anything that hasn't been out on the market for at least two years.

Susan A. Henderson
Chicago, IL

Two Views of DR DOS

Our review of DR DOS 5.0 by Lamont Wood ("DR DOS Offers Hope for the RAM-Crammed," December 1990) was at the very least enthusiastic—so much so that I ran right out and bought the product. I felt fairly safe because the article implied that this was a very DOS-compatible product with some nice enhancements.

DR DOS 5.0 has major compatibility problems. I am writing to you because I think you must be more careful with these product reviews. I trusted the information I read in your magazine. For the time being, at least, it's 200 bucks down the drain. No major deficit here; however, the money could have been spent on a product that works.

I hope that your reviews will be more thorough and more accurate in the future. They are a big responsibility.

J. Morton Stong
Potrero, CA

Problems are looked for and reported in reviews. On my system I encountered a problem only with the DR DOS COPY command, as I mentioned in the review. Further use (up to and including the writing of this letter) has revealed no other bugs.

In other correspondence, Mr. Stong has complained of Xerox Ventura Publisher (among other packages) crashing on him. I have used both the GEM and Windows versions of Ventura Publisher under DR DOS for some time now with no hint of difficulty.

Our different experiences just serve to underscore the fact that the PC world is a wilderness of partially compatible hardware and software where tiny things like the setting of an interrupt jumper on an add-in board can play havoc.

What's remarkable is that horror tales like Mr. Stong's are not (as far as I can tell) the norm. But, alas, they certainly happen.—Lamont Wood
All this was generated by Word for Windows.

"Word for Windows sets the standard among Windows word processors...remains the product to beat in the Windows environment."
—InfoWorld, January 7, 1991

"A session with Microsoft Word for Windows can make you rethink the whole category of word processing software."
—PC Magazine, December 11, 1990

"Word for Windows is the leader of the pack."
—InfoWorld, February 4, 1991

"Companies would be wise to choose Word for Windows, which most likely will become the standard for Windows word processing."
—PC Week, December 24, 1990

"Word's collapsible outlining and easy-to-manage formatting via stylesheets should now have been emulated by every other word processor, but nothing else comes close."
—PC Magazine, December 11, 1990

"...it is amazingly easy to learn and use."
—InfoWorld, January 7, 1991

Why not give us a call at (800) 426-9400, and ask for the name of the dealer near you. You'll quickly see why Microsoft® Word for Windows® is the best-selling word processor for the Windows environment. Not to mention the most talked about.

Microsoft®
Making it all make sense.
Compression Compatibility

In "Getting Your Byte's Worth" (November 1990), Steven J. Vaughan-Nichols attempted to cover the important topic of hardware-based data-compression solutions. The article began nicely and was proceeding without flaw, when lo and behold, Vaughan-Nichols penned a whopper. "Advanced Hardware Architectures, InfoChip Systems, and Hewlett-Packard have also thrown their hats into the ring. Unfortunately, their chips are completely incompatible with each other." I have difficulty believing this statement because AHA's and HP's data-compression chip technologies were jointly developed and, in fact, are exactly the same chip. If only the rest of the industry could tout such compatibility. The specially designed chip was based on the "lossless" Data Compression Lempel-Ziv adaptive algorithm, which was pioneered by HP. AHA and HP then customized a version of the DCLZ algorithm, which now offers a better than 2-to-1 average compression ratio and an average compression rate of 2.5 megabytes per second. That makes it the fastest data-compression product on the market today.

John C. Overby
President and CEO
Advanced Hardware Architectures
Moscow, ID

My face is red. My information, gathered in August 1990, was clearly incorrect. My notes indicate that I was told by HP engineers that their chips were purely HP creations. Clearly, I should have checked further. My apologies.—Steven J. Vaughan-Nichols

IDE Reliability

Roger C. Alford's article on Intelligent Drive Electronics disk drives (Under the Hood, "The IDE Hard Disk Drive Interface," March) was very informative but left one key issue unresolved. He states, "IDE drives are low-level-formatted at the factory, and you cannot employ any low-level-format utility to reformat the drive." This apparent fact has caused me to avoid IDE disk drives and recommend against using them.

Alford describes logic internal to the IDE disk drive that should improve reliability. Are there field surveys that can be used to compare the actual rate of replacement of the IDE relative to other types of disk drives? It simply does not make sense to buy a drive when you think there's a fifty-fifty chance of having to replace it within two years.

A final question: Table 3 shows Format Track as an IDE command and says it is not optional. Does this mean that there really are low-level-format capabilities in IDE drives? Are there utilities available for performing a low-level format on IDE drives? If so, it would make a big difference in my attitude toward these drives.

David Dunthorn
Oak Ridge, TN

A number of readers have expressed concern over the inability to perform low-level formats on IDE drives. Many users have encountered the infamous Sector Not Found error message and have taken the reformatting approach to solving the problem. Several available hard disk utilities also encourage periodic low-level formatting to "refresh" the magnetic sector ID information on the drive platters to avoid such errors.

Contrary to common belief, the primary cause of unreliable sector reads (often manifested through the Sector Not Found error message) is not the weakening of the magnetic sector ID information, but rather the misalignment of the drive read/write heads to the sector data. That is, the heads move slightly off the dead center of the track. This can happen because of thermal expansion or contraction of the drive platters or from mechanical changes that may occur as a drive ages.

Since the only functional purpose for a low-level format is to establish the sector interleave (which is always 1-1 for IDE drives) and to map out bad sectors, vendors perform this operation at the factory, and it should never need to be done again. As I mentioned in the article, most IDE drives include bad-sector remapping, so that if additional sectors are determined to be defective during the life of the drive, the sector data is recovered using the drive's error-correction algorithm, and the sector is logically remapped to another spare sector on the drive, disabling the defective sector.

IDE drives use the latest technology to achieve the greatest possible reliability. They have been around long enough that a substantial amount of reliability data is now available, and many drive manufacturers will provide reliability summaries of their products on request. The IDE manufacturers insist that the reliability of their drives is now proven and that low-level formatting of the drives by the customer is no longer necessary; no degradation in the long-term reliability will result from the inability to perform a low-level format.

One of the mandatory IDE commands I listed in the article is the Format Track command. This command is mandatory because it is used by standard ST506 drive subsystems, so the IDE drive must implement the command. Essentially, this means the drive must respond to the command operation is complete. Originally, most IDE drives simply ignored the Format Track command and responded immediately with a command-complete indication. Some drives, such as those from Quantum, now zero out the data fields of the affected sectors (the sectors on the logical track being formatted), since some systems use the low-level format operation to remove drive partitioning information. The sector ID fields, however, are not touched when the sectors are zeroed.—Roger C. Alford

A Matter of Inches

My company manufactures geographic and geodetic products, including some software. Our work makes it necessary to calculate the lengths of various arcs of the earth's surface.

In "More Mathematical People" (March), Hugh Kenner made the statement, "If we're calculating the circumference of the earth, the difference between a 5-place pi and a 6-place is about half an inch."...
Now, if you want to develop applications for Windows 3.0, there's a fast and easier way to do it with the premiere object-oriented programming language, Smalltalk/V.

With Smalltalk/V Windows, you can explore, prototype, build finished applications and ship them runtime free. You can tap into applications using DDE so effortlessly you don't have to be a Windows expert to do it.

And with one of the world's most comprehensive class libraries, you can choose our objects or easily build your own. But whatever you develop, it will be portable between the Windows, OS/2 and Mac versions of Smalltalk/V.

With so much at their fingertips, more people are solving more problems with Smalltalk/V than any other object-oriented programming system.

At only $499.95 and no runtime charges, you can solve them, too. Just call us at (800) 922-8255.

And see why programming Windows has never been easier.
Everyone wants more productivity out of their computers. But not everybody is willing to spend a fortune to get it. That's why Quarterdeck productivity software is outselling everyone else—including Microsoft's.

**DESQview Multitasks and Windows on Your PC**

As early as 1982, computer enthusiasts found our products helped them set up their ideal working environment. Since then, step-by-step, we've improved DESQview into what some very knowledgeable people call "the best alternative to OS/2".

Today's DESQview allows you to multitask multiple programs in windows side by side—text programs; graphic programs. But best of all, you don't have to buy a lot of new hardware and software to use it. DESQview works with the PC and the programs you own.

**QEMM Breaks the 640K Barrier**

Break the 640K barrier in DOS—or in Windows 3.0—and give your DOS programs up to 130K more room within the first megabyte of memory, plus another 96K of video memory, in some instances.

QEMM takes buffers, network drivers, TSRs and other memory-using utilities and moves them into idle areas between 640K and one megabyte.

It's not complicated. It's easy. You can just type `Optimize` and QEMM will do the rest.

QEMM 386 is incorporated into DESQview 386 to provide the optimum operating environment for productivity-oriented users of 386, 386SX and i486 PCs.

QEMM 50/60 is designed to work in IBM® PS/2™ Model 50 and 60 PCs with specific IBM adapter boards. QEMM is the #1 selling utility according to distribution sources. In fact, it was the number one selling software package in the PC industry in April, May and June 1990.

Over 1,000,000 users multitask their programs with DESQview.

Microsoft is a trademark of Microsoft Corporation. IBM and PS/2 are trademarks of IBM Corporation. PC Tools Deluxe is a trademark of Central Point Software. 80286, 386, 386SX and i486 are trademarks of Intel Corporation. ©1991 Quarterdeck Office Systems.
Manifest does for memory what PC Tools Deluxe does for disks. And it's easier to use. Manifest has been quick to win recognition.

QRAM Optimizes the Memory of 8088 and 80286 PCs

Once you know where you can move those memory-hogging utilities, QRAM lets you do it. It even works on 8088, 8086 and 80286 PCs with EMS 4.0 or EEMS memory boards.

QRAM and Manifest help you get every last 'K' out of the hardware you own.

In fact, all our products are designed to give you more productivity out of the system you already have, whether it's an 8088, 8086, 286, 386SX, 386, or i486.

Quarterdeck.
Products for Everyday Heroes

Our mission is to protect your investment. Whether your PC is 8 years old or fresh out of the box, our products make it more versatile, more flexible; and help deliver performance dividends from your computer investment. Our products help fine-tune your PC which helps you do your work better, which makes you look good.

A Glimpse of the Future: DESQview/X

We're also looking ahead to the next wave of computer development: enterprise computing. Our new DESQview/X allows different computers with different operating systems to work together. Using the advanced X-windows environment, it lets users run programs on remote computers and watch them run in their PC's windows. DESQview/X will be available later this year.

Quarterdeck products. The best way to get the most out of your PC today. And tomorrow.
LETTERS

This appeared suspect to me, as our calculations for arc lengths, using Taylor-series approximations of elliptic integrals, require at least 10 significant digits to achieve National Geodetic Survey standards of accuracy of 1 millimeter. I typically program using the IEEE 80-bit floating-point format of Turbo Pascal (19 significant digits).

When I calculate pi to 5 decimal places, the circumference is $1,577,755,230$ inches; calculated to 6 decimal places, the circumference is $1,577,756,736$ inches. The difference is $1506$ inches, or about 125 feet. While in relative terms this is a small error (about 1 second of longitude), in our field it would be disastrously large.

I enjoyed Kenner's article nonetheless. Doubtless he could find numerous deficiencies in the sentence structure of this letter! I just could not resist pointing out his mistake, remembering all the Cs I received in English.

Brad Neff, President
Neff Scientific
Lebanon, TN

You are quite right. So was my calculation. Two days later, though, I somehow misread my notes.

—Hugh Kenner

LANtastic Tale

Jerry Pournelle likes LANtastic, and so do I. We use the network mainly for printer sharing and file transfer, and it had not given us any trouble in the two years it's been running, until last week. We installed a Tecmar QT60e tape streamer for backup. With a QMS JetScript driver using Interrupt Request 7 addressed as LPT2, printers on LPT1 and LPT3, LANtastic using IRQ5, and DOS-reserved interrupts, I expected problems using the Tecmar default interrupt IRQ3. But everything worked fine.

Trouble came later that day. I had to install the LANtastic server on the local machines so the Tecmar station could see their hard disk drives. Suddenly, my local machine could log onto the server and read the server's hard disks but couldn't find any of the attached printers. Other local machines were OK. I didn't solve the problem that night, and when I came in the next morning, nothing was wrong. Temporary amnesia, silicon variety.

Then a day or so later someone else reported problems. He could log onto the server, write to the server's disks, and print on the shared printers, but not read from the server's hard disk. I removed the Tecmar card from the server, but the problem didn't go away. I moved the local machine physically, and the problem moved with it—the cabling wasn't at fault. I tried setting up another machine as server and logging onto that—exactly the same problem. I switched LANtastic cards, and the problem didn't move with the card.

Finally, I noticed by chance that the problem machine was running an earlier version (1.91) of LANbios than another machine known to work (1.95). I installed a homogeneous LANbios version throughout the network, and the problem hasn't been seen since. The Tecmar station still works perfectly, too.

I phoned the Swedish LANtastic supplier, who hadn't heard that problem variant before but warned me that there are at least two LANbios versions available later than 1.95 which are not compatible either with earlier versions or with each other. In all your justified praise of an excellent LAN, you might find room to warn those who expand their LANtastic network and find themselves with a mixed bag of LANbios versions.

Francis Markey
Uppsala, Sweden

Thank you for the story. As I've noted before, LANtastic does have problems dealing with some devices, including my WORM drive. I have never had real problems with it. Artisoft recently got a lot of new capital and is putting new people on the job, and I suspect you'll soon see some big improvements in what has always been a very good product.—Jerry Pournelle

Stimulating C

For years, I've liked Jerry Pournelle's columns in BYTE because of their lively, thought-stimulating style. But I disagree with some of his remarks about C.

In "The BYTE Summit" (September 1990) he says that C is one of the biggest obstacles to the future of programming as it is "the last attempt of the high priesthood to control the computing business." I know many people who after years of using other languages have started programming in C, while I have not yet met a single person who was a good C programmer and then stopped using it. What sinister plot in a free society could possibly brainwash so many intelligent people into switching to a new programming language devoid of any redeeming features?

C is not a perfect language, and maybe much better ones will be coming. But I believe that one of the biggest obstacles to the future of programming could be a frame of mind that looks at the language instead of the ideas expressed in it, and a priori considers as unreadable any listing printed in an unfamiliar language, instead of feeling the desire to learn enough to understand it.

Dr. Gerd Blaesser
Ispra (Varese), Italy

You may be right, of course. Once again I can only go by experience. At the annual Hackers conference, I can get a good fight going by discussing C, which is interesting given that I get about as much support as opposition, and this among some of the best programmers in the world.

—Jerry Pournelle

FIX

In the article "Oberon" (March), the word CASE was inadvertently expanded to the acronym "computer-aided software engineering." on page 138. The correct sentence should read "a failing guard is fatal, like an array-bound violation or a failing CASE selector."
The Hottest Value
In The Industry
Just Got Even Hotter!
NEW MINI DESKTOP 286 AND 386SX MODELS ARE BIG ON PERFORMANCE!

Sometimes the best things come in small packages. This saying definitely applies to Gateway 2000’s spunky little 286 and 386SX computers. These systems now come in a space-saving mini desktop model that’s sizzling with powerful new features.

The motherboard in the 286 and 386SX systems was custom-designed and manufactured for Gateway 2000 using ASICs (Application Specific Integrated Circuits) to create a cleaner, more reliable board. We integrated the floppy drive controller, the video chip set and the I/O card on the motherboard, to leave five 16-bit slots open in the standard configuration.

The Gateway 2000 286 system operates at 16 MHz, rather than 12 MHz, for better performance. Our 386SX is available as a 16 MHz or a 20 MHz system. The 386SX-20 includes a 32K cache, which makes this system another truly outstanding Gateway price/performer.

HOT-PERFORMANCE 386 AND 486 SYSTEMS ARE IN ICY GRAY, CURVILINEAR MODELS

Although Gateway’s 386 and 486 systems look entirely new, we limited changes on the inside to fine-tuning performance and reliability. In the Midwest, we firmly believe in the adage, “If it ain’t broke, don’t fix it.” And these award-winning, price/performance systems did not need fixing.

All 386 and 486 systems include a fast and reliable IDE (Integrated Drive Electronics) hard drive with built-in cache. For added reliability and lower RF emissions, we’ve incorporated ASICs in the design of our motherboards whenever the change improved cost/performance. Because our 386 and 486 computers already include the fastest, most reliable video card on the market, the only way we could improve video performance was to increase the size of video RAM. So we did. All Gateway 2000 386 and 486 systems come standard with 1 MB video RAM. We also made our new Crystal Scan 1024NI color monitor standard with these systems. The 1024NI is non-interlaced, giving you a flicker-free video display with up to 1024 x 768 resolution.

INTRODUCING THE AWESOME ANYKEY™

We call our new 124-key programmable keyboard the AnyKey because any key can be programmed to perform any function – anything you can imagine, quickly and easily. Or you can remap the keys to create your own keyboard layout. It’s a revolutionary new concept designed to let you talk to your personal computer in a very personal way.
The AnyKey includes a numeric pad and a separate, full-function cursor pad with diagonal keys, plus two sets of function keys located along the top and left side.

The AnyKey's versatility is rivaled only by its simplicity. You can learn to program it in just a few minutes. If you goof, you can easily reset the keyboard to a normal configuration. And if you hate the idea of programming anything, you'll still love the feel and extra keys on the AnyKey. The AnyKey keyboard is an option with all Gateway 2000 computer systems.

EXPANDED SERVICE HOURS

We've also expanded our telephone technical support hours to provide you with even more flexibility and better service. We're here to help you from 6 a.m. to midnight weekdays and 9 a.m. to 2 p.m. Saturdays.

BETTER-THAN-EVER VALUE

Possibly the most dramatic news about our new product line is price. When a manufacturer introduces a new product line, you expect to see an eruption of price hikes. But then you've come to know Gateway is not like most manufacturers. Prices on systems in our new line are better than ever. And that goes for quality and service too, making the hottest value in the industry even hotter.

LOOKING AHEAD

The introduction of our new product line represents almost a year of design and engineering. But it's just one phase in a process of continuous improvement that we employ at Gateway. Each day, Gateway 2000 employees come to work with one primary goal in mind: to provide you with better prices, performance, quality and service. We're committed to making Gateway 2000 the only logical choice in microcomputers.
GATEWAY 2000 SYSTEMS

16MHZ 286 VGA
- Intel® 80286 Processor
- 2 MB RAM
- 1.2 MB 5.25" Drive
- 1.44 MB 3.5" Drive
- 40 MB 17ms IDE Drive with 32K Cache
- 16-Bit VGA with 512K
- 14" Crystal Scan 1024
- Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 1 PS/2 Mouse Port
- 101 Key Keyboard
- MS DOS™ 3.3 or 4.01

$1395

16MHZ 386SX VGA
- Intel 80386SX Processor
- 2 MB RAM
- 1.2 MB 5.25" Drive
- 1.44 MB 3.5" Drive
- 40 MB 17ms IDE Drive with 32K Cache
- 16-Bit VGA with 512K
- 14" Crystal Scan 1024
- Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 1 PS/2 Mouse Port
- 101 Key Keyboard
- Microsoft™ Mouse
- MS DOS 3.3 or 4.01
- MS Windows™ 3.0

$1595

20MHZ 386SX CACHE
- Intel 80386SX Processor
- 32K Cache RAM
- 4 MB RAM
- 1.2 MB 5.25" Drive
- 1.44 MB 3.5" Drive
- 80 MB 17ms IDE Drive with 32K Cache
- 16-Bit VGA with 512K
- 14" Crystal Scan 1024
- Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 1 PS/2 Mouse Port
- 101 Key Keyboard
- Microsoft Mouse
- MS DOS 3.3 or 4.01
- MS Windows 3.0

$1995

25MHZ 386 VGA
- Intel 80386 Processor
- 4 MB RAM
- 1.2 MB 5.25" Drive
- 1.44 MB 3.5" Drive
- 80 MB 17ms IDE Drive with 32K Cache
- 16-Bit VGA with 1 MB
- 14" Crystal Scan 1024/NI
- Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 101 Key Keyboard
- Microsoft Mouse
- MS DOS 3.3 or 4.01
- MS Windows 3.0

$2295

25MHZ 386 CACHE
- Intel 80386 Processor
- 64K Cache RAM
- 4 MB RAM
- 1.2 MB 5.25" Drive
- 1.44 MB 3.5" Drive
- 80 MB 17ms IDE Drive with 32K Cache
- 16-Bit VGA with 1 MB
- 14" Crystal Scan 1024/NI
- Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 101 Key Keyboard
- Microsoft Mouse
- MS DOS 3.3 or 4.01
- MS Windows 3.0

$2595

33MHZ 386 CACHE
- Intel 80386 Processor
- 64K Cache RAM
- 4 MB RAM
- 1.2 MB 5.25" Drive
- 1.44 MB 3.5" Drive
- 200 MB 15ms IDE Drive with 64K Multi-Segmented Cache
- 16-Bit VGA with 1 MB
- 14" Crystal Scan 1024/NI
- Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 101 Key Keyboard
- Microsoft Mouse
- MS DOS 3.3 or 4.01
- MS Windows 3.0

$2995

25MHZ 486 CACHE
- Intel 80486 Processor with Co-Pro and 8K Internal Cache
- 64K Cache RAM
- 8 MB RAM, Expands to 64 MB
- 1.2 MB 5.25" Drive
- 1.44 MB 3.5" Drive
- 200 MB 15ms IDE Drive with 64K Multi-Segmented Cache
- 16-Bit VGA with 1 MB
- 14" Crystal Scan 1024/NI
- Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 101 Key Keyboard
- Microsoft Mouse
- MS DOS 3.3 or 4.01
- MS Windows 3.0

$3495

33MHZ 486 CACHE
- Intel 80486 Processor with Co-Pro and 8K Internal Cache
- 64K Cache RAM
- 8 MB RAM, Expands to 64 MB
- 1.2 MB 5.25" Drive
- 1.44 MB 3.5" Drive
- 200 MB 15ms IDE Drive with 64K Multi-Segmented Cache
- 16-Bit VGA with 1 MB
- 14" Crystal Scan 1024/NI
- Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 101 Key Keyboard
- Microsoft Mouse
- MS DOS 3.3 or 4.01
- MS Windows 3.0

$3995

STANDARD SERVICES
- 30-day money-back guarantee
- One-year warranty on parts and labor
- Toll-free technical support for the life of the machine

Due to the volatility of the DRAM market, all prices are subject to change. Prices do not include shipping.

Sales hours: 7am-10pm Weekdays, 9am-4pm Saturdays (CST)
Extended Service hours: 6am-Midnight Weekdays, 9am-2pm Saturdays (CST)
Will ACE Become King of the Workstations?

A group of 21 major computer and software companies—led by Compaq, Microsoft, Mips Computer Systems, DEC, and The Santa Cruz Operation—has publicly revealed its intention to develop a set of specifications meant to define an "advanced computing environment" for the 1990s and beyond. Despite the big names, it's too early to determine what ACE will really mean to computer users and buyers. The group is still working on its technical specifications, and resultant products are 12 to 18 months away. Besides the headlining quintet, the other ACE members are Acer, Control Data, Kobuta, NEC, NKK, Olivetti, Prime, Pyramid, Siemens Nixdorf Informationssystemes, Silicon Graphics, Sony, Sumitomo, Tandem, Wang, and Zenith Data Systems.

The ACE group proposes that computer systems be based on the Intel 386/i486 architecture and the upcoming Mips R4000 64-bit RISC CPU. ACE machines will run either OS/2 3.0 (the "New Technology" version being developed by Microsoft) or SCO Unix (with the Open Desktop interface). So far, the group has divulged only two relevant technical developments: a definition of a standard implementation for the Mips RISC CPU, which will be used by Compaq and others in new uniprocessing and multiprocessing systems (no sooner than 1992), and the first announced port of OS/2 to a non-Intel platform.

The ACE group has released few details about its Advanced RISC Computing specification, the part of ACE that defines binary compatibility for Mips machines. And none of the companies has said what kinds of capabilities or features might be typical of ACE machines—not even what size and shape they might take; nor have they ventured even approximate pricing.

The only major detail revealed was, however, of huge importance, especially in political terms: ACE will specify that compliant systems use a "little-endian" byte order, which is the one Intel chips use. Microsoft chairman Bill Gates said that adhering to the same byte order would simplify the interchange of data between Intel- and Mips-based machines and would make it easier to port applications from one machine to another.

Only DEC currently uses Mips chips in their little-endian mode; all the other Mips users use big-endian byte ordering, which means that their systems will not comply with ACE. This, plus some Mips customers' desire to support Unix System V release 4 rather than SCO Unix, has already resulted in the emergence of a dissenting faction within ACE. This "Apache Group," which includes seven ACE members, has something going for it: On the same day as the ACE announcement, Unix Systems Laboratory (USL) revealed its effort to standardize Mips-based systems operating under SVR4.

Systems companies, including DEC, Silicon Graphics, NEC, Prime, and Tandem, have used Mips processors (R2000 and R3000) in incompatible designs. The different Mips-based systems lack a standard-applications binary interface, which would let software run unmodified across them. ACE and USL (like 88open and SPARC International) are both now proposing to supply the means by bringing "shrink-wrapped" compatibility to RISC workstations. The ACE environment would do that job for Mips chips.

Here's one angle of the ACE plan that holds the greatest promise for users and developers alike. Since OS/2 3.0 and SCO Unix will run on both the Intel and Mips chips, the ACE group says that it will be easier to construct mixed networks of DOS, Windows, OS/2, and Unix machines than by using competing choices. Software developers (and end users) will gain the benefits of binary compatibility across multiple implementations of the Mips processor within a
Intel Cuts Cost, Capabilities of i486; Will Offer Companion Math Chip

After a year of rumor and speculation, not to mention the arrival of a real alternative to the profitable 386, Intel last month announced its cut-down version of the i486 processor. Like the 386SX, it is a less powerful version of its parent, but this time the drop in power comes from leaving off the math coprocessor rather than from reducing the bus width. (Despite the SX notation, the i486SX is a full 32-bit chip.)

Besides not having a math coprocessor, the i486SX differs from the i486 in one way: It’s slower. The chip is available only at 20 MHz (the i486 comes in 20-, 25-, and 33-MHz speeds, with 50 MHz in the wings). Significantly, the i486SX retains the 8K-byte on-chip cache of the i486; as a result, it should offer respectable integer performance.

The i486SX retains other features of the i486, including the 32-bit burst-mode bus and the full 32-bit integer core. Intel claims that the new chip can achieve 16.5 MIPS, compared with 11.4 MIPS for the 386 at 33 MHz and 20 MIPS for the i486 at 25 MHz. The i486SX costs about the same as the chip it’s most comparable to in real-life system performance: the 33-MHz 386. In 1000-unit quantities for OEMs, the i486SX costs $258, compared to $214 for the 33-MHz 386 and $671 for the 25-MHz i486.

The i486SX will be available in much less expensive plastic quad flat-pack packaging (as is AMD’s 386) rather than the more traditional ceramic pin-grid array, Intel says. This should result in an even lower cost once it is in full production. Like Intel’s other chips, the i486SX is implemented in 1-micron CMOS, but faster versions could appear when Intel gets its 0.8-micron facility on-line.

For those users who want the floating-point functions, Intel has plans to offer a companion math coprocessor, the 487SX. Having a separate coprocessor would normally slow down operation, but Intel says that it gets around that because the 487SX is really a full-blown i486SX, with all processing capabilities built into one chip. The coprocessor will take over for the main processor, thereby avoiding the bottleneck of CPU talking to FPU.

Intel officials say they expect manufacturers to build two sockets on their i486SX-based motherboards; one for the CPU and one for the FPU. The 487SX will not be offered to OEMs; it will be sold only to end users, who are expected to plug the chip into that second socket. They will have to really want those math capabilities, because the chip’s suggested retail price is $799. As some observers point out, if you think you’ll need the math, buy a regular i486.

Intel says that for the 1992 time frame it plans other products that could plug into the second socket and upgrade the i486SX functionality in other ways. Company officials refused to speculate on the sorts of things they might come up with to fit in this spare slot, but it’s not too hard to imagine an intelligent secondary cache and controller that could pop in there.

—Owen Linderholm

Andy Reinhardt

The DOS Protected Mode Interface Committee has started shipping DPMI 1.0, an expanded version of the interface specification for protected-mode DOS applications. DPMI defines a standard interface that lets protected-mode DOS applications multitask on Intel-based PCs. DPMI-compliant operating environments include Microsoft Windows 3.0, Desqview, OS/2, Unisys CTOS, Merge, VP/ix on Unix 386, and Ergo DOS. The DPMI Committee—Borland, Ergo Computing, IBM, IGC, Intel, Lotus Computing, Lotus Development, Microsoft, Phar Lap, Phoenix Technologies, Quarterdeck Office Systems, and Rational Systems—said that it has added enhanced memory management support to version 1.0 to take advantage of the paging and protection features of the Intel 386/i486.

Apple Computer has again lowered the U.S. prices of certain Macintosh models—as much as 31 percent on some. The high-end Mac IIcx shed $1800 on a model with an 80-MB hard disk drive; it now costs $8069. A similarly equipped IIci fell $700 to $6669. And an SE/30 with a similar drive dropped by $1700 to $3869. Such cuts usually signify new systems coming soon. Apple’s next big launch is likely to be its 68040-based Macs.

NCR, one of the developers of the SCSI connection, is now offering an assortment of SCSI-based disk-array products that should help boost the acceptance of Redundant Array of Inexpensive Drives. Two of the products are controller chips that, with NCR’s SCSI chip set, will let system designers implement SCSI RAID disk arrays. The third is a RAID controller board for OEMs that attaches to a SCSI port and provides transparent control of a disk array using RAID 3, RAID 5, or RAID 1 (conventional mirroring). A disk array uses small, inexpensive drives and distributes data among them.
Presenting Hollywood. It's where your idea can become a star.

Some presentation packages don't take your ideas very far. And even if they do, chances are pretty good it won't be exactly where you want to go.

**PRESENTATIONS MADE SIMPLE.**

But now there's Hollywood. A whole different kind of presentation tool that makes it easy for anybody to create complete presentations with real star quality. The steps are quick, simple—even fun. First, Hollywood has an integrated outliner to help you organize your thoughts. Next, you select a look from a variety of exciting templates designed by professional graphic artists. Then Hollywood gives you an overview feature and lets you view and edit your entire presentation as a whole, not just page by page, so even sweeping changes aren't a big deal. And finally, you can produce your award-winning output in any combination of slides, overheads or hard copy. Or for some real show biz, present it in a lively screen-show format.

Hollywood runs in the Windows™ 3.0 environment and gives you a supporting cast of fully scalable fonts, dynamic special effects, a comprehensive spellchecker and more. And because it's compatible with most popular graphics and spreadsheet software, importing and changing data is easy, too.

**FREE DEMO**
For your Hollywood diskette, call: 1800 IBM-7899

Take the first step. Try Hollywood and give your ideas the big break they deserve.

Circle 144 on Inquiry Card.
String of 486SX Systems Begins

Is the i486SX this year's sliced bread? Or is it more a marketing move by Intel, hoping to generate a mass delusion that the 386 is deader than Intel wishes it were?

The truth, near as it can be approximated, will lie in the computers based on the i486SX. Several companies have announced systems based on the new chip, several told BYTE that they plan to do so in the next few months, and others said that they'll make their decisions based on chip availability and user interest. Officials at those companies said that they like the new Intel chip because its low price lets them build low-cost systems that have the i486 tag.

Besides the Advanced Logic Research and AST Research machines that are covered in this month's First Impressions, early 486SX systems will come from IBM, Everex, and Acer. Sources close to Everex said that the company was readying two new 486SX machines:

![Image of Acer's new AcerPower 486SX](image)

Acer's new AcerPower 486SX is one of the first systems to use Intel's new chip.

one in the Step line and one in the Tempo line. The Step model would be designed for upgrading to a full i486 or adding a 487SX, sources said. Prices weren't settled at press time, but one source said that the machines would sell for about the same as a 33-MHz 386 PC. This was the price point mentioned most often by companies that said they're working on 486SX systems.

Acer introduced its AcerPower 486SX the day after Intel announced the chip. The desktop system comes with Microsoft Windows, 2 MB of RAM, a VGA chip set on the motherboard, and the usual assortment of interfaces. There are two coprocessor sockets: one for Intel's new 487SX and one for Weitek's WTL-4167. Prices start at $2745.

IBM has already started selling its 486SX-based PS/2 Model 90s. The systems are a good bit more expensive than the other 486SX machines announced so far, but IBM says that they're about 25 percent less expensive than the company's 486-based counterparts. The 486SX Model 90s start at $8345.

Twinhead has "some sample systems using the i486SX" and plans to introduce a machine later this year, a product marketing manager said. The company planned to show a desktop system at Spring Comdex. A color laptop is slated for Fall Comdex, he said. Northgate is currently running the new chip in test systems. "We'll certainly offer it as part of our line," said company president Art Lazere. CompuAdd has a product under development but is waiting "to see if the customer demand is there," a spokesperson said.

Expect new arrivals from Dell (which staged a "technology demonstration" of a 486SX system the day after the chip's debut), Compaq, NEC, Texas Instruments, and Toshiba, with other makers following the pack.

As preliminary BYTE Lab tests indicate, in most ordinary operations, users will not be able to tell if their PC's engine is a 40-MHz Am386 or a 20-MHz Intel i486SX. But some vendors say the i486SX lets them design systems that can be easily upgraded to an i486. These systems will show whether the i486SX is a price/performance leader or just a numbers game with a little SX appeal added.

—D. Barker

JVC and C-Cube Show Video Decompressor that Goes Beyond MPEG

JVC and C-Cube have demonstrated what could be the first Moving Pictures Experts Group video decoder/processor chip. MPEG is an emerging technique and proposed ISO standard for compressing motion video at rates of up to 50 to 1. The prototype processor can decompress full-motion digital video in real time, said Mauro Bonomi, C-Cube's manager of product marketing. C-Cube

It's the information system you can wear. Designed by PC innovator Lee "Osborne" Felsenstein, Red is an assemblage of small components that make up a mobile information system. The $2500 package consists of a slim CD-ROM/CD audio drive; a proprietary 16-bit computer; a Smart Card drive; a pressure-sensitive mouse-like device; and Reflection Technology's Private Eye, a tiny screen that attaches to headgear and hangs a few inches in front of the eye, creating the illusion of a high-resolution computer screen floating in front of you. The idea is to provide an image that you can look back and forth at while concentrating on something else. For example, a mechanic might have a page from a repair manual on the screen while working on an engine. The repair manual would be stored on CD-ROM. Red will run for about 3 hours on its rechargeable nickel-cadmium batteries, Felsenstein said. Red is being sold by Reddy Information Systems.

Slowly but surely, the CD ROM industry continues to grow. According to the research group Infotech, the installed base of CD-ROM drives grew to 1.25 million in 1990 and 2250 titles (up from 1500 in 1989). Industry sales more than doubled, reaching more than $1.5 billion in 1990, according to Infotech.

Based on a survey taken at the recent Federal Office Systems Expo, Datapro Research estimates that CD-ROM use in government installations will take a giant leap in the next year. Only 26 percent of those polled said they now use CD-ROM products, but 82 percent said they plan to use them in the coming year.
If you want the ultimate VGA graphics standard, and you've resigned yourself to paying a premium of hundreds of dollars to get it, you'll find our newest monitor pleasant viewing indeed.

The PanaSync C1381 gives you a sharp 1024 x 768 pixels, with 0.28 dot pitch. And virtually infinite color resolution. It's compatible with the most popular VGA boards, as well as analog RGB, MCGA, SuperVGA, and — of course — 8514/A standards.*

It's comfortable in virtually any IBM-compatible or Mac II environment.**

And it's a masterpiece of ergonomics. With front-mounted controls, tilt/swivel stand, plus a non-glare tinted black-matrix screen.

All this at a suggested retail price comparable to many of the ordinary VGA monitors on the market right now. For more information, simply call toll-free 1-800-742-8086.

* VG, MCGA and 8514/A are trademarks of International Business Machines Corp.
** IBM XT, AT and PS/2 are registered trademarks of International Business Machines Corp. Macintosh is a registered trademark of Apple Computer Inc. An optional cable is required for Macintosh.

Circle 230 on Inquiry Card.
demonstrated the technology at the recent Microsoft Multimedia and CD-ROM conference.

The chip is not a compression device. It is strictly for decompressing and playing back video that has been generated and compressed by other means. Compression will be handled primarily by the content provider; for example, the company that wants to squeeze moving pictures onto a CD-ROM will have to have the compression, or encoding, equipment. Users will need only the decoding device.

The C-Cube/JVC decoder will also implement the JVC Extended algorithm, which does MPEG one better with a transfer rate, after decompression, of 4 to 6 Mbps. MPEG's specified data rate is 1.2 Mbps. JVC Extended can handle four times the number of pixels specified by MPEG, Bonomi said. MPEG "is good for windowed broadcast-quality video" but is not fast enough for full-screen, broadcast-quality video, said Richard Young, JVC director of marketing. JVC says that its approach speeds up transfer of digital video to the point where it's fast enough and sharp enough to look like broadcast-quality images.

JVC and C-Cube are working together on the decoder chip. They've essentially added JVC Extended mode to the MPEG chip that C-Cube has been working on. The demonstration at the Multimedia and CD-ROM Conference was just that: a demonstration; the chip won't be a product until late this year, C-Cube officials said. Most observers at the conference said that they thought C-Cube was prematurely making an MPEG-related announcement, since the specifications are not finished yet. "Being early to market always involves some risk," Bonomi said.

While the demonstration of the MPEG circuitry was impressive, C-Cube's delivery dates, like the images in the decompressed video clip, are known to move. The company has delayed its Joint Photographic Experts Group compression chip several times.

Sony and Philips are working on an MPEG decoder, and according to rumors in Silicon Valley, Apple is working on its own technology for compressing images.

Client/Server Architecture Seen as Not Catching On

Why isn't client/server architecture being more readily accepted?" When product managers raise that kind of question—as an Oracle product manager did at the recent DB/Expo conference—there must indeed be a problem. Of some 1700 people at one Expo conference session, only about 100 said they had implemented a successful client/server database application.

Despite a steady release of new client/server products, industry consultants interviewed at the Expo were downbeat about the future of the architecture. According to consultant Jeff Tash, "The tools are not there. The experience is not there." Structured Query Language standards are still an issue. The architecture requires that the buyer deal with multiple vendors for a single application. And then there are the problems with LANs. "Client/server computing is just dressed-up LAN, and people don't have enough LAN experience," said consultant Shaku Atre.

Presentations at DB/Expo by Oracle and Microsoft featured corporate testimonial for client/server solutions. This indicated that real, live companies are really using real, live client/server applications. But not everyone is sold. When asked for his view on client/server architecture, database expert and consultant Richard Finkelstein said, "I'm not sure I'm ready to recommend it to clients."

—D. Barker

Quantum's Write Caching Offers Speed, but Is It Risky?

Quantum is incorporating write-caching technology in its new line of 3½-inch hard disk drives. Used in high-capacity drives for minicomputer and mainframe systems, write caching speeds up performance and frees the CPU to do other things. Critics, however, say that it entails certain dangers.

Write caching is similar to read caching in that data recently read from the

NEWS

MICROBYTES

Just as the chrome bulldog guarantees it's a Mack truck, this new logo will certify it's a Multimedia PC. A system that meets the MPC standard (prime movers: Microsoft and Tandy) of at least a 286 processor, 2 MB of RAM, a 30-MB hard disk drive, a CD-ROM player with audio capability, and a VGA card and monitor, will qualify to wear the MPC brand.

With so many 386s and 486s out there, how can a company distinguish its PCs? Amkly Systems, headed by AST Research co-founder Albert Wong, is trying to sell serviceability. Amkly's new 386s and 486s are based on a modular architecture that features a removable CPU complex with on-card single in-line memory modules, an EISA bus backplane, and a "peripheral platform," or removable mass-storage cage.

The design simplifies making upgrades, from the quick-release thumbscrews that secure the cover, to the snap-in disk drive cage, to the programmable system ROM.

Five vendors are forming a cooperative agreement to develop compatible applications based on Sun's Network File System protocols for letting different types of computers read each other's data. These applications will address areas not covered by existing protocols and applications. The vendors are Beame & Whiteside, for DOS; FTP Software, for OS/2; InterCon, for the Mac; Interlink, for IBM mainframes; and TGV, for DEC VAX minicomputers running VMS. The companies said that they will release specifications for the protocols to other vendors and develop "reference implementations" in Unix that others could use to develop similar applications for their systems. The new applications could provide functions such as letting a remote user retrieve E-mail, said David Kashlan, president of TGV.

NANOBYTES
We slash interface development time.
(and we can prove it!)

C-PROGRAMMERS: See for yourself how Vermont Views™ can help you create user interfaces the easy way.

If you want to start saving a tremendous amount of time and effort, call for your free Vermont Views demo kit and put us to the test. Vermont Views is a powerful, menu-driven screen designer that comes with a C library of over 550 functions. Which means you can create user interfaces in just a fraction of the time it takes to write the code yourself!

Why try to reinvent the wheel when Vermont Views lets you interactively create pull-down menus, window-based data-entry forms (with tickertape and memo fields), scrollable form regions, choice lists, context sensitive help, and a host of other interface objects.

Vermont Views combines the convenience of a fourth generation language with the power, flexibility, and blinding execution speed of native C code.

Turn your prototype into the application.

Let’s face it. With most systems, you have to throw away your prototype when coding begins. Which means you waste precious time and effort. With Vermont Views, things are a lot different. In fact, the prototype actually becomes the application. So menus and data-entry forms are usable in the final application without change. Names of functions for retrieving, processing, and storing data can all be specified as the prototype is created. And that’s just for starters.

Here’s a truly universal solution. When you create an interface with Vermont Views, you can port it among PC-DOS, OS/2, UNIX, XENIX, and VMS.

Vermont Views can be used with any database that has a C-language interface (most do), and will create interfaces for any roman-based language. Our form-locking version lets you develop quickly and safely on networks and multi-user operating systems, too.

If you need DOS graphics in your applications, we also have the answer. Vermont Views™ GraphEx allows all Vermont Views’ windows, menus, and forms to work in CGA, EGA, VGA, and Hercules graphics modes. So you can use your favorite graphics package to create charts, graphs, and other images to enhance text displays.

Vermont Creative Software
Pinnacle Meadows,
Richford, VT 05476
Phone: (802) 848-7731
FAX: (802) 848-3502

Call for your FREE demo kit!
800-848-1248
(Please mention “Offer 128”)

Don’t take our word for it. Put Vermont Views to the test by calling for your personal, free demonstration kit. Or fax us at (802) 848-3502.

WE GUARANTEE YOUR SATISFACTION, FOREVER.

We're so sure you'll love Vermont Views that we make this iron-clad, money-back guarantee. If you're ever dissatisfied with Vermont Views, for any reason, return it for a prompt, no-questions-asked refund. (All you have to do is certify that you haven't incorporated our code into any application.)

** Copyright 1990 Vermont Creative Software

Circle 348 on Inquiry Card.
hard disk is put into a memory buffer, where it can be accessed quickly, significantly reducing the overall access time. With write caching, however, data is written to a memory buffer instead of directly to disk. This frees up the processor to move on to other tasks more quickly. Then the data gets copied from the memory buffer to the hard disk separately, while the processor does something else.

Some companies have found this technique too risky. If something interrupts the process after the processor writes the data and before the data gets to the disk, the processor thinks the data is safe when, in fact, it is not. If a drive fails completely during a write operation, the processor will have written data to the cache that hasn't yet made it to the disk surface—but as far as the processor knows, the write has been successful. Quantum officials acknowledge this problem but say that the state of hard disk drive technology is good enough now that such an event is unlikely.

Quantum is offering a version of write caching, called WriteCache, on certain models of its ProDrive (200 MB or higher). Quantum claims that the technology can achieve improvements of between 50 percent and 200 percent in data throughput on write operations. WriteCache lets the drives finish a random write operation completely after it is issued in about 23 ms; the processor, however, completes the write to the data buffer in 3 or 4 ms, Quantum says.

WriteCache can simultaneously write data to disk from the buffer and write data to the buffer from the processor, Quantum says. This allows for a continuous data flow in a similar manner to the way a streaming tape drive operates.
—Owen Linderholm

## Diamond Transistors and Coolers Come Closer

Diamond is coming closer to being a practical material for use in electronic applications. Scientists at Varian Research Center (Palo Alto, CA) have fabricated diamond transistors, and a company called Diamonex (Allentown, PA) is nearing commercialization of diamond heat sinks to help keep high-speed electronics cool.

Diamond transistors are potentially faster and can take more heat and radiation than even gallium arsenide devices. A diamond's hardness, high-insulation value, and superior heat-transfer properties make it important as a substrate and heat sink for electronics.

Varian researchers are now working on their second generation of diamond transistors. The first, which was announced last fall, was the first diamond transistor that could be turned off. The new transistor is similarly built by doping a natural diamond crystal with boron, but it's small enough to fall within the range of current ICs.

Varian is building metal semiconductor field-effect transistors. The transistors are three gold-titanium contacts applied to the surface of the boron-doped region of the diamond. The outer contacts, the source and drain, are annealed to make ohmic contact with the doped diamond. The central gate contact is not annealed. When a reverse voltage is applied to the gate, the current flow through the device can be reduced to zero. According to Varian officials, this is the first time that this has been done in a diamond transistor.

Varian's work is still experimental. The company hasn't built a commercial diamond semiconductor, and neither has anyone else, although both the Japanese and the Soviets have similar projects.

Meanwhile, artificial diamond could show up in electronic equipment in a few months in the form of thin-film heat sinks. (Natural diamonds are already used in some electronic applications, but they are very expensive.) Diamond's thermal conductivity is more than four times higher than the best presently used material, beryllium oxide. The chips are bonded to a small piece of diamond that spreads the heat from the chips to a larger conventional heat sink.

Diamonex has distributed samples of a diamond-coated heat sink to potential customers. According to David S. Hoover, vice president of technology, products built on the company's diamond heat sink could be in production by the end of the year. The first market, Hoover says, is "things like laser diodes and high-power FETs [field effect transistors]." Next, there would probably be multiphase modules and eventually very dense circuits such as microprocessors using emitter-coupled logic.

The company grows its diamond films by passing a heated mixture of hydrocarbon gases (e.g., methane, ethane, and acetylene) over a substrate. If the process is properly controlled, diamond forms instead of graphite.
—Rick Cook

## Three-dimensional graphics

Three-dimensional graphics like those seen on workstations will be coming to personal computer users as a result of a new pact between Microsoft and Silicon Graphics, the companies say. Microsoft has licensed Silicon Graphics' Iris Graphics Library technology to incorporate it into its own systems and applications software. The Iris Graphics Library provides tools for developing applications that let users manipulate high-resolution, 3-D color images. "Silicon Graphics and Microsoft intend to integrate technology from the Iris Graphics Library with appropriate future Microsoft software products," a Silicon Graphics spokesperson said.

With Sun's optimizing compilers priced at around $2000, Lucid should attract attention by offering its new ANSI C optimizing compiler at $495. Lucid C for Sun Sparcstations and compatible offers ANSI C conformance and a Kernighan & Ritchie mode. A transition mode is also available, letting you write ANSI C code and link it with most K&R files. Lucid plans to release a C++ compiler later this year, as well as a C/C++ integrated applications environment.

One of the most talked-about new titles at the Multimedia and CD-ROM Conference was Desert Storm, Warner New Media's audiovisual CD covering the war with Iraq. Assembled in conjunction with Time, the CD includes the text of unedited dispatches from Time correspondents and the resulting stories as they appeared in print; audio segments, such as news reports and presidential sound bites; and about 300 photos. You can search the material using either an index or a time line. The $39.95 CD is out first for the Macintosh; a Windows version will be released later, a spokesperson said.

—Owen Linderholm

—Rick Cook
For total portability right now, your choices are a bit limited.

Only ZorTech Gives You Total Portability to MS-DOS, Windows, OS/2, DOS 386, UNIX 386. And Macintosh. Right Now.

Whatever Platform You Choose, Choose ZorTech Performance.

With ZorTech, no matter what platform you choose to develop on, a substantial performance increase will be realized due to the quality of the original ZorTech C++ implementation. For instance, on MS-DOS, your program will compile up to 35% faster with the resultant code running up to 45% faster and 25% smaller than Turbo C++. But we don’t stop there. On each platform, ZorTech C++ is designed to improve your productivity where it really matters... in the development cycle.

For example, using the DOS/MS Windows package, you can edit, compile, link and debug the largest MS windows applications...and never once leave the Windows environment. All this plus complete plug-and-go to CNS C++/View and Commonview II. And, of course, these advantages are also available on the OS/2, DOS 380, UNIX, and Macintosh platforms.

Choices, Choices, Choices...
If there is one constant in C++ development, it’s change. The ZorTech family of products keeps your options exactly how they should be. Open. To find out more, call today.

Order Hotline:
(800) 848-8408

Circle 373 on Inquiry Card.
People are always looking for affordable ways to make a better impression.

Soon a lot more people will be looking their best. Because now the best features of the HP LaserJet III printer are more affordable.

The new LaserJet IIIP printer features HP's exclusive Resolution Enhancement technology. An innovation that provides 300 dpi print quality superior to that of ordinary laser printers. The PCL5 printer language, with font scaling and HP-GL/2, brings even more to your documents.

Fourteen bit-mapped and eight internal scalable typefaces give you thousands of options. And, to make things even more interesting, the LaserJet IIIP produces patterns, shading, spirals, and mirror images. In portrait or landscape.

HP has picked up the throughput speed of this 4 ppm printer. Due to a considerably faster I/O rate, the LaserJet IIIP accepts data as quickly as your PC can transfer it. So you not only get your output faster, you get your screen back faster.

The LaserJet IIIP also has a new 16 MHz processor and PCL5 for on-the-fly typeface scaling and fast vector graphics. These advancements mean this compact printer...
requires less time to print than many laser printers with higher ppm rates.

For versatility, the LaserJet IIP has a multisized paper tray that accepts various sizes of paper and envelopes. An optional Adobe® PostScript® cartridge is available. And, of course, the LaserJet IIP is compatible with all major software and HP LaserJet accessories.

The good looks you get with the newest HP LaserJet look even better when you consider the price. Just $1,595.*

For a faxed data sheet, dial (208) 344-4809 from your FAX machine and enter document I.D. number 9600. Now everyone can add a little polish to their work.

HP Peripherals
When it's important to you.
Hold onto your hats. The PC industry is in for another CPU war. After Intel effectively buried the 286 in favor of the 386SX, the PC CPU king appears to be positioning the new 20-MHz i486SX to do the same to its 386DX chip. Perhaps not coincidentally, this move comes at the expense of Advanced Micro Devices (AMD), as it did with the 386SX.

AMD is a licensed second source for the new 486SX systems, which generated a great deal of revenue for the company in the 286's heyday. To counter the declining 286 market, AMD has cloned the 386DX—so well, in fact, that it can reliably boost the clock rate to 40 MHz; the best Intel offers is 33 MHz (see "The 386 Gets a Competitor," March BYTE).

Intel's i486SX is simply your garden-variety i486 sans working FPU functions (they are disabled) and running at 20 MHz. To add an FPU, you must buy an 80487SX, which is really an i486 CPU with its math coprocessing capabilities intact. An 80487SX retails for $799. An Intel 33-MHz 80387 math coprocessor (a 40-MHz version is not yet available) retails for $994.

The 386SX took sales away from the 286 because it let system vendors build more powerful PCs at a price competitive with those of 286-based machines. And the surging popularity of Windows 3.0 accelerated the demand for more powerful, inexpensive systems. But the case of the i486SX versus the Am386 will be different. BYTE has made preliminary tests on two prototype 486SX systems, from Advanced Logic Research (ALR) and AST Research, and a prototype Am386 system from Club American Technologies. Performance differences are minimal. All will run most business applications under DOS or Windows without working up a sweat. This battle will be won primarily on price and availability.

These machines also create a new performance niche between standard Intel 33-MHz 386 systems and 25-MHz 486 systems. The price range varies significantly, with the 486SX systems on the higher end. All three systems should be available by the time you read this.

ALR and AST: Similar Design, Different Prices

Comparing the ALR BusinessVEISA 486ASX and the AST Premium II 486SX/20 is interesting as much for their similarities as for their differences. Both feature expandable CPUs, offer a similar range of options and base configurations, and have roughly equal performance.

The main differences are in price and in the way the CPU and FPU upgrades are implemented. The ALR uses EISA architecture, while the AST has ISA slots; ALR also offers ISA and Micro Channel architecture versions of the BusinessVEISA 486ASX. Both companies were among the first to offer an expandable architecture. (For a comparison of the companies' architectures, see "Two to Grow On," June 1990 BYTE.)

The BusinessVEISA 486ASX came with 5 megabytes of RAM, a 150-MB hard disk drive, a 3½-inch floppy disk drive, a Super VGA adapter and monitor, and an UltraStor Ultra 22C EISA caching ESDI hard disk drive controller. As configured here, the ALR unit sells for about $7800 (pricing on the controller was not set at press time). As an introductory offer, ALR is bundling Windows 3.0 and DOS 4.01 with the system.

We also had ALR's SuperCharged 486 CPU/Math Chip (retailing for $1095). It is actually a fully functional i486/25 CPU that plugs into an empty socket on the CPU module. You can use a 20-MHz 80487SX in the same slot as the i486/25 (the module has both 20- and 25-MHz os-
cillators), but for about $300 more than the price of the 80487SX, ALR is offering what amounts to a CPU upgrade.

We clocked the upgraded system’s CPU index at 6.28—a respectable score for a 486/25 system. Doing the upgrade is not quite as simple as pulling one board and inserting another: The CPU module is actually two boards plugged into two proprietary slots and held together by one screw that threads into the floppy disk drive support. We had to remove the caching hard disk drive controller to gain access to that screw.

AST sent us the Model 213V, equipped with a 210-MB Intelligent Drive Electronics (IDE) hard disk drive, a 3½-inch floppy disk drive, 4 MB of RAM, and an integrated Super VGA adapter and monitor. This system will sell for $5090 with a monitor. Although ALR’s base unit is significantly cheaper than AST’s, there is little price difference between fully configured versions.

The unit will make use of AST’s Cupid CPU boards, which lets you upgrade the system by swapping boards. The Premium II 486SX/20 uses a slightly different design than previous models. Prices for upgrade modules are not set, but AST expects them to be somewhat lower than earlier versions.

The AST machine edged out the ALR machine on the CPU index: 5.14 to 5.02. Both scored lower than the Club’s 5.41, although mere mortals aren’t likely to notice the differences in their applications among these systems. The AST and ALR systems showed better hard disk drive and video performance, which reflects more on the quality of the components used than on the CPU.

The ALR machine was ruggedly built. Its metal cover and frame make for a rigid construction. It is, essentially, the basic desktop BusinessVEISA design that ALR has been using for some months now. The AST machine is not as rugged as either the ALR or the Club. Its plastic base flexed considerably with the cover off, and it did not sit evenly on a flat surface.

The AST machine offers a few advantages that the ALR machine doesn’t. It comes standard with a set of excellent system utilities, as do all AST systems, including a software disk cache and system diagnostics. The Premium II’s integrated systems showed better hard disk drive and video performance, which reflects more on the quality of the components used than on the CPU.

AST sent us the Model 213V, equipped with a 210-MB Intelligent Drive Electronics (IDE) hard disk drive, a 3½-inch floppy disk drive, 4 MB of RAM, and an integrated Super VGA adapter and monitor. This system will sell for $5090 with a monitor. Although ALR’s base unit is significantly cheaper than AST’s, there is little price difference between fully configured versions.

The unit will make use of AST’s Cupid CPU boards, which lets you upgrade the system by swapping boards. The Premium II 486SX/20 uses a slightly different design than previous models. Prices for upgrade modules are not set, but AST expects them to be somewhat lower than earlier versions.

The AST machine edged out the ALR machine on the CPU index: 5.14 to 5.02. Both scored lower than the Club’s 5.41, although mere mortals aren’t likely to notice the differences in their applications among these systems. The AST and ALR systems showed better hard disk drive and video performance, which reflects more on the quality of the components used than on the CPU.

The ALR machine was ruggedly built. Its metal cover and frame make for a rigid construction. It is, essentially, the basic desktop BusinessVEISA design that ALR has been using for some months now. The AST machine is not as rugged as either the ALR or the Club. Its plastic base flexed considerably with the cover off, and it did not sit evenly on a flat surface.

The AST machine offers a few advantages that the ALR machine doesn’t. It comes standard with a set of excellent system utilities, as do all AST systems, including a software disk cache and system diagnostics. The Premium II’s integrated systems showed better hard disk drive and video performance, which reflects more on the quality of the components used than on the CPU.

The ALR machine was ruggedly built. Its metal cover and frame make for a rigid construction. It is, essentially, the basic desktop BusinessVEISA design that ALR has been using for some months now. The AST machine is not as rugged as either the ALR or the Club. Its plastic base flexed considerably with the cover off, and it did not sit evenly on a flat surface.

The AST machine offers a few advantages that the ALR machine doesn’t. It comes standard with a set of excellent system utilities, as do all AST systems, including a software disk cache and system diagnostics. The Premium II’s integrated systems showed better hard disk drive and video performance, which reflects more on the quality of the components used than on the CPU.

The ALR machine was ruggedly built. Its metal cover and frame make for a rigid construction. It is, essentially, the basic desktop BusinessVEISA design that ALR has been using for some months now. The AST machine is not as rugged as either the ALR or the Club. Its plastic base flexed considerably with the cover off, and it did not sit evenly on a flat surface.

The AST machine offers a few advantages that the ALR machine doesn’t. It comes standard with a set of excellent system utilities, as do all AST systems, including a software disk cache and system diagnostics. The Premium II’s integrated systems showed better hard disk drive and video performance, which reflects more on the quality of the components used than on the CPU.

The ALR machine was ruggedly built. Its metal cover and frame make for a rigid construction. It is, essentially, the basic desktop BusinessVEISA design that ALR has been using for some months now. The AST machine is not as rugged as either the ALR or the Club. Its plastic base flexed considerably with the cover off, and it did not sit evenly on a flat surface.

The AST machine offers a few advantages that the ALR machine doesn’t. It comes standard with a set of excellent system utilities, as do all AST systems, including a software disk cache and system diagnostics. The Premium II’s integrated systems showed better hard disk drive and video performance, which reflects more on the quality of the components used than on the CPU.

The ALR machine was ruggedly built. Its metal cover and frame make for a rigid construction. It is, essentially, the basic desktop BusinessVEISA design that ALR has been using for some months now. The AST machine is not as rugged as either the ALR or the Club. Its plastic base flexed considerably with the cover off, and it did not sit evenly on a flat surface.

The AST machine offers a few advantages that the ALR machine doesn’t. It comes standard with a set of excellent system utilities, as do all AST systems, including a software disk cache and system diagnostics. The Premium II’s integrated systems showed better hard disk drive and video performance, which reflects more on the quality of the components used than on the CPU.
Cloning Afterlife

Club's new Eagle Series 3/40 systems present a gospel of life after the 286 for PC clones. The 40-MHz AMD Am386 DXL CPU controls Club's new tower system and a sleek desktop model. Based on our look at the desktop system, this CPU may offer enough performance and price difference to make potential customers think twice before committing to low-end 486s.

Out of the box, the Club does a yeoman's job as a midrange PC. A full configuration, at $2895 (well under similarly configured 486SX systems from ALR and AST), includes 4 MB of RAM, 64K bytes of cache memory, a 100-MB IDE hard disk drive and controller, a 1.2- or 1.44-MB floppy disk drive, one parallel port and two serial ports, a Super VGA graphics hardware, or on-site service for the desktop system, this CPU may offer enough performance and price difference to make potential customers think twice before committing to low-end 486s.

The marketplace will also make computing decisions by comparing the three systems here, we have two... to have a significant price advantage to both system vendors and end users. By comparing the three systems here, we can begin to predict where systems using either the i486 SX or the Am386 will fall in the PC hierarchy. Performance-wise, there is no secret. All three fall between 386/33 and 486/25 systems at the CPU level. Advantages inherent to the i486 SX (e.g., its built-in 8K-byte cache) will give it the edge in some applications. The AMD's faster clock speed will do likewise in others.

If you absolutely, positively must have the Intel logo on your CPU, you'll be satisfied with the performance of both the ALR CPU and AST systems. (In fact, both machines had higher CPU scores than some 486/25 PCs we've tested.) Both also offer better-performing subsystems (e.g., video and mass storage) than the Club. However, prices on 486/25 systems are falling, and you can find some with prices as good as, if not better than, the ALR and AST systems' full retail price.

The Club Eagle will appeal to those hungry for more processing power but on a tight budget. The fact that its CPU is a 386 type and not an i486 should not be a big drawback. If you really need everything an i486 has to offer, you are better off buying a 486/25 or 486/33 in terms of price/performance.

These three systems will all appeal to the same kind of user: the businessperson or professional who wants the power to run today's demanding applications and operating environments without paying top-of-the-line prices. Whether the market goes toward the i486 SX or the Am386 matters mostly to Intel and AMD. For end users, the competition between the two will mean more power at lower prices. In our book, that's a win.

Michael Nadeau is managing editor of the BYTE Lab, and Alan Joch is a technical editor for the BYTE Lab. They can be contacted on BIX as "miken" and "ajoch," respectively.
Once again, editors rave about the Tangent 486.

"...when the full 16 stations included in the test were active. The Tangent Multi-Server 433e was still the fastest..."

PC Week 1/7/91

“A consistently strong performer across all tests, the Tangent model 433e stands out in this group.”

PC Magazine April 16, 1991

Tangent Multi-Server 433ms
Capable of replacing 5 to 10 conventional servers.
- Intel 486-33 MHz EISA
- Up to 64 MB RAM
- SCSI Drive Arrays Up to 12 GB
- Continuous 1-3ms Average Access
- Up to 4 Ethernet Ports or 96 Serial Ports
- UNIX or NOVELL Configurations

Priced from $14,900

Tangent 433e / 425e
Our high-end, award winning engineering workstation.
- Intel 486-33 or -25 MHz EISA
- 200 MB to 2.4 GB of Disk Storage
- EISA Caching 32 Bit Disk Controller
- Non-interlaced SuperVGA Monitor

Priced from $5,995

Tangent 433i/425i
A 486 at a 386 price.
- Intel 486-33 or -25 MHz ISA
- 105 MB Up to 2.4 GB of Disk Storage
- Choice of IDE, ESDI or SCSI
- Non-interlaced SuperVGA Monitor

Priced from $3,695

486 your way. Tell us your applications and operating environment and we’ll configure a system to meet your needs 100%. Then we’ll build, test and ship your system. Pronto.

We’re here when you need us. Our sales and support engineers are as near as your telephone.

Tangent is your first call for affordable high performance.

Call toll free: 1-800-223-6677

When the editors got through writing about Tangent 80486 systems, they didn’t leave us a lot to say. Except price. First, compare performance. Then compare price. What you’ll see is that Tangent is the price-to-performance leader in 486 systems, with a range of models designed to fit any need.

*All pricing subject to change without notice. ©1991 Tangent Computer. Tangent is a registered trademark of Tangent Computer, Inc. 486 is a registered trademark of Intel Corporation. Other product names may be the trademarks or registered trademarks of their respective companies.
This new generation PC is remarkable for the performance and practicality it provides. Carry it from the office, to home, to multi-site locations so all your programs and files travel conveniently with you.

Customers and critics alike are praising the Brick for its portability, elegant design, whisper quiet operation and screamingly fast power. This diminutive PC with the unforgettable name is designed for the way you always wanted to do computing.

Here's a sampling from recent articles on the Brick.

"Every once in a while a PC product comes along in which the performance, design and concept are so uncommon that a little voice inside you says you really want to have one."

Jon Pepper,
PC Sources, 11/90

"Engineered with the way people actually work in mind. It answers the question of how to transport an entire environment to and from several work sites, something no other product handles elegantly."

PC/Computing, 12/90

"Overall the Brick represents a clever counter to conventional notebook designs. It solves the fundamental problem of two-location computing. You get to keep your home and away files in sync because they are the same."

Tracy Licklider
BCS UPDATE, 7/90

"Engineered with the way people actually work in mind. It answers the question of how to transport an entire environment to and from several work sites, something no other product handles elegantly."

PC/Computing, 12/90

"Ergo's Brick maintains the functionality of a desktop PC within a small form-factor...the Brick is a real performer, consistently outperforming both Compaq's and IBM's 16 MHz SXs on PC Labs computer benchmark tests."

Matt Ross,
PC Magazine, 9/25/90

"The Brick is the first real innovation in DOS based computers in a long, long time."

Computer Shopper, 1/91

"The philosophy behind the Brick is so obvious that I'm surprised that no one has thought of it before...you can keep a monitor and a keyboard at each work location, carrying only the computer guts (and your own data) between locations...in a world of boring and utilitarian PCs, the Brick stands out for both its elegance and its technological sophistication."

Stan Miastkowski,
BYTE, 6/90

"The Ergo Brick—that delightfully small, full-featured 386SX™ machine. It's almost silent, it's fast...a great personal computer in every other respect too."

Bill Machrone,
PC Magazine, 1/15/91

"The Brick is the first real innovation in DOS based computers in a long, long time."

Computer Shopper, 1/91

"The philosophy behind the Brick is so obvious that I'm surprised that no one has thought of it before...you can keep a monitor and a keyboard at each work location, carrying only the computer guts (and your own data) between locations...in a world of boring and utilitarian PCs, the Brick stands out for both its elegance and its technological sophistication."

Stan Miastkowski,
BYTE, 6/90

THE
BRICK
“The Brick is a simple idea that is beautifully executed, resulting in a machine whose time has clearly come. You get the convenience of a laptop with the uncompromising performance of a desktop.”

Jon Pepper,
PC Sources, 11/90

“An ideal system for those who split their working time between home and office...The stylish “black granite” and beige cases look as if they came straight from the pages of a Sharper Image catalog.”

PC Week, 9/24/90

Hi-res video drivers are included for over 25 major applications including Windows 3.0, WordPerfect, Ventura, Autocad, Cadkey, and Lotus. The Docking Terminal ($349) permits instant hook-up of all cables and adds another 16-bit 3/4 length slot.

“...everyone who sees it falls in love with it... Recommended.”

Jerry Pournelle,
BYTE, 1/91

“The beauty of this arrangement is that you never have to worry about the consistency of your data files... you just take it all with you.”

Henry Fersko-Weiss,
PC Magazine, 3/91

“Only slightly larger and heavier than a college dictionary, the Brick is a faux-granite-finished portable CPU that explores the middle ground between desktop PCs and portable computers.”

Fred Paul,
PC/Computing, 8/90

For further information or to request our FREE Catalog
CALL TOLL FREE
1-800-633-1925
Or to receive information via FAX, 24 hours, CALL 1-800-THE-BRICK

$2,495
INCLUDES
- 16 MHz Intel 386SX
- 4 MB RAM (exp to 8 MB)
- 44 MB 28ms hard disk
- 2,400 bps modem
- 1024 x 768 VGA adapter with 1 MB video RAM
- 3.5" floppy/1.44 MB
- 16-bit half card exp. slot
- DOS 3.3 or 4.01
- 1 year warranty
- 30 day money back guarantee
- Freight Prepaid

Plus Your Choice of:
- Windows 3.0 with Adobe ATM, Mouse or:
  - DESQview/386 with QEMM, Manifest, Tree68, Cache68
- All software completely set up, Ready to go

Options:
- 104 MB 24ms HD add $395
- 212 MB 16ms HD add $965
- 20 MHz Brick add $250
- 8 MB total RAM add $396
- 386SX Coprocessor 16 MHz add $395
  20 MHz add $445
- 12" 640 x 480 mono VGA monitor & 101 keyboard-beige add $218
- 14" 640 x 480 color VGA monitor & 101 keyboard-beige as shown add $195
- Color coordinated VGA monitor & keyboard, add $349
- Docking Terminal add $349

For information, preferences, or to receive our FREE Catalog
CALL TOLL FREE
1-800-633-1925
Or to receive information via FAX, 24 hours, CALL 1-800-THE-BRICK

Circle 105 on Inquiry Card.
System 7.0 offers compatibility, new features, and a future growth path

Back in 1984, the Mac was the first microcomputer to make a windowing operating system available to a large audience. Over time, the Mac OS was enhanced with features such as hierarchical menus and 24-bit color. However, certain parts of the interface began to show signs of age, and by the late 1980s, some expert computer users were already running into the operating system’s 8-megabyte memory limit.

In 1989, Apple announced its successor to the then-current version 6 software: System 7.0. It would fix the limitations while providing new capabilities. System 7.0 was supposed to be available in about a year, but some delays pushed back the launch date. However, Apple was making preparations for System 7.0’s arrival: The base hardware configuration of the Mac LC and Mac IIi made these machines ready for System 7.0.

System 7.0 has finally arrived, and the wait has been well worth it. System 7.0’s new features make it an upgrade that is as significant for Mac users as Windows 3.0 was for Intel-based microcomputer users. What does System 7.0 offer, and why should you switch to it? Here are a few reasons:

• A more consistent interface that makes the Mac even easier to use.
• Compatibility with existing software. Since System 7.0 is a revision of the tried-but-true System 6.0.x, many existing Mac applications, desk accessories (DAs), and cdevs continue to work. You can immediately take advantage of its high-resolution TrueType outline fonts or peer-to-peer file sharing with no modification to the software. New interface features will completely change your Mac working habits.
• Old limitations removed. Suitably equipped Macs can run System 7.0 as a 32-bit operating system, expanding the program address space from 8 MB to 1 gigabyte. Virtual memory support—where the contents of inactive portions of RAM are swapped out to a hard disk and copied back into RAM as needed—lets you run applications that are larger than the computer’s physical RAM.
• Future extensions. While System 7.0 preserves all existing OS calls for compatibility, it also augments its capabilities by supplying numerous new calls that let applications share data and communicate to other applications or computers. You’ll be able to use off-the-shelf applications that dynamically exchange data with each other and provide seamless access to remote databases.

The System 7.0 beta 4 software we saw occupies eight 800K-byte floppy disks. Its hardware requirements are simple: a Mac Plus or better with 2 MB of RAM and a hard disk drive. The Installer application is an enhanced version of the one used since System 6.0.4. It automatically identifies the Mac it’s running on and offers to install the complete set of System software, utilities, and printing services. Installation is just a matter of feeding in the Mac disks until the job is done. A Network Install application lets you install System 7.0 over a network.

Not Just Another Pretty Interface

After you restart a color Mac, you’re in for a surprise. The Desktop icons are in color. We’re not talking about the seven color shades that you could use to tint icons using System 6.0.x. These icons sport many different hues, which imparts a dramatic three-dimensional effect to Desktop objects.

Similarly, the scroll and title bars on windows exhibit 3-D features, much like Windows 3.0 or Motif (see the screen shot). Naturally, Macs with black-and-white screens use the old bit-mapped icons and window dressing.

An application icon located on the right side of the menu bar hints that you’re running MultiFinder. You have cooperative background tasking at all times now (see Don Crabb’s Macinations column for further details). This new Finder has taken on additional interface duties besides managing the screen and files, while all the tasking switching code has been moved into a hidden Process Manager (more on this later). Clicking on the application icon presents a pull-down menu that lets you pick from a list of running applications.

Returning to the menu bar, a new icon next to the application icon resembles a balloon. Clicking on this icon gives you access to Balloon Help, a built-in context-sensitive help mechanism. When Balloon Help is enabled, cartoon-style voice balloons appear as you move the mouse over the screen. The balloon’s tip points to the object selected by the mouse, and inside the balloon is a brief descriptive explanation of the object’s function.

Consistency Is the Key

Apple has rediscovered the value of the keyboard: The cursor keys let you navigate around the Desktop, an icon at a time. Or, you can type the first character of a filename or folder name to select an item. This closely copies the behavior of the ubiquitous Standard File dialog box, and it provides a consistent way to select files whether you’re in an application or at the
The Complete Solution
For 9-Track & 3480 Tapes
On Your PC

- Transport data between locations regardless of system type
- Saves the high cost of data conversion
- Flexible, easy to use software
- Doubles as a high performance, high capacity backup device
- Superior service and support. Cipher offers field service and a 1 year factory repair warranty
- Cipher product connectivity includes: SUN, APOLLO, DEC, NCR, AS/400, RISC/6000, ALTOS, Motorola
- Accessories and media

Cipher Data Products, headquartered in San Diego, California, is a subsidiary of Archive Corporation, the largest independent tape drive manufacturer in the world. Cipher has been a leader in the computer tape drive and subsystem business for the past 22 years with over 60 distributors worldwide.

With one of the broadest product lines in the industry, Cipher is the leading supplier to the largest computer companies in the world.

For the solution to your interchange and backup needs, call Anita or Kim now at 1-800-4-CIPHER (1-800-424-7437) for US Sales, Spares & Repairs information, for Europe, call 44-734-775757 (UK) for Technical Support information, call 1-619-693-7700

The choice of the world's leading computer companies

Circle 66 on Inquiry Card (RESELLERS: 67).
Desktop. A new Desktop button in the Standard File dialog box gives you an overview of all the Mac’s mounted volumes (i.e., disk drives, floppy disks, and servers), and, like the new application icon menu, it lets you choose from the list.

When you view a crowded folder’s contents as text, new visual indicators help you sort through the blaze of names. Folder names are prefaced by a right-pointing arrowhead. Clicking on the arrowhead opens the folder, showing its contents as text names indented slightly to the right. The arrowhead then points downward, indicating that the folder is open. This gives you a useful visual hierarchy of folder directories.

System 7.0 handles DAs and cdevs in a consistent manner. DAs were formerly invoked from the Apple menu, and cdevs hid out within the Control Panel DA’s window. This made for a confusing interface for novices. DAs and cdevs now behave like miniapplications: Double-clicking on them launches them. The Apple menu can still be used to start DAs, even though they aren’t part of the System file now. Instead, they live in a special Apple Menu Item folder. Cdevs are no longer accessed from the Control Panel DA, but from the Finder within their own Control Panel folder. This normalizes the Mac interface so that you can access files, launch applications, or modify system features the same way.

Easy Changes
System 7.0 also simplifies how you customize your system. Adding new fonts or DAs to a System 6.0.x file required the use of a Font/DA Mover application. Adding new sounds meant using either ResEdit, a developer’s tool, or third-party INITs. Now you simply drag DAs, fonts, or sound resource files into the System Folder to install them.

New folders within the System Folder organize the population explosion of specialized files. The previously mentioned Apple Menu Item folder places objects on the Desktop menu and is where DAs are copied by default.

The Control Panel folder is where cdevs go, and an Extensions folder holds the system extensions (e.g., AppleShare, printer drivers, and INITs). A Preferences folder contains all those preference files that applications create to store user settings. A Startup folder holds those applications and DAs that you want launched when the Mac starts.

The System file now lets you add or remove certain items easily. Double-clicking on it opens a window, displaying all the fonts and sounds. You can add sounds and fonts by dragging the files to this System window, or you can remove them by dragging the selected objects out of the window. However, the System file still does its old job of packing essential resources that the Mac OS needs to operate. A peek inside the System file with ResEdit 2.1 shows dozens of different resources. The System file window lets you view and manipulate resources (i.e., sounds and fonts) you’re likely to change.

The Find item does just what it says: It finds files. It has Boolean search operations for multiple files and can be set to locate files on a particular volume by name, kind, or date.

New Changes Inside
The changes to System 7.0’s graphical user interface (GUI) are obvious. However, there are numerous modifications to the Mac OS internally that, while not as obvious, are just as significant. First, the Desktop file, with all its size and speed problems, is gone. All of a file’s bundle information (the icon to display and the file’s creator and type) is collected into a Desktop database.

Unlike the old Desktop file, which retained the icon of every file copied to the disk, the Finder updates the database as files are added or removed. Files and folders dragged to the Desktop are stored in a hidden Desktop folder, and Trash itself is now a folder.

There are a number of enhancements to existing Mac OS managers. The File Manager now assigns a file a unique ID number. Applications use this ID number to locate a file, even when it is moved to a new folder or renamed. New File Manager calls perform special file saves (so as not to alter the ID number), handle catalog searches, and control file access rights on foreign file systems, such as Unix volumes.

The Event Manager’s role has been expanded beyond simply dealing with low-level events such as keystrokes or mouse clicks. It helps to handle a new class of events called high-level events, which transmit commands to other applications. Another new event class, OS events, is used by the Process Manager and coordinates application switching (suspend/restart events).

The Resource Manager has new calls that enable it to read portions of a resource into memory, edit it, and write it back to disk. Formerly, the Resource Manager had to read an entire resource—regardless of its size—into RAM.

The new Memory Manager supports both 24- and 32-bit addressing modes. All applications that are “32-bit clean” (i.e., that use all 32 bits of the address and don’t manipulate a memory block’s characteristics directly) will run in the 32-bit mode without modification. Only Macs with 32-bit-clean ROMs (i.e., the IIci, IIsi, and IIfx) can operate in the 32-bit mode.

System 7.0 operates in a 24-bit compatibility mode to support older Macs. The Memory Manager also supports virtual memory on 68030-based Macs or 68020-based.
Free i860™ Processor and i860/APX Software!
By now, you've probably heard about our industry-first i860 MotherBoard that packs the power of the Intel 80486 CPU with the Intel 80860 RISC processor (i486™ + i860 = 4860).

What you haven't heard is that, for a limited time, when you buy a 4860 MotherBoard with 8MB of RAM, Hauppauge will give you an i860 RISC processor and the i860/APX operating system at no additional cost.

Why give you this capability? Because you'll enjoy a level of processor performance never before seen in a PC. Our bet is that you'll be so impressed, you'll come back for more!

A PC Revolution: In the PC environment, the 4860 is a 486-based MotherBoard with the new EISA I/O bus. It runs over 2 times faster than 386 computers and delivers mainframe power for applications including CAD, LAN and desktop publishing. This board is fully compatible with DOS, IBM's OS/2, Novell Netware and SCO UNIX. What's more, Hauppauge's 4860 supports up to 64 MBytes of memory without a RAM expansion board.

RISC-Y Business: The i860 processor is ideal in complex applications, performing up to 25 million floating-point operations per second. It adds to the power of the 486, so you can run rings around ordinary PCs.

By adapting Intel's APX (Attached Processor Executive) software to our 4860 MotherBoard, we've created a way to exploit the power of the i860 to give you practical multiprocessing. In fact, 4860/APX provides a base for entirely new applications made possible by the advent of the i860 RISC processor.

Technical Features: 25 or 33MHZ 486/860 · 4 Mbytes of high speed RAM expandable to 64 Mbytes shared between i486 and i860 processors · Socket for optional Intel Turbo Cache 485™ and Weitek 4167 · 7 EISA I/O slots · 64-bit expansion slot for optional high-speed graphic frame buffer · 1 parallel, 2 serial ports and a built-in PS/2-style mouse port.

Enjoy a RISC-free investment. Our 4860 MotherBoard is designed with the world's highest performing microprocessors. So you can have the world's highest performing PCs and workstations.

For more information, call 1-800-443-6284.

Hauppauge Computer Works, Inc.
91 Cabot Court
Hauppauge, New York 11788
Telephone: 516-434-1600
Fax: 516-434-3198

In Europe (49) 2161-17063
In Australia: (7) 262-3122

Available at your local computer dealer.

Trademarks: OS/2: IBM · Intel 386, i486, i860 and Turbo Cache 485™: Intel Corp. · DOS and Xenix: Microsoft Corp. · 4860, 4860 MotherBoard: Hauppauge

Circle 133 on Inquiry Card.
Last Year A Patchwork Document Imaging System Might Have Cost You $250,000.

Now There's A Powerful Turn-Key Solution For Less Than $35,000.

E E F
Elex Electronic Filing

Get the full picture on page 53.
"My Dolch 486™ is awesome..."

"Hey, I now own the perfect portable that lets me get my work done anywhere. Not just a few files...everything I had on my desktop!"

"Powerful! You bet! After I downloaded all my desktop stuff, on it's 200 MB HD, I still had plenty of room left and it screamed through everything at 11 MIPS!"

"My Dolch P.A.C. is setting new rules. It's portable, fast and I still can add 4 full-size internal expansion cards. Wow!"

"You have to see the brilliant display—I mean really see it. TFT is the latest color technology, that's fully VGA compatible."

"Hey! Don't take my word for it. Experts like PC Magazine judged my Dolch P.A.C. to...outclass all other portables' and picked Dolch three years in a row as Editors' Choice!"

"Get a Dolch today, choose a 286™, 386SX™, 386DX™ or a 486™ like mine...clearly the best PC you can buy today, and it happens to have a handle. Get a lot more work done—where and when you want."

Why Wait?...Call today.
(800) 538-7506 US; (800) 233-2077 CA
In Canada call Laptech 1-800-561-4527

Dolch.
ROAD-POWER FOR THE BEST OF US
Cooper Black
Franklin Gothic
Garamond Bold Condense
Univers Bold

The two folders with cable icons indicate that their contents are shared across the network. An icon shows that someone is accessing the Shared documents folder.

NEWS

FIRST IMPRESSIONS

of Mac OS-supported tools where applications can seamlessly exchange information or access data sources. It will be up to third-party vendors to lay the bricks of new applications on this foundation.

Road Test
Our tests of System 7.0 included four Macs: a Mac IIci with 8 MB of RAM and equipped with a SuperMac Technology 19-inch monitor and a Spectrum/24 PDQ board, a Mac IIfx with 8 MB of RAM and equipped with an AppleColor 13-inch monitor and an 8x24 GC board, a Mac SE/30 with 2 MB of RAM, and a Mac SE with 4 MB of RAM. We found that you're going to need at least 4 MB of RAM to reap the benefits of System 7.0. On the Mac SE/30, the Mac OS used about 1.5 MB, leaving only 500K to 800K bytes of RAM free.

Many of our favorite applications (e.g., PageMaker 4.0, FreeHand 3.0, Illustrator 3.0, and MacWrite II) worked fine. Lots of DAs worked, including Zedcor's DeskPaint 3.03 and CE Software's DiskTop 3.0.1. QuickKeys 2.0 works, but some features (e.g., a utility for mounting file servers) signaled an error and quit. INITs and cdevs were a mixed lot: Some provided us with a number of different TrueType fonts that produced gorgeous results, proving that the TrueType technology works.

System 7.0's Sharing feature worked reliably, and even System 6.0.x users were able to access shared folders and volumes. Our networking links to Unix via a Caiman GatorBox and to DOSdom via NetWare still worked. A beta copy of Farallon Computing's Timbuktu 4.0 worked fine, relaying color screens across a LocalTalk network. In fact, users running Aldus PageMaker 7.0 can attach, view, and control System 7.0 Macs, getting a color preview of the situation. We use Shiva's networked NetModem to dial remote sites, and it operated fine, once we sorted out where the cdev had to go.

The TrueType fonts produced excellent output on both an Apple StyleWriter and black-and-white laser printers using the Adobe PostScript interpreter, and you can actually mix both font types in a word processing document. The new LaserWriter 7.0 driver no longer uses a Laser Printer dictionary file, and it remembers whether your last print job required color or just black and white. Bitstream generously provided us with a number of different TrueType fonts that produced gorgeous results, proving that the TrueType technology works.

ATM 2.0 still operates, so you have access to both PostScript fonts on top of the TrueType fonts. Adobe's Illustrator 3.0 also works, but if you use a TrueType font with its text tool, the text fails to appear. Adobe is working on a fix. FreeHand 3.0 works with both PostScript and TrueType fonts, down to setting the text's fill and stroke colors. However, printing color TrueType text from FreeHand 3.0 to a Tektronix Phaser II color printer (which uses a PostScript clone interpreter) gave the printer fits. We could print the file to an NEC ColorMate PS, which uses Adobe PostScript 51.9. Both Illustrator 3.0 and FreeHand 3.0 printed color text and graphics fine on the Phaser II using PostScript fonts.

The upshot of these results is that, for most applications, TrueType does well. People who use graphics-intensive applications with text should check for potential problems, although the FreeHand 3.0 results hint that the situation isn't as bad as it seems. A bigger question mark mark for TrueType is if you have to send your work to a typesetting service, but for now the solution is to stick with PostScript fonts.

Should You Switch?
What does it cost to switch? Final pricing wasn't set when we went to press, but the latest figures provided by Apple indicate that the Personal Upgrade Kit, which includes eight floppy disks, manuals, and telephone support, is available for $99. A Group Upgrade Kit includes the Personal Upgrade Kit, plus software on a CD-ROM and the NetWork Install application. It costs $349.

It's crucial in these days of blazing processors and more powerful microcomputers to understand that hardware alone doesn't provide you with a working solution. Equally important is the software that makes the system go. Apple's System 7.0 solves the immediate problem of software compatibility while providing new interface and networking features that you can use immediately. Apple is to be commended for pushing the envelope for making its tried-and-true GUI more consistent and easier to use.

Over time, you can expect System 7.0-aware applications that will cooperate with one another in a powerful synergy. These applications will have transparent access to databases and exchange information with other applications, all while letting you work cooperatively with others in the office. Apple has taken the lead in showing that the office computer can still be a productivity solution—and not a problem.

Tom Thompson is a BYTE senior editor at large, and Owen Linderholm is a BYTE senior news editor. They can be contacted on BIX as "tom_thompson" and "owenl," respectively.

NEWS

FIRST IMPRESSIONS

System 7.0's Sharing feature worked reliably, and even System 6.0.x users were able to access shared folders and volumes. Our networking links to Unix via a Caiman GatorBox and to DOSdom via NetWare still worked. A beta copy of Farallon Computing's Timbuktu 4.0 worked fine, relaying color screens across a LocalTalk network. In fact, users running Aldus PageMaker 7.0 can attach, view, and control System 7.0 Macs, getting a color preview of the situation. We use Shiva's networked NetModem to dial remote sites, and it operated fine, once we sorted out where the cdev had to go.

The TrueType fonts produced excellent output on both an Apple StyleWriter and black-and-white laser printers using the Adobe PostScript interpreter, and you can actually mix both font types in a word processing document. The new LaserWriter 7.0 driver no longer uses a Laser Printer dictionary file, and it remembers whether your last print job required color or just black and white. Bitstream generously provided us with a number of different TrueType fonts that produced gorgeous results, proving that the TrueType technology works.

ATM 2.0 still operates, so you have access to both PostScript fonts on top of the TrueType fonts. Adobe's Illustrator 3.0 also works, but if you use a TrueType font with its text tool, the text fails to appear. Adobe is working on a fix. FreeHand 3.0 works with both PostScript and TrueType fonts, down to setting the text's fill and stroke colors. However, printing color TrueType text from FreeHand 3.0 to a Tektronix Phaser II color printer (which uses a PostScript clone interpreter) gave the printer fits. We could print the file to an NEC ColorMate PS, which uses Adobe PostScript 51.9. Both Illustrator 3.0 and FreeHand 3.0 printed color text and graphics fine on the Phaser II using PostScript fonts.

The upshot of these results is that, for most applications, TrueType does well. People who use graphics-intensive applications with text should check for potential problems, although the FreeHand 3.0 results hint that the situation isn't as bad as it seems. A bigger question mark mark for TrueType is if you have to send your work to a typesetting service, but for now the solution is to stick with PostScript fonts.

Should You Switch?
What does it cost to switch? Final pricing wasn't set when we went to press, but the latest figures provided by Apple indicate that the Personal Upgrade Kit, which includes eight floppy disks, manuals, and telephone support, is available for $99. A Group Upgrade Kit includes the Personal Upgrade Kit, plus software on a CD-ROM and the NetWork Install application. It costs $349.

It's crucial in these days of blazing processors and more powerful microcomputers to understand that hardware alone doesn't provide you with a working solution. Equally important is the software that makes the system go. Apple's System 7.0 solves the immediate problem of software compatibility while providing new interface and networking features that you can use immediately. Apple is to be commended for pushing the envelope for making its tried-and-true GUI more consistent and easier to use.

Over time, you can expect System 7.0-aware applications that will cooperate with one another in a powerful synergy. These applications will have transparent access to databases and exchange information with other applications, all while letting you work cooperatively with others in the office. Apple has taken the lead in showing that the office computer can still be a productivity solution—and not a problem.

Tom Thompson is a BYTE senior editor at large, and Owen Linderholm is a BYTE senior news editor. They can be contacted on BIX as "tom_thompson" and "owenl," respectively.
If You Have Windows 3.0... You Should Have CorelDRAW!

CorelDRAW 2.0. It's the award winning PC graphics package that's easy to learn and use. If you're artistic, you can create your own graphics from scratch with CorelDRAW's powerful drawing tools. In a hurry? Choose from CorelDRAW's collection of over 4000 clipart images and symbols, or use CorelTRACE to automatically trace scanned images and bitmaps. You can even import graphics from other packages and jazz them up in CorelDRAW.

And the CD-ROM version of CorelDRAW comes with over 3500 extra clipart images from ArtRight — a $2000 value. Thanks to the large storage capacity of the CD-ROM, we are able to offer top quality images and symbols in uncompressed format, for easy and instant access.

If you don't already have a CD-ROM drive, Corel offers a package that includes CorelDRAW, a high-performance CD-ROM drive and an easy to use CorelDRIVER SCSI interface kit. Corel offers you powerful plug and play solutions for all your CD-ROM needs, as well as access to the hundreds of exciting CDs available.

Ride the CD-ROM and multimedia wave today!
As you can see, there are few notebooks more affordable than the new 20 MHz Tandon NB/386sx. That's because our new notebook's only $3,495, a price thousands of dollars less than most other computers in its class. And in addition to great savings, you get a superior, full-functioning computer with standard features that are options on most other notebooks.

The ready-to-go Tandon NB/386sx boasts the 20 MHz Intel® 80386SX processor, the highest level of power you can get in a battery-powered notebook today. But that's just for starters. You also get a 30MB IDE hard drive and a 3.5" internal floppy drive, 2 MBs of memory expandable to a whopping 16MBs, and three hours of battery life. Not bad for a 6.5 lb. machine small enough to fit on this page.

The NB/386sx is extremely versatile, too. It has one parallel port and two serial ports. So you can plug into a large combination of devices like a printer, mouse, graphic tablet, or modem. At the office, you can connect up to an external monitor and keyboard, or even communicate with your company's larger computers.

And while the Tandon notebook may be extremely small, its extra large 9 inch, non-glare VGA display makes even the most complex graphics easy to read. The paper-white screen, specially designed to reduce eye strain, provides a sharp, bright image using triple super twist LCD technology.

Of course, with any Tandon Computer you also get the support you expect from a $400 million corporation. Prompt delivery, a one year limited warranty, and helpful toll-free tech support. We even offer a special leasing program. And if for any reason you're not pleased, you get a full refund within the first 30 days.

So if you're interested in a great little portable computer with desktop performance, call us today about the new Tandon NB/386sx or the Tandon NB/386sx, Model 60 with a 60MB hard drive, for only $3,995.

There are other ways to save thousands of dollars on a notebook, but just none quite as practical.
- $3,495
  Lease: As low as $123/month

- Non-glare, paper-white VGA screen

- 2 MBs of memory expandable to 16 MBs

WORK WITH A BETTER PRICE
18.6 Hz TANDON NB/386sx.
ONE WITH BETTER FEATURES.

"Tandon moves to the head of the class when you compare Notebook features you get for the dollars spent."  
Bye, March 1991

<table>
<thead>
<tr>
<th></th>
<th>Tandon NB 386sx/20</th>
<th>Compaq LTE 386sx/20</th>
<th>T.I. Travelmate 3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max RAM</td>
<td>16MB</td>
<td>10MB</td>
<td>6MB</td>
</tr>
<tr>
<td>Base RAM</td>
<td>2MB</td>
<td>2MB</td>
<td>2MB</td>
</tr>
<tr>
<td>Hard Drive</td>
<td>30MB</td>
<td>30MB</td>
<td>20MB</td>
</tr>
<tr>
<td>Hard Drive Option</td>
<td>60MB</td>
<td>60MB</td>
<td>40/60MB</td>
</tr>
<tr>
<td>Screen</td>
<td>VGA</td>
<td>VGA</td>
<td>VGA</td>
</tr>
<tr>
<td>Dimensions</td>
<td>8.5&quot;D x 11&quot;L x 2.1&quot;H</td>
<td>8.5&quot;D x 11&quot;L x 2.2&quot;H</td>
<td>8.5&quot;D x 11&quot;L x 1.8&quot;H</td>
</tr>
<tr>
<td>Weight</td>
<td>6.5 lb.</td>
<td>7.5 lb.</td>
<td>5.7 lb.</td>
</tr>
<tr>
<td>Price</td>
<td>$3,495.00</td>
<td>$4,399.00*</td>
<td>$5,499.00*</td>
</tr>
</tbody>
</table>

  Actual dealer prices may vary.

- 30-Day Money Back Guarantee
- 1-Year Limited Warranty
- 24-Hour Toll-Free, On Call Technical Support
- Leasing Program Available

Tandon moves to the head of the class when you compare Notebook features you get for the dollars spent.

Tandon reserves the right to amend specifications without notice: Tandon 486, Tandon 386, SL386/SX, SL 486, LT/286, LT/386, SL386/SX, SL 386, LT/486, NB/386, Tandon Tower 386, Tandon Tower 486, PowerPointer, MURCACHE and MAT are trademarks of Tandon Corporation. Intel is a registered trademark of Intel Corporation. All other products or services are identified by the trademark or service marks of their respective companies. Lease terms vary by system. ©1991 Tandon Corporation, Moorpark, CA.

Circle 306 on Inquiry Card.
A New Workstation Standard

Not since the introduction of the IBM RISC System/6000 has there been such an impressive introduction in the RISC workstation market as the HP/Apollo 9000 Series 700. But, unlike the RISC System/6000, the Hewlett-Packard Precision Architecture (PA) RISC processor is not completely revolutionary; earlier versions have been used in HP minicomputers since 1986.

In the Series 700, the CPU board contains three fin-cooled large-scale CMOS chips: the FPU, the CPU, and the memory and I/O controller chip. High-speed graphics-related operations are integral to the design of the CPU board rather than being implemented as a separate unit. The FPU has special instructions for three-dimensional graphics, including inverse square root. The CPU includes the integer processing unit and the memory management unit. The memory and I/O controller chip is specially designed for high-speed graphics, including z-buffering. The 256K bytes of data cache and 128K bytes of instruction cache (256K bytes on the Model 750) are separate chips.

The CPU board can hold 64 megabytes of RAM (128 MB with a daughterboard on the Model 750). Because of the large amount of memory involved, HP/Apollo uses error-checking and correcting RAM. Any multibit memory errors can be diagnosed, and any single-bit errors are both diagnosed and corrected.

A few elements of the new PA-RISC design have migrated from Apollo's PRISM design: the multiply/add and multiply/subtract compound instructions (the RISC System/6000 has similar instructions) and graphics operations that are closely integrated with the CPU instruction set. The PA-RISC design does not include innate multiprocessing, a feature of Apollo's PRISM RISC. Unfortunately, the use of PA-RISC in the Series 700 signals the death of the PRISM.

Software designed for older versions of PA-RISC can run on the newer versions without recompilation. Therefore, more than 3500 applications are immediately available for the Series 700 workstations. The HP/Apollo 9000 Series 700 consists of three models: the 720, a desktop design running at 50 MHz; the 730, a desktop design running at 66 MHz; and the 750, a desktop design also running at 66 MHz, but with an internal capacity of 192 MB of RAM and 2.6 gigabytes of disk storage.

The system box for desktop designs is 20 inches wide by 17 1/2 inches high. All systems are highly modular: The separate elements (i.e., disk, CPU, power, communications, and video) are built as drawers that slide out of the back of the units. The SCSI-2 link between the disk drive module and the communications module is created with a short external cable rather than through an internal communications bus.

Besides the SCSI-2 port, the communications module includes two serial ports, a Centronics parallel port, thin and thick Ethernet ports, an audio speaker jack, and the HP interface loop jack for the keyboard, mouse, and user input devices.

The high-end models include from one to four EISA slots. Besides the array of existing third-party EISA boards, you can order a Series 700 with an optional fast SCSI-2 bus that delivers 10 MB per second.

When we designed the Unix benchmarks (see "The BYTE Unix Benchmarks," March 1990), the DECsystem 3100 was the fastest machine in the desktop workstation class. Our benchmarks seemed to have plenty of headroom for higher performance. Less than a year later, however, we found that the RISC System/6000 (with more than 50,000 Dhrystones) had driven the benchmarks to the limit, so we began developing a new set of benchmarks.

The HP/Apollo 720 exceeded many of our original tests. Unofficial tests show that it was giving more than 80,000 Dhrystones. Unfortunately, our new benchmarks are not yet released, so we can give only rough numbers on performance. But there is no question that these machines outperform not only all the Sun machines in their price range, but also the RISC System/6000, MIPS machines, and others. The HP/Apollo machine showed even higher floating-point performance over the RISC System/6000. We will publish actual figures along with our new Unix benchmarks. For the time being, there is no reason to doubt HP/Apollo's claims of from 57 to 76 million integer instructions per second (depending on the model) and from 17 to 22 million floating-point operations per second.

The Model 720 CRX with two 210-MB hard disk drives and 32 MB of RAM is the fastest workstation BYTE has looked at to date. Even with the low-end color display board, the Motif displays are instantaneous. Because the display processing is integral to the CPU design, the display speed is nothing less than phenomenal.

The User’s Perspective

Despite IBM’s effort to capture the lead in the RISC workstation market, Sun Microsystems still has a firm grip on the posi-
The ELEX Electronic Filing System (EEF) is a hardware/software system designed to reduce the frightening volumes of paperwork that burden businesses on a daily basis. As paper is eliminated, transactions are made in a fraction of the time required by traditional means, costly storage facilities are reduced, data security and integrity is enhanced, and work quality and quantity is increased. These factors all give companies and individuals the competitive advantage they need to excel in the business environment of the 90's.

Filing vs. Archiving

Document image processing is a new technology which has just begun to evolve. The myriad of hardware devices on the market, and the lack of an industry standard protocol for communicating between them, make the integration of an electronic filing system a formidable task. And without intelligent software to control all aspects of the storage, management, and retrieval of documents, the filing system will be nothing more than a micro-fiche machine in disguise.

With these considerations in mind, EEF was designed as a turn-key solution which relieves the clients of all the intricacies involved in integrating a truly functional electronic filing system. Yet its flexible design allows continuous and smooth upgrade as the users needs grow and change.

Open Architecture

EEF is designed as a totally open architecture system. Rather than being a closed package, EEF is composed of individual building blocks defined by their area of electronic filing functionality. These blocks are not bound to specific hardware/software limitations. As such, they can be combined in a variety of forms on each of the following operating platforms, to achieve optimal satisfaction of an application's specific demands:

- A single user workstation under the DOS or the OS/2 operating system.
- A local area network - Novell NetWare 286 and higher or any DOS 3.1 compatible network.
- A host computer under the UNIX, VAX/VMS or IBM AS/400 system with a PC connection.

EEF Applications

The EEF system opens a vast new world of opportunities for you. The possible applications are limitless, and to name a few:

Management Systems

Any application which requires original documents and forms (e.g. verification of signatures and L/C in the banking area).

Scientific and Engineering Data

Any application in these fields that requires maps, charts, logs, sketches, etc.

Medical Uses

The kind of visual information which is so essential for medical applications is handled by EEF in a natural, straightforward manner.

Art Catalogs

Making multi/media presentations of art works, for example at auctions, can provide an exciting new display method.

Real Estate / Travel Agency

EEF can be used to take the customers on an on-site electronic tour without ever leaving the office, thus shortening the process of selection.

EEF Pilot System

For prospective clients wishing to enter the field, we have prepared a pilot system, enclosing in one package the full range of functions necessary for electronic filing. The system components are:

Hardware

386 base micro-computer at 33MHz with 64K cache, 8 MB RAM, 1.2GB with access time of 0.8MS (disk caching), proprietary scanner and printer interfaces, high resolution (1660 x 1200) CRT display, laser printer 300 dpi at 8 ppm, scanner 300 dpi with 100 page feeder.

Software

The EEF software package, including the document manager, the retrieval engine, the hypermedia interface, and 20 hours of customization services.

Total cost for the pilot system is $30,000 US$. For further details and literature, please contact:

EUROPE: ELEX INFORMATION SYSTEMS SA
65, Rue de Lausanne 1202 Geneva Switzerland Tel. + 41 22 738 11 88 Fax. + 41 22 738 11 90
USA: ELEX INFORMATION SYSTEMS INC.
125-127 North 4th Street Philadelphia, PA 19106 USA Tel. + 1 215 627 7202 Fax. = 1 215 627 2342.

Trademarks: DOS, OS/2, Microsoft Corp; NetWare, Novell, Inc.; UNIX, SCO Corp; AS/400, IBM Corp; VAX/VMS, Digital Equip. Corp.

Circle 102 on Inquiry Card.
Motorola-based workstations from HP and Apollo are commonplace, but they’re certainly no match for the RISC market, which is dominated by SPARC- and MIPS-based machines. SunView and OpenWindows have attracted many developers and purchasers. Motif may be pretty, but it leaves much to be desired when compared to the Sun interfaces. Motif requires additional software for file management and session control.

HP’s VUE has everything that is missing from Motif, including an excellent file manager that not only looks better than Looking Glass (Visix Software) and X.Desktop (IXI), but uses windows in an economical way. An outstanding (for Motif) feature of the VUE file manager is the drag-and-drop action associated with the file icons: Drag a text file to the printer icon, and the file prints. Drag it to root (background), and you are editing it.

The Workspace Manager is completely configurable, but only with some editing of two quite technical description files (a trait found with most Motif applications). But the default design and two other samples will cover the taste range of most users. The default VUE Workspace Manager control bar includes a clock, date, system load plot, mail, hpterm, printer, file manager, application manager, trash bin directory, help, terminal lock, resources control (Style Manager), and virtual screen menu.

The system administration and documentation interfaces aren’t nearly as impressive as VUE, but they’re still the best you will find on any system.

The version of HP-UX (HP’s license of Unix) seems particularly robust. Unlike Apollo’s Domain, this is a real Unix kernel and operating system, with HP’s own mix of Berkeley Standard Distribution and System V utilities and system calls. HP is very much part of the Open Software Foundation camp and, along with DEC, is promoting the move to OSF/1. HP-UX 8 complies with more elements of more standards than I care to list here. I’ll just say that this system will fit into any Unix environment. The speed of the display and X Window System implementation is so fast that applications running on remote machines are at least as fast as on the host, and in most cases faster.

The only criticism that I have as a user is focused on an inexpensive, although important, component: the keyboard. The keys feel loose, the tactile feedback is minimal, and the Escape key is combined with the Delete key (shifted) and placed in an unconventional position in the lower left.

Potent Portables for Power Purchasers

Since its acquisition last year by Groupe Bull, Zenith Data Systems has been unusually quiet. Once known for regularly rolling out innovative computer products, the company’s apparent lack of activity led some pundits to assume that ZDS’s aggressive days were over. Wrong. It has come blasting back with a raft of new computers. I had a chance to take an early look at two trailblazing products: the first shipping notebook computer based on Intel’s cutting-edge 386SL chip set, and a top-of-the-line i486-based portable.

The MastersPort 386SL is an example of the first truly innovative technology for PCs in years. It’s based on Intel’s 386SL, a two-chip set that lets computer makers build portable PCs with a minimum of parts. Although this means less...
When you think about it, a one-size-fits-all mouse makes as much sense as a one-size-fits-all shoe. That's why Logitech created MouseMan—the first line of mice designed to fit different kinds of hands. All MouseMan products are ergonomically shaped for comfort and ease of use. They're also totally plug compatible with the Microsoft mouse. Of course, all come with Logitech's legendary quality and lifetime warranty.

MouseMan for the Right Hand

MouseMan for the Left Hand

MouseMan Cordless Radio Mouse

For more information, call:

800-231-7717 ext. 2606

In CA: 800-552-8885 ext. 2617.

Circle 179 on Inquiry Card (RESELLERS: 180).

MouseMan for the Right Hand and MouseMan for the Left Hand are for IBM PC's and compatibles and Macintosh® systems. MouseMan Cordless is for IBM PC's and compatibles only (TMVR). Trademarks and registered trademarks of their respective holders.
A PC that looks good in your office won't look good for long out in the plant. Heat murders microprocessors. Dust decimates disk drives. Vibration victimizes video cards. Any or all can wreck your entire operation.

The Texas Micro line of rugged, reliable ISA Bus products and systems are specifically engineered for those brutal industrial environments that eat pretty PCs for breakfast.

**Durability built in from scratch**

To ensure maximum durability we design and manufacture from scratch practically everything that goes into our systems, like passive backplanes which we pioneered for microcomputers in 1983. These backplanes accommodate a full complement of convenient, plug-in components, all compatible with Compaq DeskPro.® They're why our Mean Time To Repair (MTTR) is a phenomenal 10 minutes.

You won't find passive backplanes — or lower MTTR — in any of the leading office PCs.

**More options mean more choices**

We also build industrial-strength option cards to handle myriad functions, in addition to our 286, 386SX,™ 386DX™ and 486™ CPU cards in a full range of processor speeds. Our CPU card designs use Very Large Scale Integrated circuits and programmable array logic devices to reduce component counts by 50–60% which enhances reliability and resistance to physical stress. Ultimately, the design contributes to our remarkably long Mean Time Between Failures (MTBF): 70,000–100,000 hours, calculated against the MIL Standard Handbook 217E.

You won’t find that kind of card selection — or MTBF — among the leading PC makers.

**We pretest, test, and then retest**

You won't find them torturing their systems like we torture ours either. Not only do we perform extensive "shake, rattle and roll" tests on each new design, we pretest all our systems before they leave our dock. We burn them in at 55C/131F for 48 hours straight.
just to make sure they can take the heat.

What’s more, we shock mount our disk drives to stand up to vibrations surpassing Richter scale proportions and we use only high-reliability power supplies that can go for 100,000 hours MTBF.

Our guarantee is your guarantee

With all this reliability designed into our products, is it any wonder that we guarantee better support than any of the other leading PC makers? Every system comes with a full one-year, on-site warranty. Theirs don’t. We also offer a toll-free number for technical and sales information, a regional network of sales engineers and engineering support for system integration.

Why the competition is no competition

<table>
<thead>
<tr>
<th></th>
<th>Backplane architecture</th>
<th>Shock mounted drives</th>
<th>48 Hour burn-in at 131 degrees</th>
<th>Total ISA slots</th>
<th>100,000 MTBF</th>
<th>Power supply</th>
<th>Built like an M1A1</th>
<th>Manufacturers SRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaq 386SX Model 84</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>5</td>
<td>No</td>
<td>No</td>
<td>$3699</td>
<td></td>
</tr>
<tr>
<td>Texas Micro 2003</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>10</td>
<td>Yes</td>
<td>Yes</td>
<td>$3950</td>
<td></td>
</tr>
</tbody>
</table>

Both systems similarly configured with 2MB RAM, Texas Micro-104MB hard drive, COMPAQ-84MB hard drive, 1.2MB floppy, VGA graphics, keyboard, monitor not included, purchase price discounts may vary by quantity and reseller.

Tough systems at gentle prices

The leading office PCs may look prettier than ours. But our industrial-strength systems are designed to be more reliable, and to do it for no more money than it costs for the fancy office system.

Which makes a Texas Micro PC look a whole lot better in two places where it really counts:

Your production line and your bottom line.

For technical or sales information, call:

1-800-627-8700

Texas Micro

Mission Critical Benchtop 2003: With 10 option slots and 2 drive bays the 2003 makes desktop computing possible in extreme environments. A complete 386SX system from $3950 without monitor.
NEWS
FIRST IMPRESSIONS

power, there’s a lot more than meets the eye in the 386SL. The 20-MHz processor and its associated I/O subsystem controller have quite a few power-saving tricks up their sleeves.

ZDS engineers have always specialized in designing systems with pioneering power-saving technology. They’ve taken the 386SL chip set, pushed it to the limit, and then added their own bells and whistles. The end result is a system that you essentially never need to turn off. There are standby and rest modes that will save your work for what the company claims is up to three weeks. This is done using a variety of interesting tricks.

For example, the system state is stored in two places. First, ZDS uses slow-refresh (128-ms) RAM that’s one-eighth the speed of conventional RAM (and uses less power). Also, the system state is saved in a special secure area of the built-in Conner Peripherals 60-megabyte Intellic Drive Electronics hard disk drive. The SL chip set can also dynamically turn ports on and off as they’re needed. Admittedly, few of us would leave a machine unused and turned on for three weeks. What the design of the MastersPort 386SL really means is that it’s the first notebook that you can use battery-powered for a full day of note taking and other work. It’s important to note that there’s nothing particularly special about the battery system; it’s all done through power management. When the system is resting, it draws a paltry 40 milliamperes of power. This sort of thing just wasn’t possible before.

Physically, the system is a little wider than the now-standard 11½ inches of most notebooks. Its 12½-inch width leaves room for an almost-full-size keyboard. And it still fit easily into my briefcase. The MastersPort 386SL weighs in at 6½ pounds and comes standard with 2 MB of RAM, a 1.44-MB floppy disk drive, and a 32-shade gray-scale VGA backlit supertwist display. There’s also room inside for an optional 2400-bps MNP level 5 modem.

Innovation isn’t inexpensive. Although the exact price of the MastersPort 386SL hadn’t been set at press time, it’s expected to retail for about $5800.

ZDS also introduced a top-of-the-line portable: the SupersPort 486. It’s available in two incarnations: one based on the new 25-MHz i486SX chip (sans math coprocessor), and the other with a full-fledged 25-MHz i486 chip. If you remember the TurboPort 386 (the first 386 portable), you won’t be surprised by the design. The new machine is similar, with a detachable keyboard. The keyboard has a built-in IsoPoint, the interesting “roll-and-slide” substitute for a mouse.

The SupersPort 486 is loaded: 4 MB of RAM, a 120-GB hard disk drive, and a 64-level VGA display are standard. There is even room inside the case for a 4½-length ISA add-in card. The unit—complete with a magnesium case—weighs 15 pounds with its standard battery pack. Detach the pack, and it weighs 10 pounds. Most users are likely to use this behemoth near an AC plug, and there’s an optional docking unit (with ports and power supply) for the deskbound SupersPort user. Its price hasn’t been set yet.

Systems like these show that ZDS hasn’t been sitting still while the rest of the industry moves ahead. With the MastersPort 386SL, it has leapfrogged the competition in one fell swoop. Certainly, many other manufacturers will soon introduce SL-based systems, but if you want one now (and I sure do), ZDS is the only game in town.

—Stan Mistasowski

Turbo Pascal Makes Windows Programming a Breeze

At last someone did it—brought out a relatively mainstream compiler that runs in the Microsoft Windows environment and produces Windows programs. The surprise is not just the company that did it, Borland, but also the language, a Borland mainstay—Turbo Pascal. Many people considered it a surprise that Microsoft didn’t have a QuickBASIC for Windows included as part of Windows 3.0. It left a programming gap that couldn’t be quite closed by the likes of The Whitewater Group’s Actor or Microsoft C 6.0 and the Windows Software Development Kit. Fortunately, Turbo Pascal for Windows goes a long way toward closing that gap.

The program operates completely within the Windows environment. However, one major part, the debugger, is still a character-based application running
Tektronix introduces the first color printer that's software-based PostScript-compatible for less than $5000. Our new Phaser II SX is great for individuals or small groups. It works with Windows 3.0 or Macintosh QuickDraw using brilliant 300 dpi thermal-wax color.

For bigger businesses, we have the Phaser II PX. It's PostScript-compatible with HP-GL and licensed by Pantone. It works with Macs, PCs, and UNIX workstations. At the same time. And, like all our other printers, it's upgradeable so you'll never outgrow it.

So give us a call at 1-800-835-6100, Dept. 14J for more information. Because no other color printer looks this good on paper.

The best and the brightest.

PostScript is a registered trademark of Adobe Systems, Inc. Phaser is a trademark of Tektronix, Inc. Copyright © 1991 Tektronix, Inc. All rights reserved.

Circle 309 on Inquiry Card (RESELLERS: 310).
under Windows, rather than a fully Windows-based program. In terms of the language, little has been changed. Many regular Turbo Pascal for DOS programs that stay in character mode will run right away with one tiny change—renaming the Crt unit as the WinCrt unit. These programs run in a default window under Windows that acts like a view onto a text screen but which can be moved, resized, scrolled, and so forth.

Programs that use the Borland Graphics Interface are out of luck, as are those that try to play lots of tricks with DOS or directly access machine hardware. They will have to be completely rewritten to use Windows calls instead. It also isn’t possible to write applications that are intended to run just under DOS. Turbo Pascal for Windows will write programs to run only under Microsoft Windows.

Fortunately, Borland goes a long way toward making this an easy task. Only one tool, The Whitewater Group's Resource Toolkit, is required. It is included and also runs under Windows. Best of all, Borland has included a powerful and easy-to-use object library for Windows programming called ObjectWindows. ObjectWindows abstracts the development of Windows interface code so that it is much easier for the Turbo Pascal programmer to deal with. For example, a Hello World program written using Turbo Pascal and straight Windows calls takes about 100 lines of code. An identical ObjectWindows program takes only 16 lines of code. I found ObjectWindows a great benefit, especially for the user new to Windows programming.

Turbo Pascal for Windows can also write and use Windows dynamic link libraries. This lets you make use of existing code from other languages or write sections of another program in different languages, as appropriate. An in-line assembler is included, as is a command-line version of the compiler for use with make files. Full context-sensitive help is included.

All in all, Turbo Pascal for Windows is a powerful and straightforward way to do Windows programming, especially for the Pascal enthusiast. It offers a great deal of power and a good deal of help in dealing with the complexities of Windows. While it’s not as powerful for programming Windows in depth as Borland’s C++ or Microsoft C, it does make Windows programming more approachable.

—Owen Linderholm

### The Facts

<table>
<thead>
<tr>
<th>Turbo Pascal for Windows</th>
<th>$249.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements:</td>
<td>A 286 or better with Windows 3.0, 2 MB of RAM, and a hard disk drive.</td>
</tr>
<tr>
<td>Borland International, Inc.</td>
<td>1800 Green Hills Rd.</td>
</tr>
<tr>
<td></td>
<td>P.O. Box 66001</td>
</tr>
<tr>
<td></td>
<td>Scotts Valley, CA 95067</td>
</tr>
<tr>
<td></td>
<td>(408) 438-8400</td>
</tr>
<tr>
<td></td>
<td>fax: (408) 438-8696</td>
</tr>
<tr>
<td>Circle 1170 on Inquiry Card.</td>
<td></td>
</tr>
</tbody>
</table>

### GPF Shortcuts Presentation Manager Development

When I think of France, I think of the cathedrals at Chartres and Mont-Saint-Michel, of the wines, and of bicycles and racing cars. I didn’t think of software in connection with France, until now. From Microformatic in Montreuil-Sous-Bois comes the GUI Programming Facility (GPF), one of the more complete application generators for OS/2 Presentation Manager (PM) I’ve seen.

It’s more than a little work to write an OS/2 PM application, especially one that queries databases. You have to copy the code skeleton from a sample application, edit your own menu structure, design all your dialog boxes, and finally write the code to tie menu actions and dialog box controls to actual operations.

Once you get to the point of writing code, the edit-compile-link test for a PM application of any size can be tedious. On a fast machine, even a small PM program can take several minutes to build; on a not-so-fast machine, a sizable PM program can take hours to build. Using embedded Structured Query Language slows down the process even more by adding SQLPrep and SQLBind steps to the already time-consuming compile, link, and resource compile steps.

GPF short cuts the PM development process in several ways. First, you don’t have to write any user-interface code. You design the menus and dialog boxes in GPF, and it generates all the UI and SQL source code you need: not only the resource files, but also the C code (with comments and embedded SQL), a skeleton help file for the Information Presentation Facility, and a make file.

Second, you don’t have to go through the code-generation, compile, and link steps very often. GPF has an “animator” that interprets your interface definitions to simulate an actual running program. And finally, you don’t have to do nearly as much bookkeeping and debugging with GPF as you would writing the code by hand. GPF keeps track of all the information in one centralized database, and it always generates the correct code for the interface you’ve designed.

Quite a feat, actually. GPF combines a design facility with a design interpreter and a code generator. Add to that a large assortment of predefined actions, and you have a tool that can really save you time.

The version I’m working with has about 45 predefined...
It's no joke. A survey conducted among computer users recently revealed that half of them have lost time and money because of accidental data loss. Perhaps that explains why so many people have felt compelled to make the jump.

From other disks to Verbatim®. After all, no other disks in the world guard against accidental data loss better than ours.

Take our DataLifePlus® disks, for example. They're the only disks on earth protected by an exclusive Teflon® coating. Which means you can actually wipe fingerprints, dust, even pencil shavings off the recording surface. Without wiping out your valuable data.

Even more remarkable is our 5¼-inch Rewritable Optical Disk. It has the capacity to store twelve file drawers full of paperwork. Yet because it uses laser technology, it's virtually incapable of losing data. Verbatim also offers high performance data cartridges, color disks and more.

And all of our products are certified 100% error-free and backed by a lifetime warranty. So next time, insist on Verbatim. Because trusting your data to anybody else would definitely be a step in the wrong direction.
**THE FACTS**

**GUI Programming Facility**
$3500

**Requirements:**
OS/2 Extended Edition 1.2 or higher, 6 MB of RAM, IBM or Microsoft C compiler, and OS/2 toolkit.

Microformatic U.S.A., Inc.
26 Plains Rd.
P.O. Box 571
Moodus, CT 06469
(203) 873-1950
fax: (203) 873-2171

Microformatic, S.A.
2 Rue Navoiseau
Montreuil-Sous-Bois
93100 France
01-11-3-1-4870-1900
Circle 1171 on Inquiry Card.

---

**First Impressions**

action objects, which are pieces of code to do a specific task—in other words, a function. I'm told that list is about to double, and it will continue to grow as the product evolves. Buyers of GPF get automatic updates for one year from date of purchase.

I should also mention GPF's support of the IBM OS/2 Database Manager. GPF knows all about making SQL database queries and automatically includes the SQLPrep and SQLBind steps when generating code for the DBM. That's a big plus for the product. The GPF Animator can run the SQL queries interpretively—another big plus.

On the negative side, the Animator requires you to have IBM's SQL dynamic link library on your machine, whether or not you want to develop database code. So, if you want the benefits of the Animator, you must have Extended Edition. You can use GPF without the Animator on Standard Edition, but you will waste a lot of time waiting for the Compiler. (A spokesperson for Microformatic says there will soon be a full-fledged version that will run on Standard Edition.)

GPF is similar to the less expensive CASE:PM from Caseworks, but it does more. GPF has its own window and dialog box editor; CASE:PM doesn't. GPF gives you more control over presentation objects, supports SQL, lets you place control in client windows (not just in dialog boxes), and animates your design. GPF's predefined action objects save you writing a lot of UI code that you would have to write with CASE:PM. And GPF links your custom code to the design at the design level, so you never have to edit the generated code; CASE:PM forces you to fiddle with the generated code, although it can usually recognize and preserve your custom code when it regenerates.

If you care at all about developing ordinary PM applications, GPF is a tool worth considering, assuming you can deal with the prerequisites. But if you want to develop small, fast PM applications that access IBM's DBM, GPF is likely to save you a lot of time and money.

—Martin Heller
Actor™ just got friendlier...

...and Windows™ programming easier!

Actor is an interactive development system for both beginning and advanced Microsoft Windows programmers. Relying on the most modern object-oriented programming techniques, Actor boils down the complexities of the Windows API to a few simple, but powerful, principles called ObjectWindows™. Actor delivers ObjectWindows™ in an easy-to-use programming environment ideal for learning Windows while writing your programs one step at a time. Add to this support for C libraries and DDE, and you've got the fastest route to Windows.

Actor 3.1 with Object-Windows™

Everything you need to start developing Windows applications. The quickest way to learn about Windows programming. Runtime generation system not included.
List: $249  Ours: $99*

Actor 3.1 Professional with Object-Windows™

Includes Actor 3.1, The Whitewater Resource Toolkit™, Object-Graphics™ class library, and runtime generation system. Everything you need to develop and distribute unlimited copies of your Windows applications.
List: $495  Ours: $399

Actor is an award winning product:

Finalist, Technical Excellence Award, 1988, 1990
PC Magazine

Winner, Programmer's Productivity Award, 1990
Computer Language Magazine

Best in its Class, 1989
Info World

The Whitewater Group™

SPECIAL OFFER!!

Actor 3.1 FOR $99
Reg. List Price $249
Exp. 6/30/91

Call Programmer's Paradise Now!

1-800-445-7899
Corporate: 800-422-6507
CORSOFT Division
International: 908-369-9228
Customer Service: 908-369-9229
Canada: 800-445-7899
Fax: 908-369-9227
FAXservice 908-369-8173

Policies
Phone Orders
Mon-Fri 8:30 AM-7 PM EST, Sat 9:30-2:30 EST. We accept MC, Visa, AMEX. Domestic shipments, please add $5 per item for shipping/handling by UPS ground. For domestic COD shipments, please add $3. Rush service available.
Mail or FAX / International / P.O.s
Phone number required with order.

Circle 257 on Inquiry Card.

Call 908-369-8173 from your FAX telephone, and follow the instructions to receive more information on the products featured above!

POLICIES
Phone Orders
Mon-Fri 8:30 AM-7 PM EST, Sat 9:30-2:30 EST. We accept MC, Visa, AMEX. Domestic shipments, please add $5 per item for shipping/handling by UPS ground. For domestic COD shipments, please add $3. Rush service available.
Mail or FAX / International / P.O.s
Phone number required with order.

*For a limited time only.
Tailor your volume purchase agreements.

Returns
Subject to $25 processing charge.
* All prices subject to change without notice.


**DEVELOPMENT SOFTWARE**

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>386 Development Tools</td>
<td></td>
</tr>
<tr>
<td>386 VM&amp;M</td>
<td>295</td>
</tr>
<tr>
<td>386/386DOS Extender SDK</td>
<td>495</td>
</tr>
<tr>
<td>Intel 386 C Code Builder</td>
<td>695</td>
</tr>
<tr>
<td>Lahey F77-LM/21 (w OS/286)</td>
<td>1390</td>
</tr>
<tr>
<td>MetaWare High C 386</td>
<td>995</td>
</tr>
<tr>
<td>OS/286 Developer's Kit</td>
<td>665</td>
</tr>
<tr>
<td>WATCOM C 6.0/386 Prof. w/MS/386 Extender</td>
<td>1295</td>
</tr>
<tr>
<td>WATCOM C 6.0/386 Standard</td>
<td>895</td>
</tr>
<tr>
<td>WATCOM FORTRAN 77/386</td>
<td>1005</td>
</tr>
<tr>
<td>Zortech C++ Devel. Ed. 386</td>
<td>995</td>
</tr>
<tr>
<td>Assembly Language</td>
<td></td>
</tr>
<tr>
<td>Advantage Disassembler</td>
<td>255</td>
</tr>
<tr>
<td>MS MacroASM</td>
<td>150</td>
</tr>
<tr>
<td>Source w/ Pro-Processor</td>
<td>170</td>
</tr>
<tr>
<td>SpontaneousAssembly</td>
<td>195</td>
</tr>
<tr>
<td>Turbo Debugger &amp; Tools</td>
<td>150</td>
</tr>
<tr>
<td>C++</td>
<td></td>
</tr>
<tr>
<td>Borland C++</td>
<td>465</td>
</tr>
<tr>
<td>++/Views</td>
<td>419</td>
</tr>
<tr>
<td>Rogue Wave Tools++, ++</td>
<td>200</td>
</tr>
<tr>
<td>Turbo C++</td>
<td>170</td>
</tr>
<tr>
<td>ZZ ++</td>
<td>255</td>
</tr>
<tr>
<td>Zinc for DOS</td>
<td>200</td>
</tr>
<tr>
<td>Zinc for DOS &amp; Windows</td>
<td>300</td>
</tr>
<tr>
<td>Zortech C++</td>
<td>165</td>
</tr>
<tr>
<td>Zortech C++ Database</td>
<td>305</td>
</tr>
<tr>
<td>Zortech C++ Develer's Ed.</td>
<td>450</td>
</tr>
<tr>
<td>C++/Bundle</td>
<td></td>
</tr>
<tr>
<td>Borland C++ and 3 in 1 C++</td>
<td>475</td>
</tr>
<tr>
<td>Communications</td>
<td></td>
</tr>
<tr>
<td>Essential Communications</td>
<td>325</td>
</tr>
<tr>
<td>Greendale CommLib</td>
<td>279</td>
</tr>
<tr>
<td>SilverComm &quot;C&quot; Mycnic Library</td>
<td>245</td>
</tr>
<tr>
<td>C-Compilers</td>
<td></td>
</tr>
<tr>
<td>Instant C 5.0</td>
<td>405</td>
</tr>
<tr>
<td>Microsoft 3.0</td>
<td>300</td>
</tr>
<tr>
<td>w/MS Software Dev. Toolkit</td>
<td>700</td>
</tr>
<tr>
<td>w/Objective-C</td>
<td>599</td>
</tr>
<tr>
<td>MS QuickWin w/QuickAssembler</td>
<td>190</td>
</tr>
<tr>
<td>WATCOM C++ Professional</td>
<td>465</td>
</tr>
<tr>
<td>WATCOM C++ Standard</td>
<td>355</td>
</tr>
<tr>
<td>C-File Management</td>
<td></td>
</tr>
<tr>
<td>Codebase IV</td>
<td>295</td>
</tr>
<tr>
<td>c-tree Plus</td>
<td>555</td>
</tr>
<tr>
<td>dBcII Plus</td>
<td>439</td>
</tr>
<tr>
<td>Essential B-Tree w/source</td>
<td>195</td>
</tr>
<tr>
<td>The Toolbox - Prof. Edition</td>
<td>1065</td>
</tr>
<tr>
<td>The Toolbox - Special</td>
<td>595</td>
</tr>
<tr>
<td>G-General Libraries</td>
<td></td>
</tr>
<tr>
<td>C-Function Library</td>
<td>99</td>
</tr>
<tr>
<td>C-TOOLS PLUS/9.0</td>
<td>149</td>
</tr>
<tr>
<td>C Utility Library</td>
<td>249</td>
</tr>
<tr>
<td>Greendel Functions</td>
<td>239</td>
</tr>
<tr>
<td>Greendel Superfunctions</td>
<td>239</td>
</tr>
<tr>
<td>Turbo C TOOL2/9.0</td>
<td>149</td>
</tr>
<tr>
<td>C-Screens</td>
<td></td>
</tr>
<tr>
<td>C-Worthy</td>
<td>399</td>
</tr>
<tr>
<td>Green and DataWindows</td>
<td>395</td>
</tr>
<tr>
<td>Vermont Views</td>
<td>415</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>145</td>
</tr>
<tr>
<td>VC Screen</td>
<td></td>
</tr>
</tbody>
</table>
| WindowsMAKER** **PROFESSIONAL**

The fastest way to create Windows applications. Generates the Windows .EXE with complete source & production files (no royalties). Point & Click to define the user interface. Animate your design to instantly test its look & feel. Make changes on the fly without compiling. Custom code is preserved during code regeneration. A state-of-the-art programming tool. Supports C++.

List: $995  Ours: $795

**WATCOM C++/386**

Unleash 386 power on your Microsoft C code with WATCOM C++.9/386, a 100% ANSI C optimizing compiler and run-time library generating applications for 32-bit 386 protected mode. With C++.9/386, you can go beyond the 640K DOS limit. Library and source compatibility with Microsoft C simplifies porting 16-bit applications to the 386. Significant features include: full-screen source-level debugger, protected mode version of the compiler, execution profiler, linker, graphics library, run-time compatible with WATCOM F77/386. Standard List: $895  Ours: $719  Professional List: $1295  Ours: $969

**CLEAR FOR C**

Automatically creates accurate flowcharts, treecharts and source prints from any code, no matter how old, big or complex. Can save days of reading listings and taking guesses. Also provides instant presentation-quality documentation which increases perceived value of your work and impresses clients or managers. Powerful features: 3 preprocessor options, function cross-references, prototype files, detail control. Full support for most C compilers.

List: $290  Ours: $169

**BRIED 3.1 New Version!**
The programmer's editor, from Solution Systems, adds support for Microsoft mouse, EMS caching, and step-by-step Redo to all the features that have made BRIED the editor of choice for over 120,000 PC programmers worldwide. BRIED features multiple windows, template editing, smart indenting, search/replace, complete keyboard configurability, editable keyboard macros, a C-like macro language with source-level debugger and a powerful Undo for faster, more productive programming.

List: $249  Ours: CALL

**C-Utilities/Other**

| Bar Code Library             | 395   |
| Clear for C                  | 295   |
| INTERWORK                    | 189   |
| Label Master                 | 195   |
| Lex YACC                     | 249   |

**COBOL**

COBOL/2 Compiler & Toolkit 1900  Ours: 1699

**Database Development**

| Clarion Personal Developer   | 495   |
| Clarion Prof. Developer 2.1  | 645   |
| Database Graphics Toolkit    | 295   |
| DBASE IV                     | 179   |
| R&R Code Generator           | 159   |
| R&R Report Writer            | 249   |
| S/T for C++                   | 59    |
| SuperComm "C" Interface      | 99    |
| SilverComm Library 2.0       | 479   |

**Debuggers (DOS)**

| Periscope Debuggers          | CALL  |
| Trapper                      | 179   |
| CALL                         |       |

**Embedded Systems**

| CMS/PRO                      | 249   |
| Link & Locate ++             | 129   |
| Multi-edit Standard          | 99    |
| Multi-edit Professional      | 159   |
| Sage Professional Developer  | 249   |
| VDLIT PLUS                   | 179   |
| Wyper                       | 179   |

**FORTRAN Language**

| FORTRAN Dev. Tools           | 99    |
| Graphicro                           | CALL  |
| X-Y FORTRAN 77                  | 179   |
| MS FORTRAN                      | 459   |
| SALFORD FTN 77                  | CALL  |

**Graphics Libraries**

| Essential Graphics            | 339   |
| Graf/Trac Plus Developer's    | 269   |
| Graf/Print Developer's        | 325   |
| Graf/Print for Graphics       | 95    |
| Graf/Print Professional       | 75    |
| Graf/Print Plus               | 159   |
| graphics-MENU                 | 139   |
| graphics-MENU Data Entry      | 99    |
| GX Graphics                   | 139   |
| HALO                           | 375   |
| HALO Personal                  | 415   |
| HALO Window Toolkit            | 415   |
| Icom-Tools                    | 119   |
| PCK Effects                   | 99    |
| PCK Programmer's Toolkit      | 175   |
| PCK Text                      | 175   |
| Super-Pro-Pak                 | 99    |
| Turbo Geometry Library        | 209   |
| Z-PHIS Lite                    | 199   |
| Z-PHIS Professional           | 797   |

**Graphics Libraries**

<p>| Essential Graphics            | 339   |
| Graf/Trac Plus Developer's    | 269   |
| Graf/Print Developer's        | 325   |
| Graf/Print for Graphics       | 95    |
| Graf/Print Professional       | 75    |
| Graf/Print Plus               | 159   |
| graphics-MENU                 | 139   |
| graphics-MENU Data Entry      | 99    |
| GX Graphics                   | 139   |
| HALO                           | 375   |
| HALO Personal                  | 415   |
| HALO Window Toolkit            | 415   |
| Icom-Tools                    | 119   |
| PCK Effects                   | 99    |
| PCK Programmer's Toolkit      | 175   |
| PCK Text                      | 175   |
| Super-Pro-Pak                 | 99    |
| Turbo Geometry Library        | 209   |
| Z-PHIS Lite                    | 199   |
| Z-PHIS Professional           | 797   |</p>
<table>
<thead>
<tr>
<th><strong>APPLIED SOFTWARE</strong></th>
<th><strong>LIST</strong></th>
<th><strong>OURS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BLAST II</td>
<td>250</td>
<td>225</td>
</tr>
<tr>
<td>Crossstalk Communicator</td>
<td>99</td>
<td>CALL</td>
</tr>
<tr>
<td>Crossstalk for Windows</td>
<td>195</td>
<td>145</td>
</tr>
<tr>
<td>Crossstalk MK4</td>
<td>245</td>
<td>145</td>
</tr>
<tr>
<td>Crossstalk XI</td>
<td>115</td>
<td>115</td>
</tr>
<tr>
<td>Paramet</td>
<td>80</td>
<td>72</td>
</tr>
<tr>
<td><strong>Mathematics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Derive</td>
<td>250</td>
<td>215</td>
</tr>
<tr>
<td>Mathematica 386</td>
<td>695</td>
<td>625</td>
</tr>
<tr>
<td><strong>Op. Sys./Environments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS/2 Developer’s Kit</td>
<td>695</td>
<td>625</td>
</tr>
<tr>
<td>OS/2 DPMI Developer’s Kit</td>
<td>995</td>
<td>895</td>
</tr>
<tr>
<td>OS/26 Developer’s Kit</td>
<td>695</td>
<td>625</td>
</tr>
<tr>
<td>VMS/386</td>
<td>245</td>
<td>200</td>
</tr>
<tr>
<td><strong>Utilities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lotus 1-2-3 3.1</td>
<td>595</td>
<td>499</td>
</tr>
<tr>
<td>Microsoft Excel</td>
<td>495</td>
<td>349</td>
</tr>
<tr>
<td>Quattro Pro</td>
<td>495</td>
<td>329</td>
</tr>
<tr>
<td><strong>Spreadsheet</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>386MAXX5.0</td>
<td>130</td>
<td>114</td>
</tr>
<tr>
<td>BlueMAX</td>
<td>155</td>
<td>125</td>
</tr>
<tr>
<td>Central Point Backup</td>
<td>99</td>
<td>80</td>
</tr>
<tr>
<td>DIS DDC Professional</td>
<td>245</td>
<td>225</td>
</tr>
<tr>
<td>Dynamic Memory Control</td>
<td>80</td>
<td>72</td>
</tr>
<tr>
<td>Grasp 4.0</td>
<td>349</td>
<td>CALL</td>
</tr>
<tr>
<td>HiJaak 2.0</td>
<td>199</td>
<td>120</td>
</tr>
<tr>
<td>HolHeld</td>
<td>199</td>
<td>120</td>
</tr>
<tr>
<td>MDS Toolkit</td>
<td>245</td>
<td>199</td>
</tr>
<tr>
<td>Norton Anti-Virus</td>
<td>129</td>
<td>99</td>
</tr>
<tr>
<td>Norton Commander</td>
<td>149</td>
<td>99</td>
</tr>
<tr>
<td>Norton Utilities 5.0</td>
<td>179</td>
<td>129</td>
</tr>
<tr>
<td>Opt-Tech Sort/Merge</td>
<td>149</td>
<td>113</td>
</tr>
<tr>
<td>PC Tools Deluxe 6.0</td>
<td>143</td>
<td>95</td>
</tr>
<tr>
<td>PreCorser</td>
<td>96</td>
<td>79</td>
</tr>
<tr>
<td>SideKick 2.0</td>
<td>100</td>
<td>69</td>
</tr>
<tr>
<td>SpinPlus</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>SunShow EDIUN CEG</td>
<td>CALL</td>
<td>CALL</td>
</tr>
<tr>
<td>Switch-It</td>
<td>99</td>
<td>90</td>
</tr>
<tr>
<td>Tree 66</td>
<td>90</td>
<td>65</td>
</tr>
<tr>
<td>Zeno</td>
<td>269</td>
<td>225</td>
</tr>
<tr>
<td><strong>Word Processing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ami Professional</td>
<td>495</td>
<td>CALL</td>
</tr>
<tr>
<td>Microsoft Word for Windows</td>
<td>495</td>
<td>349</td>
</tr>
<tr>
<td>WordPerfect</td>
<td>495</td>
<td>CALL</td>
</tr>
</tbody>
</table>

**Thousands more products available! Call or fax today for your FREE catalog.**

**KnowledgePro WINDOWS**

Use KnowledgePro to build fast, royalty-free Windows applications in record time. Interactive design tools and a rich object-oriented language combine rapid development with low-level control. Built in hyper text and expert system features lets you create smart, easy-to-use solutions. Use DDE to create intelligent front-ends for Windows applications like Excel, Word and Superbase. Add your own extensions with DLLs written in C or C++.

**List:** $955  
**Ours:** $629

**Savings:** 34%

**3-in-1 C++ VERSION**

The first case tool for Windows programmers, it consists of a Screen Designer and a C++ Code Generator. The C++ Version emphasizes the window object-oriented design rather than just window programming. The detailed examples discuss the advantages of object-oriented design of encapsulation, inheritance and dynamic binding. The design difference between C and C++ code provides you an excellent instruction to master object-oriented design.

**List:** $1395  
**Ours:** $1399

**Savings:** $6

**Attention Corporate Customers**

**Call CORSOFT (800) 422-6507**

- Select from over 5,000 titles—and we special order too!
- Get quick delivery at great prices on Microsoft, Borland, Lotus,... We buy software directly from all the major publishers, and keep plenty of stock on hand. And we're now an authorized IBM software dealer!
- Ask about volume purchase agreements, contracts, and personally assigned inside & outside sales representatives.

CORSOFT is a Division of Voyager Software Corp

**1-800-445-7899**

**Corporation:** 800-422-6507 (CORSOFT Division)

**International:** 908-389-9228

**Customer Service:** 908-389-9223

**Canada:** 800-445-7899

**Fax:** 908-389-9227

**FAX-Tel:** (908) 389-8173

**1163 Shrewsbury Ave., Shrewsbury, NJ 07702**

**POLICIES**

**Phone Orders**
Mon-Fri 9:30 AM-7 PM EST, Sat 9:30-2:30 EST. We accept MC, Visa, AMEX. Domestic shipments, please add S5 per item for shipping/handling by UPS ground. For domestic COD shipments, please add S3. Rush service available.

**Mail or FAX / International / P.O.s**

**Fax number required with order.**

**FAX-Tel:** (908) 389-8173

**Call from your FAX telephone and follow the instructions to receive more information on the products featured above!**

**Corporate Accounts**

Call CORSOFT, our corporate sales division. Ask about volume purchase agreements.

**Returns**

Subject to $25 processing charge.

*All prices subject to change without notice.*
Power in a PeeWee Package

The PeeWee, a system that measures 1 1/4 by 10 by 8 inches and weighs just over 4 1/2 pounds with a 40-MB hard disk drive, is designed to be transported without a monitor and keyboard. The manufacturer says the PeeWee is not a portable PC but a powerful system for office and home.

Each 12-MHz 286 unit includes 1 MB of on-board memory (expandable to 2 MB), a 40-MB Intelligent Drive Electronics hard disk drive (expandable to 200 MB), a 9- or 14-inch monochrome monitor, and a keyboard. Its zero wait states include dual speeds, and it has a built-in 110-/220-V switching power supply, two serial ports, a parallel port, and a 3 1/2-inch floppy disk drive. Color and monochrome VGA monitors and a LAN adapter for E-Net are also available.

Price: $1095.
Contact: SAI Systems Laboratories, Inc., 911 Bridgeport Ave., Shelton, CT 06484, (800) 331-0488 or (203) 929-0790; fax (203) 929-6948.

---

Hand-Held with a Switchable Axis

Weighing less than 1 1/2 pounds with batteries and measuring 7 3/4 by 4 by 1 1/8 inches, the CT1000 is a hand-held computer operating at 10 or 4.77 MHz. The IBM XT-compatible device has 640K bytes of static RAM and uses memory cards in place of a disk drive.

The CT1000 includes a serial and a parallel port, a math coprocessor slot, and a clear resistive matrix touchpad over a 240- by 128-dot supertwist LCD. The display is software switchable for vertical or horizontal use. Current run-time libraries support only C, but you can develop an application in any language on your PC. Custom options are available.

Price: $2495; development kit, $4995.
Contact: CogiTech, Inc., 10 Birch Court, Goffstown, NH 03045, (603) 497-8898; fax (603) 497-8899.

---

More Power for the T1200XE

A 40-MB hard disk drive version of the T1200XE 286 notebook computer is available from Toshiba. Running at 12 MHz, the system has 1 MB of RAM (expandable to 5 MB) and a 3 1/2-inch floppy disk drive. Its 16-bit supertwist LCD has a 640- by 400-pixel resolution.

Price: $3799.
Contact: Toshiba America Information Systems, Inc., 9740 Irvine Blvd., Irvine, CA 92718, (800) 334-3445; in Canada, (800) 387-5645; fax (714) 583-3437.

---

Travel Light with a Touchscreen

The 16 1/2-pound TravLite 286 menu-driven touchscreen computer has a full-size backlit display with touch overlay and internal nickel-cadmium batteries. It has bar code, serial, parallel, keyboard, and docking connectors. Other features include integrated mouse emulation, zero wait states, 1 MB of RAM, and a 512K-byte EPROM. Options include digitized voice, a docking unit, and an integrated keyboard and case.

Price: $2495.
Contact: DFM Systems, Inc., 1601 48th St., West Des Moines, IA 50265, (515) 225-6744; fax (515) 225-7183.

---

Desktop Features on a Laptop

A 12-MHz 80C286 laptop with 1 MB of single in-line memory module memory (expandable to 4 MB), the 9000LT uses a Chips & Technologies NEAT chip set and a 40-MB hard disk drive. The 640- by 480-pixel VGA page-white, backlit screen includes 16 gray scales.

The 9000LT's internal rechargeable nickel-cadmium battery runs for more than 3 hours on a single charge, according to the company. The 16 1/2-pound unit comes with a battery-status report, a low-battery alarm, automatic shutdown of the hard disk drives and screen, and a 110-/240-V auto-switching power supply.

The unit's full-size keyboard features 80 keys, 12 function keys, and an embedded numeric keypad. Its one serial and one parallel port let you attach an external keyboard or monitor so you can create a Docking Station or use the laptop as a desktop computer.

Price: $1699.
Contact: Leading Technology, Inc., 10430 Southwest Fifth St., Beaverton, OR 97005, (800) 999-5323 or (503) 646-3424; fax (503) 626-7845.

---

The lightweight PeeWee is geared for home and office.
Personal Printing on the Mac

Low-cost, high-quality laser printing for the Mac is what GCC Technologies says you get from its $999, 4-ppm Personal LaserPrinter II. The PLP II features six Bitstream outline font families that let you reduce and enlarge text from 25 percent to 400 percent in 1 percent increments and rotate characters to any angle.

The print engine in the PLP II includes a patented toner recycling system, edge-to-edge printing, and a user-defined sleep mode. It also has an interactive LCD panel. An 8-ppm PLP IIIS and a 4-ppm Business LaserPrinter II (BLP II) are also available.

Price: $999; PLP IIIS, $1499; BLP II, $1999.

Contact: GCC Technologies, 580 Winter St., Waltham, MA 02154, (800) 422-7777 or (617) 890-0880; fax (617) 890-0822.

CD-ROM Drive Comes Outfitted

An external CD-ROM drive for less than $500 is available from Genesis. The GenStar 2000 drive comes with Microsoft DOS compact disc extensions, audio software, device driver software, a caddy, computer cable, audio cables for stereo hookup, and an interface card.

Price: $499; bundled with CD-ROM software, $699.

Contact: Genesis Integrated Systems, 1000 Sherard Pkwy., Suite 270, Minneapolis, MN 55426, (800) 325-6582 or (612) 544-4445; fax (612) 544-4347.

A Graphics Display in Three Frequencies

The Model RE9514 Super VGA color monitor for the PC offers three horizontal scanning frequencies (31.5, 35.2, and 35.5 kHz) and vertical frequencies of from 50 to 90 Hz. Compatible with VGA, Super VGA, and 8514/A cards, it has interleaved and noninterleaved resolutions: 1024 by 768 interleaved and 800 by 600 or 640 by 480 noninterleaved.

The monitor's 0.28-mm dot pitch of unlimited colors is combined on a nonglare screen with 90 degrees of deflection. Geometric distortion is held to less than 1.5 percent. Additionally, the Model RE9514's casing has a tilt-and-sitivel base and a shallow silhouette.

Price: $695.

Contact: Relisys, 320 South Milpitas Blvd., Milpitas, CA 95035, (408) 945-9000; fax (408) 945-0587.

A Desktop Video Publisher That's Portable

Mediator, from VideoLogic, converts computer graphics to NTSC or PAL video output. Able to change most PC or Macintosh display output signals into a composite or S-video signal, Mediator lets you record the output to VHS, S-VHS, Hi-8, and Video 8 tapes or display it on color or LCD video projectors, video monitors, or TVs.

The lightweight plug-and-play converter is easily transportable and automatically determines if the input source is PC graphics or a Mac. Using its backlight keypad menu, you can overscan or underscan, freeze a frame, sharpen the picture, align the graphics, and select the output.

Price: $2995.

Contact: VideoLogic, Inc., 245 First St., Cambridge, MA 02142, (617) 494-0530; fax (617) 494-0534.

Feed Your Data to a Panther

Based on Tandberg's TDC 3800 and TDC 3600 quarter-inch tape drives, the Panther Tape Backup Systems have capacities ranging from 60 to 525 MB. Backup/restore rates range from 5 MB per minute to 12 MB per minute. The high-end Panther model can back up 525 MB of data in less than 45 minutes, according to Tandberg.

For the PC, the Panther systems are available in internal and external configurations. Panther software is compatible with DOS, OS/2, Novell, Unix/Xenix, Pick, and LAN Manager.

Price: 60-MB internal system, $995; 525-MB external system, $2695.

Contact: Tandberg Data, Inc., 2649 Townsgate Rd., Suite 600, Westlake Village, CA 91361, (805) 495-8384; fax (805) 495-4186.

CD-ROM Drive Comes Outfitted

An external CD-ROM drive for less than $500 is available from Genesis. The GenStar 2000 drive comes with Microsoft DOS compact disc extensions, audio software, device driver software, a caddy, computer cable, audio cables for stereo hookup, and an interface card.

Price: $499; bundled with CD-ROM software, $699.

Contact: Genesis Integrated Systems, 1000 Sherard Pkwy., Suite 270, Minneapolis, MN 55426, (800) 325-6582 or (612) 544-4445; fax (612) 544-4347.

The low-cost Personal LaserPrinter II is for Mac users.

Feed Your Data to a Panther

Based on Tandberg's TDC 3800 and TDC 3600 quarter-inch tape drives, the Panther Tape Backup Systems have capacities ranging from 60 to 525 MB. Backup/restore rates range from 5 MB per minute to 12 MB per minute. The high-end Panther model can back up 525 MB of data in less than 45 minutes, according to Tandberg.

For the PC, the Panther systems are available in internal and external configurations. Panther software is compatible with DOS, OS/2, Novell, Unix/Xenix, Pick, and LAN Manager.

Price: 60-MB internal system, $995; 525-MB external system, $2695.

Contact: Tandberg Data, Inc., 2649 Townsgate Rd., Suite 600, Westlake Village, CA 91361, (805) 495-8384; fax (805) 495-4186.
Motherboard Convertibility

A two-in-one motherboard lets you have a 386 or 486 machine at the snap of a CPU. The board is based on the 386/i486 AT chip set from United Microelectronics. You can upgrade the board from a 386 to a 486 by changing the CPU and some jumpers.

The board includes selectable cache memory from 64 to 256K bytes and eight single in-line memory module sockets for up to 64 MB of RAM. It supports shadow RAM and the 80387.

Price: $635, without a CPU.
Contact: Zeny Computer Systems, Inc., 4033 Clipper Court, Fremont, CA 94538, (415) 659-0386; fax (415) 659-0468.

Work in DOS on Your Mac

The Orange386, a DOS coprocessor for the Mac, is a single-slot card that works in any Mac II, including the Ilsi. The card, which features a 16-MHz 386SX processor and 1 MB of expandable RAM, lets you run DOS in a Macintosh window as if it were a Mac application.

Two AT slots on the card let you attach any half-size or three-quarter-size (depending on your style of Mac) IBM add-on card, according to the company. You can also add an optional 80387 math coprocessor. The expandability of the RAM allows fully independent processing, according to Orange Micro, letting the Mac and the Orange386 work simultaneously on different applications.

An optional peripherals kit includes PC interface hardware.
Price: Starts at $2299; peripherals kit, $199.
Contact: Orange Micro, Inc., 1400 North Lakeview Ave., Anaheim, CA 92807, (714) 779-2772; fax (714) 779-9332.

Refresh Quickly on a Super VGA Board

PH6 Technologies has released the PH6 Super VGA board. The 16-bit board, with 1 MB of on-board memory, has a refresh rate of 70 Hz, which is said to be easier on the eyes than the standard 60-Hz rate.

Designed to provide up to 1024- by 768-pixel resolution in 256 colors, the board has a palette of 16.7 million colors. Features include automatic backup of the Setup program and built-in password protection. It supports CAD, desktop publishing, and word processing applications.

Price: $245 to $395.
Contact: PH6 Technologies Corp., 5819 Uplander Way, Culver, CA 90230, (213) 216-0055; fax (213) 216-4931.
Circle 1300 on Inquiry Card.

This Digitizer Captures in Color

The VIP 640C video digitizer board captures resolutions of 640 by 480 pixels with a color resolution of up to 24 bits. Designed for AT compatibles, the board lets you capture, manipulate, and store images from a source such as a video camera.

The color-enhancement hardware on the VIP 640C simulates more than 125,000 colors and produces real-time display of the video image on any standard VGA monitor. The company bundles the board with Fotofiler image-database management software and Picture Publisher Plus.

Price: $449.

A Cache Card for the Mac IIci

A 1½- by 4¾-inch cache card for the Mac IIci, Cache-In uses only nine active components, increasing its reliability while decreasing power consumption. The company says that performance gains should be most noticeable when you use applications such as CAD, desktop publishing, and programs requiring recalculation.

Price: $299.
Contact: Applied Engineering, 3210 Beltline Rd., Dallas, TX 75234, (214) 241-6060.
Circle 1299 on Inquiry Card.

Snap out a 386 CPU to make way for an i486 CPU on Zeny's new motherboard.

Contact: Ventek Corp., 31336 Via Colinas, Suite 102, Westlake Village, CA 91362, (818) 991-3688; fax (818) 991-4097.
Circle 1298 on Inquiry Card.

Refresh Quickly on a Super VGA Board

PH6 Technologies has released the PH6 Super VGA board. The 16-bit board, with 1 MB of on-board memory, has a refresh rate of 70 Hz, which is said to be easier on the eyes than the standard 60-Hz rate.

Designed to provide up to 1024- by 768-pixel resolution in 256 colors, the board has a palette of 16.7 million colors. Features include automatic backup of the Setup program and built-in password protection. It supports CAD, desktop publishing, and word processing applications.

Price: $245 to $395.
Contact: PH6 Technologies Corp., 5819 Uplander Way, Culver, CA 90230, (213) 216-0055; fax (213) 216-4931.
Circle 1300 on Inquiry Card.

A Cache Card for the Mac IIci

A 1½- by 4¾-inch cache card for the Mac IIci, Cache-In uses only nine active components, increasing its reliability while decreasing power consumption. The company says that performance gains should be most noticeable when you use applications such as CAD, desktop publishing, and programs requiring recalculation.

Price: $299.
Contact: Applied Engineering, 3210 Beltline Rd., Dallas, TX 75234, (214) 241-6060.
Circle 1299 on Inquiry Card.

Work in DOS on Your Mac

The Orange386, a DOS coprocessor for the Mac, is a single-slot card that works in any Mac II, including the Ilsi. The card, which features a 16-MHz 386SX processor and 1 MB of expandable RAM, lets you run DOS in a Macintosh window as if it were a Mac application.

Two AT slots on the card let you attach any half-size or three-quarter-size (depending on your style of Mac) IBM add-on card, according to the company. You can also add an optional 80387 math coprocessor. The expandability of the RAM allows fully independent processing, according to Orange Micro, letting the Mac and the Orange386 work simultaneously on different applications.

An optional peripherals kit includes PC interface hardware.
Price: Starts at $2299; peripherals kit, $199.
Contact: Orange Micro, Inc., 1400 North Lakeview Ave., Anaheim, CA 92807, (714) 779-2772; fax (714) 779-9332.
Circle 1301 on Inquiry Card.
Get High Performance Under Microsoft Windows 3.0™ With db_VISTA III DBMS.
Develop Windows applications that are better, faster, and more profitable. db_VISTA III combines speed, flexibility, and productivity into one DBMS tool for C and Windows programmers. Add db_VISTA III’s high-speed SQL retrieval to your application and watch your users enjoy power they’ve never experienced before.

Built For Windows.
db_VISTA III for Windows 3.0 follows all of the Microsoft guidelines for memory use. Dynamic linked libraries (DLL), multi-tasking, and multi-user environments are all supported. For even faster development, use db_VISTA III with products like ToolBook®, Windowcraft®, or Actor®.

No Other DBMS Opens Windows Like db_VISTA III!
• Speed. Benchmarks show db_VISTA III significantly outperforms any DBMS under Windows.
• No Royalties. Increase your profits; decrease your overhead.
• C Source Code Available. For total programming flexibility.
• Portability. db_VISTA III supports most environments.

Call 1-800-db-RAIMA
(1-800-327-2462)
In Washington State call: (206) 747-5570
Ask for extension 143.

Full Raima Support Services - Including Training. Develop your applications even faster with Raima Training Classes:
June 10-14, 1991 - NYC, NL
June 12-14, 1991 - Switzerland
June 18-20, 1991 - Santa Clara
June 19-20, 1991 - United Kingdom
June 24-28, 1991 - New Orleans

Special $195 Developer’s Edition
For a limited time only, you can get our db_VISTA database engine for Windows for only $195. Call today and ask about our Developer’s Edition and experience how db_VISTA III can open Windows for you.
Developer license only; not for distribution.
Add Hand-Drawn Data to a Computer Image

Color Writer, a color electronic chalkboard, lets you add hand-drawn comments to a projected computer image. The board combines your hand-drawn information with the computer image. It then simultaneously sends the combined image to a projector and to a local computer monitor.

With Color Writer, you can combine eight colors and four line sizes as well as highlight, hide, or reveal portions of the computer image. You can also use the product as a remote mouse.

Color Writer is compatible with VGA, MCGA, EGA, CGA, MDA, and Hercules graphics monitors. It works independently of your operating system and application.

Price: $2995.

Contact: Chisholm Corp., 910 Campisi Way, Campbell, CA 95008, (800) 888-4210 or (408) 559-1111; fax (408) 559-0444.

Circle 1302 on Inquiry Card.

Vacuuming Tools Fit for Your Computer

If you’re wondering how to easily and safely rid your computer of accumulated dust, you may find the answer in a set of minitools from Eureka. The mini vacuum attachments are available in a kit.

The minitools fit onto a 36-inch clear flexible tube that attaches to your vacuum cleaner. The specialized tools include an oval brush for screens, a round brush for keyboards, a straight extension pipe, a curved extension pipe, and a crevice tool for hard-to-reach areas.

Price: $1.08.

Contact: Eureka Co., 1201 East Bell St., Bloomington, IL 61701, (800) 950-9991 or (309) 828-2367.

Circle 1304 on Inquiry Card.

Data Linkage in the Palm of Your Hand

Data transfer and storage are now possible between systems normally regarded as incompatible, according to Cadent Technology. A hand-held data-transport device with 64K bytes of RAM, Datalync is designed to transfer data between systems and devices with fixed-media storage or between systems with incompatible disk formats.

Completely self-contained in a palm-size case with a replaceable 9-V battery, Datalync uses an RS-232 interface. It captures, stores, and transmits data by emulating a file server or bulletin board. The unit’s embedded software supports standard modem transfer protocols.

Price: $379.

Contact: Cadent Technology, 2021 West Commonwealth Ave., Fullerton, CA 92633, (714) 738-7756; fax (714) 738-7992.

Circle 1305 on Inquiry Card.

Create Multipart Forms on Your Printer

An alternative to standard cut-sheet paper, carbonless paper for laser printers lets you quickly create multiple-part forms. You load the cut laser sheets as you would conventional paper. The paper is available in two sizes: 8½ by 11 inches and 8½ by 14 inches.

Price: Starts at $20.85 per

500-sheet package of 8⅛ by 11-inch paper; starts at $26.50 per 500-sheet package of 8½ by 14-inch paper.

Contact: Great Lakes Business Forms, 2480 Walker Ave. NW, P.O. Box 1157, Grand Rapids, MI 49501, (800) 950-9530 or (616) 791-0100; fax (616) 791-1131.

Circle 1303 on Inquiry Card.

An Oscilloscope on a Bus Card

CompuScope Lite is a single-slot bus card that adds full digitizing oscilloscope functions to your PC. It lets you store, analyze, print, and communicate the data you acquire. The CompuScope Lite also can digitize 40 million samples per second on one channel and 20 million samples per second on two channels, as well as provide auto-calibrated A/D conversion.

Price: $595.

Contact: Gage Applied Sciences, Inc., 5465 Vanden Abeele, Montreal, Quebec, Canada H4S 1S1, (514) 337-6893; fax (514) 337-8411.

Circle 1306 on Inquiry Card.
Take a look at the vast majority of graphical workstations developed over the past decade and you'll see something they all have in common:

An integrated UNIX® System environment.

Now take a look at the vast majority of businesses that have put computing power directly onto their office desktops over the past decade, and you'll see something they all have in common: Industry-standard personal computers.

I t doesn't take a computer to forecast the platform that's going to put graphical workstations on the vast majority of business and engineering desktops in the next decade:

An integrated UNIX System environment for industry-standard personal computers.

And that's what Open Desktop® is all about.

Open Desktop is the complete graphical operating system that's built on the most popular UNIX System platform of all time—SCO®. And it lets you create your own networked, icon-driven workstation environment using the industry-standard 386 or 486 computers and peripherals of your choice.

In a single, easy-to-use, fully-supported—and completely integrated—package, Open Desktop delivers:

- the full 32-bit, multitasking computing power of SCO UNIX System V/386, designed to meet C2-level security
- compliance with POSIX™ and X/Open® standards
- an OSF/Motif®-based, Presentation Manager-compatible, graphical user interface
- distributed SQL database management services
- compatibility with existing DOS, XENIX®, and UNIX System applications and data files
- NFS™, TCP/IP, and LAN Manager networking facilities

And all at an unbelievably affordable price.

Discover the complete graphical operating system that leading companies worldwide are choosing as their development platform for the '90s—and using to turn their 386 and 486 PCs into instant workstations today.

Open Desktop from SCO.
The new Microsoft BallPoint mouse represents one giant step for you and your laptop computer.

That's because new BallPoint is the first and only mouse specifically developed for laptops. It's compact, yet includes all the features that made the
Microsoft Mouse the industry leader. Simply attach it to either side of virtually any laptop keyboard, and adjust it to the most comfortable angle. Then thumb your way through Microsoft Windows' graphical environment version 3.0 and all your favorite mouse-driven applications.

And for a limited time, you can get a free BallPoint mouse when you purchase a COMPAQ notebook or laptop PC. Just call (800) 541-1261, and ask for Dept. P40. They'll send you everything you need to know about the mouse designed to go where no mouse has gone before. Anywhere.

Microsoft
Making it all make sense
Replaceable RIMs for Token Ring Adapter

A 4-Mbps Irmatrac Token Ring Adapter that's convertible to 16 Mbps is available from Digital Communications Associates. The interface card uses the company's Ring Interface Module technology, which lets you switch between 4 and 16 Mbps by removing one RIM and replacing it with the other.

The Irmatrac 4-Mbps provides dual ISA and Micro Channel architecture bus support, bus-master support, on-board processing of logical link control, Token Ring industry-standard support, IBM software interface compatibility, and 128K bytes of on-board memory. The board also supports 10Net Plus, PC LAN, LAN Manager 2.0, 3+ Open, and NetWare 286 and 386.

Price: $795; 16-Mbps RIM, $99 with coupon; $195 without coupon.

Contact: Digital Communications Associates, Inc., 1000 Alderman Dr., Alpharetta, GA 30202, (800) 348-3221 or (404) 442-4000.

Circle 1307 on Inquiry Card.

Faxes Change Direction in Windows

LanFax Redirector for Windows uses print redirection to convert Windows files into fax format and transmit them to any fax machine worldwide. LAN users send the WYSIWYF (what you see is what you fax) messages peer-to-peer. Available for 8, 25, or unlimited users, LanFax Redirector for Windows is compatible with Novell, 3Com, Banyan, and IBM systems and the NetBIOS interface. It supports intelligent fax cards such as SpectraFax, Satisfaction, and Connection Coprocessor.

Price: Starts at $995.


Circle 1308 on Inquiry Card.

A Micro Channel Architecture and OS/2 Fax Team

SuperFax for OS/2 is a complete Micro Channel bus-master fax communications package, according to its manufacturer. The combination of Micro Channel architecture and OS/2 lets you easily use such applications as Lotus 1-2-3/G, WordPerfect, and PageMaker while SuperFax works in the background.

On a network, SuperFax works in a variety of configurations. With SuperFax on the server, any workstation running in OS/2 or running Windows within a DOS shell can use the respective software version to send and receive faxes via the server.

Price: Stand-alone, $750; with hardware, server software, and four workstation licenses, $995.


Circle 1309 on Inquiry Card.

Transparent Printer Language Switching

Two connected PCs and an AppleTalk network can share the Hewlett-Packard LaserJet IIIISi printer via the BridgePort 2674 intelligent switching device. Once the device is connected, you can send files to the printer without designating whether you're using PostScript or Printer Command Language.

On a printer equipped with the Adobe PostScript upgrade kit from HP, the BridgePort 2674's automatic language switching transparently senses and analyzes the data stream to determine the language of the incoming data. It then configures the printer for the appropriate language.

The BridgePort 2674 plugs into the modular I/O slot of the HP LaserJet IIIISi. Its three input ports are a mini-DIN-8 AppleTalk port, a 36-pin Centronics port, and a port that incorporates Extended Link.

Price: $595.

Contact: Extended Systems, 6123 North Meeker Ave., Boise, ID 83704, (208) 322-7575; fax (208) 377-1906.

Circle 1310 on Inquiry Card.
WATCOM C/386
Optimizing C Compiler and Tools
for 386 Extended DOS

WATCOM C/386
for Windows

Unleash 386 Power on
Your Microsoft C Code.

Interactive source-level debugger
 Generates high-performance code for 32-bit protected mode
 Microsoft source and library compatible
 Fast, tight code
 Profiler
 Protected-mode version of compiler
 Graphics library
 100% ANSI C and SAA compatible
 Run-time compatible with WATCOM FORTRAN 77/386

Experts Agree on WATCOM C:

“When Novell went looking for a 32-bit compiler for use with the NetWare 386 developer's kit, the company selected WATCOM's...It's clear that Novell chose wisely; this product is a winner.”
Fred Hommel, BYTE, December 1989

“WATCOM C/386 is a fantastic new ANSI C compatible compiler for 386-based PC's...If you have written your application in Microsoft C, you will love this compiler.”
J. Richard Hines, Electronic Test, December 1989

“Microsoft library- and source-compatibility makes WATCOM C7.0/386 ideal for porting DOS applications to 32-bit native mode. This compiler enables full 386 performance without 640K limitations.”
Richard M. Smith, President, Phar Lap Software, Inc.

“WATCOM is definitely the leader in object-level optimizations...For flat-out executable speed...WATCOM C showed shining performance.”
Computer Language, February 1989

WATCOM C8.0/386 Professional

• 100% ANSI C optimizing compiler • Protected-mode version of compiler • 386 run-time library object code • Windowed source level debugger
• Profiler • Editor • 386 graphics library
• MAKE • Linker • Object-code librarian
• Object-code disassembler • Supports Phar Lap and ERGO DOS extenders

1-800-265-4555

WATCOM C/386 for Windows

• Enables 32-bit Windows 3.0 GUI applications
• Interactive debugger for 32-bit Windows GUI applications
• Ideal for porting 32-bit Unix applications to Windows
• 32-bit flat model simplifies Windows memory management
• Royalty-free run-time license
• Requires Windows 3.0 SDK, does not require DOS extenders

415 Phillip Street, Waterloo, Ontario, Canada N2L 5X2
Tel. (519) 886-3700  Fax (519) 747-4971

WATCOM C is a trademark of WATCOM Systems Inc.
Trademarked names are the properties of their respective owners.
© Copyright 1990 WATCOM Products Inc.
Redefining the price-performance ratio in high-resolution color monitors

For the whole sweep of advanced, demanding applications: CAD/CAM, graphic design, desktop publishing, medical and scientific imaging, and Windowing.

Flat square technology and innovative focus system virtually eliminate distortion and flicker and reduce eye strain. Both 17" and 21" monitors offer brilliant color and automatic scanning over wide frequency ranges (30-65KHz). VGA-, 8514A- and Mac II-compatible with resolution up to 1280 pixels x 1024 lines. Smart, compact design with handy controls and easy adjustments.

All this at undeniably realistic prices.
At $3499 list the 21" is $1000 less than the competition. At $2100 list the 17" delivers far more monitor than anything else in its price range. Seeing is believing. Try a Toshiba at your dealer's. For more information phone or fax today:
1-800-253-5429
Extension 321 708-541-1927 fax
Let Your Laptop Take the Bus to the LAN

External Ethernet and Token Ring LAN adapters from Megahertz connect to the 100-pin bus connector on Toshiba 1000SE, XE, and LE, 1200XE, and 2000SX notebook computers. The adapters are completely compatible with existing software packages, according to the company.

The 10-MB Ethernet adapter supports thick and thin Ethernet cabling via a 10Base-5 15-pin female connector and a 10Base-2 BNC connector. It uses Western Digital's Ethernet chip set. Systems supported include NetWare, 3+ Open, Vines, OS/2 LAN Manager, and Unix.

The 4-MB Token Ring adapter includes software drivers for PC LAN and NetWare version 2.1x. It also supports the NetBIOS interface. Price: Ethernet version, $599; Token Ring version, $999.

Contact: Megahertz Corp., 4505 South Wasatch Blvd., Salt Lake City, UT 84124, (800) 527-8677 or (801) 272-6000; fax (801) 272-6077.

Circle 1311 on Inquiry Card.

Full Fax Features on a Modem Board

The Twincom 24/96 modem/fax board with Rockwell International's RC9624 chip set combines a Hayes-compatible 2400-bps data modem with a 9600-bps Group 3 send/receive fax modem. Bundled with Quick Link II Fax, Twincom 24/96 features true background fax operation, pull-down menus, mouse support, full call-progress monitoring, macros, and automatic answer/dial and log-on scripting.

Price: $149.

Contact: Image Communications, 6 Caesar Place, Moonachie, NJ 07074, (800) 666-2496 or (201) 935-8880; fax (201) 935-6548.

Circle 1312 on Inquiry Card.

Protect Your LAN Line

Two LAN data-line surge protectors available from Patton are the Model 531 for Ethernet and the Model 533 for ARCnet. Both surge protectors are for thin coaxial cable and can handle 1.8K watts of energy per wire.

Key to the design of the protectors are silicon avalanche diodes in the passive, high-speed hybrid circuitry. These SADs allow the devices to respond in less than 5 ns. The devices, encased in ABS plastic, do not require additional cables for hookup. Configurations available are in-line and T-splitter.

Price: Starts at $50.

Contact: Patton Electronics Co., 7958 Cessna Ave., Gaithersburg, MD 20879, (301) 975-1000; fax (301) 869-9293.

Circle 1313 on Inquiry Card.

Integrated Motherboard for Workstations

Two new 16-MHz Triumph 386SX workstations are available for use on Novell NetWare LANs. The Triumph SX-Lite and Triumph SX-Tra feature a motherboard with an integrated Intelligent Drive Electronics hard disk drive controller; a floppy disk drive controller; a VGA chip set; and serial, parallel, and mouse ports.

Each workstation comes with 1 MB of RAM (expandable to 8 MB) and 40 MB of hard disk storage (expandable to 135 MB). Each includes a Phoenix BIOS, math coprocessor support, and a 14-inch monochrome VGA monitor.

The Triumph SX-Lite, measuring 2 1/2 by 14 1/2 by 15 inches, has two half-height disk drives (one floppy and one hard) and one expansion slot. The Triumph SX-Tra, which measures 5 1/4 by 16 1/2 inches, has one full-height 5 1/4-inch and one half-height 3 1/2-inch floppy disk drive or three half-height 3 1/2-inch floppy disk drives, plus four expansion slots.

Price: Basic configuration of 1 MB of RAM, 40-MB hard disk storage, and a floppy disk drive, $1395; with VGA color monitor, $1625.

Contact: The Network Connection, 1324 Union Hill Rd., Alpharetta, GA 30201, (800) 327-4853 or (404) 751-0889; fax (404) 751-1884.

Circle 1314 on Inquiry Card.
The Carry-I 9000 series comes complete with 80386SX/80286-16/80286-12 microprocessor (Co-Processor optional). 1024 x 768 VGA/MGA & CGA display interface, 1/2 MB RAM, one 3.5" 1.44 MB FDD or one FDD plus one 40/80 MB HDD, one 8 bit expansion SLOT, one parallel and two serial I/O ports, and one 30W auto range switching power adapter, all in the traditional 240mm x 185mm x 45mm (9.4" x 7.3" x 1.8") casing of Carry-I. Each package includes two mini-tower stands and a carry bag. The 81 key mini keyboard with 101 functions and 9 inch color or monochrome VGA monitor are optional.

Other Carry-I products include the 8000 series XT & AT book-size personal computers and the 6000 series XT and AT book-size LANstations. All Carry-I product lines are bundled with DR DOS 5.0.

**FLYTECH GROUP INTERNATIONAL**

**Germany:**
TEL# 69-7455681, 746453
FAX# 69-749375

**Hong Kong:**
TEL# 305-1268
FAX# 798-8427

**Taiwan:**
TEL# 2-7852556, 7827538
FAX# 2-7852371, 7837970

**U.S.A.:**
TEL# 408-7277373, 7277374
FAX# 408-7277375

---

**DISTRIBUTORS**

**Belgium:** Celeri Tel 62-68434 Fax 62-68515

**Brazil:** Micronova Systems Tel 031-325089 Fax 031-323934

**Canada:** Budgetron Tel 416-564780 Fax 416-564579

**Chile:** G & G Computer Tel 026-227151 Fax 026-367135

**Germany:** L'Informatique du Succès Tel 1-4832797 Fax 47265196

**Greece:** Aller Tel 0331-802207 Fax 0331-8031857

**Hong Kong:** Hongkong Computer Trading Tel 0351-826 Fax 0351-796527

**India:** Indian Industries Tel 011-882591 Fax 011-885308

**Israel:** Micronex Systems Tel 031-325089 Fax 031-323934

**Italy:** Italy Micro Computer Trading Tel 02-506399 Fax 02-506399

**Japan:** Japan Micro Computer Trading Corp. Tel 0351-304656 Fax 0351-304656

**Korea:** Korea Electronics Technology Tel 0351-304656 Fax 0351-304656

**Malaysia:** Malaysia Communication Technology Tel 033-279837 Fax 033-279837

**Netherlands:** Nederland Kopierapparaten Nederland Tel 026-546141 Fax 026-546141

**New Zealand:** New Zealand Systems Tel 06-883605 Fax 06-683605

**Norway:** Money Systems Tel 67-722312 Fax 67-722312

**Portugal:** Portugal Microcomputer Systems Tel 351-477222 Fax 351-477222

**Singapore:** Singapore Transline Tel 00-745808 Fax 00-745808

**South Africa:** South Africa PC Market Tel 011-444-3274 South Africa PC Market Tel 011-444-3274

**Sweden:** Sweden Trading Tel 08-62100 Fax 08-62100

**Switzerland:** ESS Software Tel 022-62100 Fax 022-62100

**United Kingdom:** United Kingdom Centronics Tel 026-463754 Fax 026-463754

**U.S.A.:** Sigma Data Corporation Tel 031-937077 Fax 031-937077

---

Circle 114 on Inquiry Card.
Control for Controls

Diagl0gC0der, the W1ndows 3.0 programming tool for managing how dialog controls should interact with the end user, now lets you test and simulate your dialog without compiling or linking. Using DialogCoder’s point-and-click interface, you can design and then generate the source code for dialog controls ranging from simple WYSIWYG dialogs to those with stacked, overlapped, hidden, and disabled controls with multiple triggers.

DialogCoder 2.0A integrates with Caseworks’ Case:W and Blue Sky’s WindowsMaker application builders. It generates code for Microsoft C and Borland C++ 2.0.

Price: $499.
Circle 1271 on Inquiry Card.

Create 32-bit Applications for Windows

With Objectworks’ Smalltalk release 4 for Windows 3.0, you can develop true-color graphical interactive applications for Windows, the Mac, and Unix without needing intimate knowledge of the low-level windowing application programming interface for each platform. Applications created for Windows will run unchanged on a Mac or a Unix workstation running the X Window System, ParcPlace says.

The environment is the first to exploit the 32-bit linear mode of Windows 3.0, the company says. While you could previously write applications to take advantage of 32-bit capabilities by using the Winmem32.DLL dynamic link library in the Windows Software Development Kit, Objectworks’ Smalltalk has the tools to make the job much easier. The environment also provides a migration path to future 32-bit versions of Windows.

Objectworks’ Smalltalk provides more than 350 types of Portable Objects and 7400 reusable methods. It also has third-party tools from Tigre Object Systems and for creating graphical user interfaces, and Synergistic Solutions’ SQTalk/80, which provides a link between SQL Server and the Objectworks environment. An Objectkit|Smalltalk advanced programming kit has analysis and programming tools, additional browsers and classes, and terminal-emulation capabilities.

Price: Objectworks’ Smalltalk release 4, $3500; Objectkit’ Smalltalk, $500.
Contact: ParcPlace Systems, 1550 Plymouth St., Mountain View, CA 94043, (415) 691-6700; fax (415) 691-6715.
Circle 1272 on Inquiry Card.

WindowsMaker Turns Pro

WindowsMaker, the application C code generator for Windows 3.0, now includes an animation test mode and the ability to work interactively. With the animation test mode, you can simulate your designs without wading through the traditional compile/link process, Blue Sky says.

WindowsMaker Pro lets you attach functionality to your buttons, custom controls, bit maps, and icons. It supports almost unlimited nesting for menus. Blue Sky also lets you collapse all the nested menus with one key-click.

WindowsMaker Pro requires Borland C++, the Microsoft Software Development Kit 3.0 with Microsoft C 5.1 or higher, or Zortech C++ 2.1.
Price: $995.
Circle 1273 on Inquiry Card.

CASE for Real-Time Mac Applications

Excel’s new CASE package for the Mac provides real-time analysis, object analysis, and a requirements database.

By generating state-transition diagrams, decision tables, process-activation tables, state-transition matrices, and state-transition tables, MacAnalyst/Expert lets you more quickly develop time-critical real-time applications for embedded control systems, avionics, defense, and manufacturing, the company says. With the database, you can identify, specify, and trace requirements throughout the development cycle.

The program supports C++, Object Pascal, and other object languages on a Mac.
Price: $1595.
Contact: Excel Software, P.O. Box 1414, Marshalltown, IA 50158, (515) 752-5359; fax (515) 752-2435.
Circle 1274 on Inquiry Card.
REO-650 with Opticase Disk Holder

There is no optical illusion when choosing the best rewritable optical storage system. Pinnacle Micro's REO-650 was rated the #1 ISO/ANSI standard optical drive by PC Digest & NSTL (National Software Testing Laboratories) - and for good reason. Pinnacle is 100% dedicated to leading the optical storage revolution.

With Pinnacle's optical drive solutions, there is no need for hard disk or tape drive systems ever again. Optical mass storage technology provides fast reliable storage for the future. The REO-650 is ideal for storing on-line, network or backed up databases. Each optical disk can hold 650 Megabytes of spreadsheets, CAD/CAM files or millions of pages of desktop publishing graphics. Since optical disks are removable, the applications and capabilities are virtually endless.

☎ (800) 553-7070

Now all of this is Novell Lab's Tested and Approved. This allows users to utilize removable media in a network environment.

Pinnacle offers the largest selection of optical storage systems, from the world's first 3.5" optical drive, to the most popular 5.25" optical drives and disk changers. Interface kits are available for IBM, MAC, SUN, and DEC computers.

Invest in your data's future with the optical storage leader. Call today to receive your Pinnacle 1991 Optical Catalog.
The Relaxing Legacy of No More Downtime

Although top-quality disk drives experience an approximate failure rate of only 6 percent per year, even this relatively high reliability is unacceptable to many businesses with installed networks. Mirroring is one solution, but it requires you to invest in twice as much storage to hold your data and programs. RAID (redundant arrays of inexpensive disks) offers another solution to this problem. RAID provides improved performance and the ability to withstand the failure of a single disk drive by means of check bytes, which reconstruct the failed drive’s data from the remaining drives.

Tense Lectronix says that its Legacy Array Software 1.0 achieves Level 5, the highest level of RAID. LAS 1.0 lets you rebuild a replacement drive in the background while reads and writes continue, making it suitable for transaction processing, financial institutions, and other businesses.

The system supports DOS, Novell NetWare, Unix, SunOS, and OS/2. For RAID Level 5, LAS runs on the Legacy Hot Fix Device (HFD) SCSI-based storage subsystem that connects directly to file servers and workstations.

Price: $1495 to $1595.
Contact: Tense Lectronix Corp., 200 Butterfield Dr., Unit B, Ashland, MA 01721, (508) 881-6442; fax (508) 881-4116.
Circle 1275 on Inquiry Card.

SQL Added to Windows Database

Precision adds an embedded Structured Query Language command set to the new version of its Superbase 4 Windows database. The SQL command set, along with the new Superbase SQL Library, lets version 1.3 of the database link to and operate on popular SQL database servers.

Precision says that the new SQL support, along with support for Windows Dynamic Data Exchange and dynamic link libraries, lets Superbase act as a graphical database center for businesses. A revised networking scheme is based on standard DOS locks.

The library now supports Microsoft SQL Server on OS/2; Sybase; and Gupta SQLBase on DOS, OS/2, and Novell NetWare’s NLM. A future release will support other servers.

Price: SQL Library, $495; Superbase 4 Windows, $695; network extension, $995.
Contact: Precision Software, 8404 Sterling St., Suite A, Irving, TX 75063, (214) 929-4888; fax (214) 929-1655.
Circle 1276 on Inquiry Card.

New R:base Acts as a Control Center

Microrim’s Express 3.1A R:base upgrade lets you run any dBASE, word processing, spreadsheet, or graphics application from within a database. For network administrators, the company developed R:scope, a database, diagnostic, and network utilities package that uses Dynamic Application Integration to bind itself to R:base.

Price: R:base, $795; Upgrade Express subscription (three a year), $129; individual upgrades, $99 each; LAN Pack users, $149 per subscription, $99 for runtime; R:scope, $129.
Contact: Microrim, 15395 Southeast 30th Place, Bellevue, WA 98007. (206) 649-9500; fax (206) 746-9350.
Circle 1277 on Inquiry Card.

Link the Wizard and B.O.S.S. to Windows PIMs

With IntelliLink/DDE, you can link the Sharp Wizard or Casio B.O.S.S. with a Windows 3.0-based personal information manager and upload and download information between the two. You can use IntelliLink/DDE to upload and download from the hand-held PC either through an Asymetrix Toolbar application or via Dynamic Data Exchange to applications such as Excel and Microsoft Word for Windows.

Price: $99.95.
Contact: IntelliLink, 7 Parker St., Acton, MA 01720, (508) 264-9943; fax (508) 369-6900.
Circle 1278 on Inquiry Card.
“THE MOST POWERFUL COMPUTERS ARE THE ONES PEOPLE ACTUALLY USE.”

—Apple Computer
First off, let’s get one thing straight.
We totally agree with Apple. A truly powerful computer is measured in how often it’s used.

**IF YOU LISTEN TO APPLE, THIS IS THE MOST POWERFUL COMPUTER IN THE WORLD.**

But while Apple has taken great strides in making the personal computer more useful, we’ve gone substantially farther.

**Introducing the T2000SX notebook computer.**

Quite simply, the T2000 SX is a more useful personal computer because it allows you to work how you want to work. When you want to work. And where you want to work.

Painstakingly engineered with you clearly in mind, the T2000SX will help you work more efficiently than ever before.

Virtually every feature you can find on a desktop computer, you will find on the T2000SX: An 80386™ SX processor with a math coprocessor socket, VGA compatible display, 1 MB (expandable to 9MB) of 80 nsec RAM, a 40 MB hard disk with 19 msec access time and 1.5 MB/sec data transfer rate.

Our technologically superior battery can be fully recharged in a mere ninety minutes.

Because the T2000SX can fit easily into a briefcase (it weighs a scant 6.9 pounds), you can take it anywhere you go and use it in more ways than you can imagine.

Need to make revisions to a...
Our internal AutoResume back up battery automatically saves your work if your main battery runs out. Back to the office? The T2000SX gives you the freedom to do it from a train. The client wants an estimate on costs? You can give it to him right then and there—wherever there is.

No more wasting time running back to the office. Because the office is always with you.

But just in case there's something back at the office you still need, you can get back to it with our optional built-in modem, which supports industry standard error corrections and data compression (CCITT V.42, V.42bis, MNP* 5). It even supports cellular data communications via our optional smart cable adapter.

The T2000SX also has a unique feature you won't find on any other computer in the world. It is called AutoResume.

AutoResume: Think of it as a bookmark for your computer.

AutoResume automatically saves whatever you're working on whenever you turn the computer off. And it lets you go directly to the program you were using last when you're ready to start up again. So you don't have to reboot, restart your application and reload your files.

AutoResume also helps save on battery life and it allows you to change batteries without losing an ounce of information.

As for batteries, the T2000SX touts the latest in battery technology—Nickel Hydride. Nickel Hydride delivers 22% more watt-hours per pound than NiCad and it doesn't suffer from memory effect.

In keeping with the Toshiba tradition, the T2000SX also offers superior ergonomics. Like full-size, standard-spaced keys on a keyboard which has a full set of 12 dedicated function and 8 cursor control keys. And a VGA compatible, reversible black on white or white on black high resolution display.

Okay, let's wrap this thing up.

These are just a few of the reasons why we believe the T2000SX is the most useful, and therefore, most powerful computer in the world. And why PC Week Labs said, "the T2000SX offers performance comparable to the LTE 386s/20, plus many of the design features that have made Toshiba a market leader in portable PCs."

We invite you to learn more about the T2000SX and Toshiba's best-selling line of portable computers by calling us at 1-800-457-7777 for a complete information kit.

In closing, we'd like to thank you for reading our ad.

We'd also like to thank our friends at Apple for giving us such a wonderful endorsement.

In Touch with Tomorrow
TOSHIBA
Gräbert Blitzes the AutoCAD Stair-Step Effect

The AutoPack Blitz combines software drivers for AutoCAD and Edsun Laboratories' Continuous Edge Graphics technology to let you display photo-realistic graphics on VGA-type displays. The combination of drivers and a single-slot board eliminates the stair-step effect in AutoCAD drawings by mixing more than 750,000 colors and shades at a virtual resolution of 2048 by 2048 pixels.

AutoPack Blitz also provides BirdsEye View capabilities; its display-list capabilities let you pan, zoom, and generate images as much as 10 times faster than with AutoCAD alone, the company claims.


Circle 1279 on Inquiry Card.

AEC Products for Generic CADD

Softdesk, developer of AutoCAD add-ins for civil engineering, surveying, and other architectural, engineering, and construction disciplines, now offers similar add-ins for Generic CADD 5.0 for the PC.

The GenCADD architectural program performs such tasks as layouts, drawing of walls and footings, addition of doors and windows, and the creation of building elevations. The GenCADD FF&E module provides furniture, fixtures, equipment, and other symbols.

GenCADD CoGo performs coordinate-point tasks, such as setting points, drawing lines, performing closures, and labeling points and bounds.

Other products will include Landscape, Structural, HVAC (heating, ventilation, air conditioning), Electric, Plumbing, Data Collection, Input Reduction, Site Design, and DTM (digital terrain modeling).

Price: CoGo or Topo, $1250; Roads, $2900; Core, $750. Contact: Softdesk, Inc. (formerly DCA Software), 7 Liberty Hill Rd., Hen- niker, NH 03242, (603) 428-3199; fax (603) 428-7901.

Circle 1280 on Inquiry Card.

On a normal VGA display, this CAD drawing would appear jagged. But AutoPack Blitz, which uses Edsun Labs' technology, displays the drawing at a virtual 2048-by-2048-pixel resolution.

“Hydrate” Your CAD Applications

Nth Graphics' Hydra View/AC visualization software lets you view, shade, and rotate images from within AutoCAD 386 release 11. You can render the model, check it for design flaws, and hot-key back to AutoCAD for quick editing.

A stand-alone version called Hydra View works outside AutoCAD and works with VersaCAD, MicroStation 3-D, and AutoCAD release 10 and 11 models.

Price: $595; Hydra View, $495. Contact: Nth Graphics, 1807-S West Braker Lane, Suite S, Austin, TX 78758, (512) 832-1944; fax (512) 832-5954.

Circle 1281 on Inquiry Card.

Hit the Road, Mac

Vector Systems' latest version of the MacRoad interactive road-design package lets you lay out multiple roadbeds on a single contour map. The program can now save drawings in the DFX format for use in AutoCAD. For logging companies, Vector has added support for survey-data entry in standard forestry survey formats.

MacRoad 3.6 supports digital terrain modeling, profiling, cross-section views, plan drawings, and the ability to calculate earthworks quantities.


Circle 1282 on Inquiry Card.

New ASG Applications

ASG's new surveying, terrain modeling, and road construction modules now support AutoCAD 386 release 11. ASG CoGo (surveying) features multiple traverse and sideshot capabilities. ASG Topo (terrain modeling) incorporates 3-D digital terrain modeling techniques for cross-section modeling and slope analysis.

ASG Roads features programmable design templates for earthworks calculations and multiline highway design. The programs require the ASG Core program.

Price: CoGo or Topo, $1250; Roads, $2900; Core, $750. Contact: ASG, 4000 Bridgeway, Suite 309, Sausalito, CA 94965, (415) 332-2123; fax (415) 332-2146.

Circle 1283 on Inquiry Card.
OK. We know it's hard to believe. So just consider this.
Coherent" is a virtual clone of UNIX.
But it was developed independently by Mark Williams Company. Which means we don't pay hundreds of dollars per copy in licensing fees.

What's more, Coherent embodies the original tenet of UNIX: small is beautiful. This simple fact leads to a whole host of both cost and performance advantages for Coherent. So read on, because there's a lot more to Coherent than its price.

SMALLER, FASTER... BETTER.
Everybody appreciates a good deal. But what is it that makes small so great?

For one thing, Coherent gives you UNIX capabilities on a machine you can actually afford. 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. You can also have it running faster, learn it faster and get faster overall performance. All because Coherent is small. Sounds beautiful, doesn't it?

But small wouldn't be so great if it didn't do the job it was meant to.

EVERYTHING UNIX WAS MEANT TO DO.
Like the original UNIX,
Coherent is a powerful multi-user, multi-tasking development system. With a complete UNIX-compatible kernel which makes a vast world of UNIX software available including over a gigabyte of public domain software.

Coherent also comes with Lex and Yacc, a complete C compiler and a full set of nearly 200 UNIX commands including text processing, program development, administrative and maintenance commands plus UUCP.

CRITICS AGREE: IT'S AN INCREDIBLE VALUE!
"Mark Williams Co. seems to have mastered the art of illusion; 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!, November 26, 1990

"...(Coherent) may be the best thing that has happened to UNIX yet."
—William Zachmann, PC Week, November 5, 1990

"If you want to come as close as you can to real UNIX for a low price, COHERENT can't be beat."

"If you want a UNIX-like development and learning system for less than $100... I don't see how you can go wrong with Coherent."
—David Fiedler, BYTE Magazine, November 1990

EXPERIENCE, SUPPORT AND A 60-DAY MONEY BACK GUARANTEE.
Wishing how something as good as Coherent could come from nowhere? Well it didn't. It came from Mark Williams Company, people who've developed C compilers for DEC, Intel, Wang and thousands of professional programmers.

We make all this experience available to users through complete technical support via telephone. And from the original system developers, too!

Yes, we know $99.95 may still be hard to believe. But we've made it fool-proof to find out for yourself. With a 60-day money-back no-hassles guarantee.

You have to be more than just a little curious about Coherent by now. So why not just do it? Pick up that phone and order today.

You'll be on your way to having everything you ever wanted in UNIX. And for a lot less than you ever expected.

1-800-MARK WMS
(1-800-627-5967 or 1-708-291-6700)
FAX: 1-708-291-6750
60-DAY MONEY BACK GUARANTEE!
Travel to the Planets on Your Mac

C D-ROM Voyage to the Planets, a collection of three CD-ROMs full of images from Mars, Jupiter, Neptune, and other planets, is now available for the Mac.

Each disc has more than 500 images. Volume 1 contains images of Jupiter, Saturn, Uranus, and its moons; Volume 2, Mars, and Volume 3, Neptune and its moons. Each disc also available for the PC with a VGA, SVGA, or EGA display) provides 3-D displays, zoom, and histogram analysis.

Price: For the PC: $120 each volume, all three for $300; for the Mac: $180 each, all three for $400.


Circle 1284 on Inquiry Card.

Unix GUE for Real-Time Engineering

A new graphical user environment (GUE) for the aerospace and manufacturing community lets you develop front-end displays for real-time or database residing data in a distributed computing environment over several platforms and operating systems.

The Sammi GUE lets you modify the display without requiring complex programming and source code modification. Unlike traditional graphical user interfaces, the Sammi GUE is not embedded into the code of applications software programs, Kinesix says.

Sammi consists of a runtime environment, a format editor, and an application programming interface (API). With Sammi, you can create a graphical interface in front of application data in a client/server computing environment. It does this through the X Window System version 11 and remote procedure calls.

The system lets you access and modify a series of color-coded meters and gauges, bars and graphs, push buttons, and other widget objects. The system also supports data plotting and alarm handling. Through windowed displays, you can view data in a format tailored for the operator or industry.

Building an interface with the included format editor first involves defining the background, using either your drawing created with Sammi's tools or a scanned X bit-map, GIFF, or CGM file. Without programming, you can define dynamic fields using the library of objects that are tied to data.

If you need complex relationships with the data source, the included API utilities let a C programmer create a customized interface between the data-source application and Sammi. Sammi acts as a stand-alone task.

Sammi will run on a variety of IBM, Sun, DEC, and Hewlett-Packard/Apollo platforms.

Price: $12,500 to $25,000, depending on configuration.

Contact: Kinesix, 10333 Richmond Ave., Suite 1100, Houston, TX 77042, (713) 953-8300; fax (713) 784-4159.

Circle 1285 on Inquiry Card.

Labtech Expands to Unix and Windows

Labtech Notebook, for data acquisition, analysis, and control, and Labtech Control, for industrial-process monitoring and control, are now available for Windows 3.0. The new versions support virtual memory and flexible multitasking, Laboratory Technologies says.

The company has also released Chrom/RT, a programmable for gas, high-pressure liquid, and ion chromatography. Chrom/RT supports the X Window System, Windows 3.0, and Presentation Manager under OS/2.

Another new program, Notebook/XE for DOS, X Window, Windows 3.0, or OS/2, supports multiple real-time screen displays, remote instrumentation support, and real-time data transfer to foreground programs.

Price: Notebook for Windows, $1495 before July 31; Control for Windows, undetermined at press time; Chrom/RT: DOS/Windows or OS/2 version, $2495 before July 31, $2995 after; Unix version, $7000; Notebook/XE: $2495 and up.

Contact: Laboratory Technologies Corp., 400 Research Dr., Wilmington, MA 01887, (508) 657-5400; fax (508) 658-9972.

Circle 1286 on Inquiry Card.
Here's What We PROMISE

More Quality, Value and Throughput for your dollar.

How?

By assembling our systems with the best components possible. You want names? How about genuine Intel 386® and 486® processors? How about TEAC floppy drives and Trident 8900-based SVGA controllers?

And our hard drives? They're all caching versions from either Maxtor or Imprimis.

The truth is, we really do want to give you the very best system for your money; so we don't just stop at using the best components. We also burn every St. Croix in for at least 48 hours and give you a Full 2 Year Parts and Labor Warranty on the Entire System.

At St. Croix the facts of business life are really quite simple. We figure it's better to spend our time building better PCs, not bigger repair shops.

Here's What We DELIVER

Satisfaction! But please don't take our word for it . . . listen to some of our customers.

"The 386 you configured for me is addictive! Its speed and power are quite out of the ordinary."

"I have multiple communications programs with my main frame, and this (St. Croix) unit has cut the transfer time down tremendously."

"Very few companies extend the level of courtesy, knowledge and service I've received from St. Croix."

"I run acceptance diagnostics on all systems . . . the St. Croix outperformed a similar 386-SX we purchased from a local outlet. It functioned twice as fast in the math functionality test and in video response time. The motherboard tested faster too."

Our letter file is always open, so you're welcome to read our mail. But nothing's going to happen until you pick up that phone. If you're serious about getting the best performance and value for your money, call us today!

1-800-950-0174

For Technical Support call: 1-800-950-0182

© 1991, St. Croix Computer Corporation

386® and 486® are registered trademarks of another great name in the computer industry, Intel Corporation.

Circle 569 on Inquiry Card (RESELLERS: 570).
A Familiar Look for Your Desktop

A new front end for Windows takes desktop familiarity to the extreme with the goal of expediting the learning curve for new Windows 3.0 users. The deskMinder program provides the ability to launch applications, managers, and utilities from what appears to be an actual office desk.

You can place up to four applications on the deskMinder bookshelf and configure four shelves so that you can launch up to 16 Windows and non-Windows applications from your hard disk. On top of the desk, you have access to a notepad, time manager, help file, and clock. By clicking on the pencil cup, you activate a paint program, and by clicking on the PC that resides on the deskMinder desktop, you open a link to your file server, minicomputer, or mainframe. When you click on the phone, you can take phone messages or activate the modem.

In the file drawer, you can create folders to hold your files and projects, indicate which application to launch from each file, and search and sort through files. Clicking on the out basket activates E-mail.

Of course, when you’re done working in the deskMinder environment, the way that you quit is by turning out the lights.

Price: $199.
Contact: TechSoft Systems, Inc., 1375 Kemper Meadow Dr., Suite 11, Cincinnati, OH 45240, (800) 825-8386 or (513) 825-8386; fax (513) 825-9726.
Circle 1002 on Inquiry Card.

Join the 1990s with Electronic Click-It Notes

If the personal computer was supposed to automate the office environment, why do you still put sticky notes all over your desk and computer? A new groupware program, called Pinboard, lets you create on-screen notes for pinning to the Windows desktop or sending over the network.

On a network, each Pinboard user can password-protect a private board, while shared boards are accessible to several people simultaneously. Pinboard supports all disk-sharing networks, including LAN Manager and Novell NetWare. For power users, Pinboard supports Dynamic Data Exchange. You can also attach programs and documents to a note.

Perhaps the best thing about Pinboard is the way it lets you dispose of messages: When you receive a nasty note from your boss or colleague, after you read it and place it in the wastepaper basket, you can watch it burst into flames.

Price: $129.95; 25-user extension, $1495.
Contact: Raindrop Software Corp., 845 Arapaho, Suite 105, Richardson, TX 75081, (214) 234-2611; fax (214) 234-2674.
Circle 1003 on Inquiry Card.

A New VUE for Sun

Hewlett-Packard will soon have a version of its Visual User Environment that will support Open Look and Motif applications running on Sun Sparcstations.

HP VUE, previously available only for HP computers, offers multiple workspaces, a front panel that holds frequently used applications, and systemwide help. Five main components include a log-in manager, file manager, workspace manager, style manager, and help manager.

Contact: Hewlett-Packard Co. Inquiries, 19310 Prunetrade; ridge Ave., Cupertino, CA 95014, (800) 752-0900.
Circle 1004 on Inquiry Card.
486 33MHz Power!

STANDARD FEATURES....

$3295.00

80486 33MHz 32 Bit Intel CPU
4MB RAM-Expandable to 64MB
MICRONICS Motherboard, Phoenix BIOS
64K Cache (expandable to 256K)
Desktop Style Case (Tower Option available)
8 Expansion Slots (ISA 16 bit)
EISA System -- Add $900.00 (486 only)
w/7-32 Bit EISA slots, 1-16 bit ISA
220W Switching Power Supply
101 Enhanced Keyboard
12" Hi-Res Monochrome Monitor
Monochrome Graphics Card
1.2 or 1.44 MB Floppy Drive
100MB 18ms Hard Drive
Serial, Parallel & Game Ports
Full 1 Year Limited Warranty
486-25, as above only $2995.00

MS-DOS 3.3 or MS-DOS 4.01 add $50.00

Complete 386 33MHz System

Configured as 486 above except with
128K Cache
386-33MHz ECS Motherboard, AMI BIOS
1MB RAM Expandable to 16MB
7 Expansion Slots, 6-16 bit, 1-8 bit
MICRONICS System

Our Best Value!

$1995.00

Quality Service and Support Since 1984

Locations Nationwide

Lucky Computer Co.

Lucky Star International
2132 N. Collins
Arlington, TX 76011
1-800-966-4056

1701 Greenville Ave. #602
Richardson, TX 75081
1-800-966-5825 (L-U-C-K)

4151 Beltline Rd. #120
Addison, TX 75244
1-800-966-7687

10773 SW Beaverton-Hillsdale Hwy.
Beaverton, OR 97005
1-800-348-5825

14220 NE 20th #D
Bellevue, WA 98007
1-800-336-5825

17338 Southcenter Pkwy.
Tukwilla, WA 98188
1-800-367-5825

Reasons to buy an
LSI PROFESSIONAL
COMPUTER

☐ 30 Day Satisfaction Guarantee
☐ Satisfied Customers Like...
BOEING
ROCKWELL INTL.
CHRYSLER
ARCO

☐ Toll Free Tech Support
☐ Top Rated MICRONICS
Motherboard Options Available

☐ Complete line of 386 and
486 ISA and EISA Systems

Upgrades From 486/386 33MHz Standard System

<table>
<thead>
<tr>
<th>Upgrade</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard ISA 486/64MB, 16 Color</td>
<td>$300</td>
</tr>
<tr>
<td>Super-VGA ISA 64MB, 16 Color</td>
<td>$400</td>
</tr>
<tr>
<td>Super-VGA ISA 4MB, 128 color</td>
<td>$40</td>
</tr>
<tr>
<td>Sony 120MB/1MB VGA (non-interlaced)</td>
<td>$550</td>
</tr>
<tr>
<td>200MB Hard Drive (IDE 16ms)</td>
<td>$250</td>
</tr>
<tr>
<td>200MB IDE (5v)</td>
<td>$300</td>
</tr>
<tr>
<td>233MB (ESDI 16ms)</td>
<td>$1150</td>
</tr>
<tr>
<td>76MB (ESDI 16ms)</td>
<td>$1650</td>
</tr>
<tr>
<td>76MB (ESDI above EISA Controller)</td>
<td>$2190</td>
</tr>
<tr>
<td>1.2GBigbyte (SCSI 16mb)</td>
<td>$2250</td>
</tr>
</tbody>
</table>

HD Upgrades are from 100MB add $250 add to 40MB System Call For Stand Alone Pricing

MICRONICS CIRCUIT BOARD

Components / Accessories

<table>
<thead>
<tr>
<th>Component</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logitech Mouseman Serial</td>
<td>$69</td>
</tr>
<tr>
<td>Logitech Mouseman Bus</td>
<td>$79</td>
</tr>
<tr>
<td>Logitech Trackman Serial</td>
<td>$89</td>
</tr>
<tr>
<td>Logitech ScanMan Plus</td>
<td>$179</td>
</tr>
<tr>
<td>Logimouse w/Windows 3.0</td>
<td>$149</td>
</tr>
<tr>
<td>Supermouse w/Windows 3.0</td>
<td>$89</td>
</tr>
<tr>
<td>DTC 3250 SCSI cntl</td>
<td>$150</td>
</tr>
<tr>
<td>DTC 6250 SCSI 32K Cache</td>
<td>$150</td>
</tr>
<tr>
<td>IDE cntl. with I/O</td>
<td>$45</td>
</tr>
<tr>
<td>UltraStar ESDI 32K Cache</td>
<td>$375</td>
</tr>
<tr>
<td>Ultra EISA/ESDI cntl.</td>
<td>$795</td>
</tr>
<tr>
<td>Printers</td>
<td></td>
</tr>
<tr>
<td>Brother I224 (24 pin, 9 foot)</td>
<td>$259</td>
</tr>
<tr>
<td>Epson LQ2010 (24 pin)</td>
<td>$309</td>
</tr>
<tr>
<td>Panasonic H324 (24 pin)</td>
<td>$279</td>
</tr>
<tr>
<td>Citizen G3S 324 (24 pin)</td>
<td>$289</td>
</tr>
<tr>
<td>Color Kit for Citizen</td>
<td>$50</td>
</tr>
<tr>
<td>Laser Printers (incl. toner)</td>
<td></td>
</tr>
<tr>
<td>Brother HL60 (1MB, IBM)</td>
<td>$1195</td>
</tr>
<tr>
<td>HP DeskJet 350 Series III</td>
<td>$1895</td>
</tr>
</tbody>
</table>

Lucky Star International, LS-PC-85, Incl. Microsoft, ECS, HP are trademarks of their respective companies. All Prices Specifications subject to change.

Circle 560 on Inquiry Card (RESELLERS: 561).
Software Tester for Character Applications

Automator QA, the CASE-like tool for testing software, is now available in the U.S. The program provides software testing that will improve your application, increase your productivity, reduce development time, and cut validation and quality-assurance costs, Direct Technology says.

The program offers a full range of test services: Regression, which ensures that features of a previous release are still present; Performance, which checks minimum, average, and maximum acceptance criteria; Response, which checks interference, error handling, and math and system functions for adherence to specification; and Volume, which provides the benefits of beta testing at an earlier stage by testing over a wide range of tasks with random or sequential input. The product resides in a PC workstation, which is typically attached to the host as a terminal.

Automator QA was designed for testing complex character-based applications. You can test any application that is accessible from a PC workstation in terminal-emulation mode, including MVS, VM, VMS, and Unix. Test-system requirements include a 286- or 386-based system with 640K bytes of RAM, DOS 3.0, and an 80-MB hard disk drive.

Price: $5495.
Contact: Direct Technology, 10 East 21st St., Suite 1204, New York, NY 10010, (800) 992-9979 or (212) 475-2747; fax (212) 529-4941.
Circle 1007 on Inquiry Card.

Real-Time Graphics, Control for C and Pascal

The Real-Time Graphics and Measurement/Control Tools for Microsoft C, Turbo C, Borland C++ 2.0, and Turbo Pascal combine real-time graphics routines with measurement and control algorithms. Quinn-Curtis says you can use the tools to create graphics-based programs that perform process-control, data-logging, and instrument-interface operations.

Price: $200 each version.
Contact: Quinn-Curtis, 21 Highland Cir., Needham, MA 02194, (617) 449-6155; fax (617) 449-6109.
Circle 1005 on Inquiry Card.

Add Breathing Space for Your Applications

Rational's new utility, called Oxygen, binds the company's DOS extend- er technology to Microsoft's C compiler and linker. The utility lets you compile and link large applications from Windows, your editor, or the Programmer's WorkBench without having to remove network drivers, TSR programs, and other tools from your environment. With Oxygen installed, the Microsoft compiler and linker consume less than 50K bytes of the first 640K bytes of RAM, with the remaining portion running in extended memory.

Oxygen conforms to the Virtual Control Program Interface, DOS Protected Mode Interface, and EMS interface standards. It operates alone or with Windows 3.0, QEMM, 386Max, and other extended memory managers with Microsoft C 6.0.

Price: $199.
Contact: Rational Systems, Inc., 220 North Main St., Natick, MA 01760, (508) 653-6006; fax (508) 655-2753.
Circle 1006 on Inquiry Card.

Brief Gets Expanded, Redone

Solution Systems adds mouse support, EMS caching, a redo command, enhanced window capabilities, and support for Microsoft's C 6.0 Advisor in the new Brief text editor for the PC.

By supporting EMS, Brief 3.1 lets you edit larger files and hold macros in memory throughout the editing session. Mouse support provides faster cursor placement and the ability to control where and how your windows appear on the screen.

A new redo command complements the undo command. Other features include support for more than 40 compilers, smart indenting, and template editing. With template editing, you can type in an abbreviation, and Brief will expand it into a programming construct.

The company has also released Charge, a profiler with a direct interface to Brief. You can use Charge to identify often-used routines and optimize them for a faster-executing application.

Price: $249; Charge, $99.
Contact: Solution Systems, a division of Software Developer's Co., Inc., 372 Washington St., Wellesley, MA 02181, (800) 821-2492 or (617) 431-2313; fax (617) 740-0089.
Circle 1006 on Inquiry Card.
BUSINESS/HOME

- Am-Tax 1990 (3990) - Prepare & print your 1990 tax form 1040 & all schedules A-E51
- Amortization Table 3.5 (1115) - Handles all types.
- Express Check 4.07 (2 disks) (1110) - A great program to manage your checking accounts! Even prints checks!
- FormGen 4.1a/FormFill 1.5 (2 disks) (3240) - A very versatile form generator and form filler. Create and/or fill out any kind of form for home or business on any printer. Includes examples and sample forms to get you started!
- Home Inventory 4.0 (3137) - Helps you keep track of everything you own. Great for insurance.
- Home Legal Advisor 8.1 (3 disks) (3290) - Over 150 legal forms.
- HTML Editor (2695) -
- Headlines (2 disks) (2611) -
- HUB (20 disks)

CLIP ART (PCX)

- Note: These disks contain clip art in PCX (PC-Paintbrush) format. They can be used with Windows Toolbook. Pagemaker, Ventura Publisher, Windows or programs that can read PCX files.
- Accent/ImgBits (2617)
- Birds (2 disks) (2620)
- Business (2 disks) (2630)
- Butterflies (2650)
- Church (4 disks) (2650)
- Education (2 disks) (2650)
- Family (3 disks) (2650)
- Food (2 disks) (2650)
- Headlines (2 disks) (2650)
- Holidays (2616)
- Houses (3 disks) (2580)
- Kids/Cartoons (2 disks) (2623)
- Ladies (2 disks) (2690)
- Misc. (4 disks) (2760)
- Sports (2 disks) (2760)
- Teddy Bears (2 disks) (2830)
- Wedding (3 disks) (2850)

EDUCATION

- Amy's First Primer (1717) - Six different learning programs for children ages 4-6. (CGA)
- The DOS Learning System (1417) - Learn how to use DOS with this great program. Covers all versions of DOS 2.0-4.0.
- Fun House (1277) - Teaching children basic math skills
- Lotus Learning System (2 disks) (1420) - Learn Lotus 2.0 easily and quickly.
- Play'n Learn 2.50 (1735) - Contains over 800 programs for children 18 months to 4 years.
- Typing Teacher (1426) - Fun great programs designed to improve the speed and accuracy of your typing!
- World 2.29 (1846) - The ultimate globe! Learn about cities, countries with this computerized globe. (CGA)
- Tether DOS (4 disks) (1458) - The ultimate DOS tutorial. Everything you wanted to know about DOS and more! (HD)

GAMES

- Arcade Games 1 (1811) - Pac-man (3 versions), Hopper Space Invaders, Fusion (Tetris variation), etc. (CGA)
- Arcade Games 2 (1812) - Double Blocks (another Tetris variation), C-Bert, Breakout, Beast and others. (CGA)
- Ed's Chess 1.90 (2420) - The best chess game available anywhere. (It beat Chessmaster 2000.)
- Kid's Games (2317) - Fun for the under-12 set.
- Strategy Games (2461) - Risk, Dohello, Chess, Nyet (Tetris clone), and others. (CGA)

MISCELLANEOUS

- AutoDraw 4.7 (3515) - Latest version of the most popular menuing program of all time!
- Banner & Sign Makers (3218) - Make banners or signs for any occasion. Works with any printer.
- Best DOS Utilities (2 disks) (3820) - Essential utilities for DOS. Screen blankers, file finders, numerous other handy utilities that will save you time. Very easy to use!
- Broth'er Keeper 4.5 (3 disks) (3210) - Excellent, full-featured genealogy program that's easy to use.
- Mea'maker 6.4.1 (3 disks) (3160) - A complete recipe files. Comes with over 450 recipes to start you off.
- Mt. Label 5.0 (2325) - Powerful & versatile label maker. Online Catalog 5.0 (1790) - Complete KJV Bible. Includes Greek/Hebrew Lexicon & Cross Reference. (HD)
- PC Key-Draaw 3.75 (4 disks) (2780) - An exceptionally powerful graphics program. Comes with a large collection of ready-made graphics. (CGA) (HD)
- Planeman 4.0 (3137) - Create and play music on your PC.
- Vaccines and Virus Killer Vers. 7.5 (2 disks) (3150) - Protect your system from viruses! This set will find (and destroy!) over 200 viruses and 400+ virus strains.

WORDPERFECT 5.0/5.1

- WordPerfect 5.0/5.1 Art & Graphics Vol. 1 (2 disks) (5160) - Over 100 graphics for WordPerfect 5.0/5.1.
- WordPerfect 5.0/5.1 Art & Graphics Vol. 2 (2 disks) (5770) - Over 100 additional graphics for WordPerfect 5.0/5.1.
- WordPerfect 5.0/5.1 Art & Graphics Vol. 3 (2 disks) (5780) - Over 100 more graphics for WordPerfect 5.0/5.1.
- WordPerfect 5.0/5.1 Tools (2 disks) (3750) - 17+ great utilities for WordPerfect 5.0/5.1.
- WordPerfect 5.0/5.1 Macros (2 disks) (4220) - Over 100 helpful macros for WordPerfect 5.1.
- PC-BrainIt & II (3 disks) (3780) - Create clip-art & graphics for WordPerfect 5.0/5.1. (CGA) (HD)

Free catalog of over 200 programs with every order or by request.

Unconditional Money-Back Guarantee!

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.75 per disk</td>
<td>$2.25 per disk</td>
</tr>
</tbody>
</table>

Order Toll Free 1-800-876-3475
Information: 503-776-5777
Fax: 503-773-7803

WINDOws 3.0

- Note: these disks require Windows 3.0.
- Active Life/Organizer (4538) - Two "Personal Information Managers" that will keep track of important information.
- Almanac (4539) - The ultimate calendar for Windows!
- AT3 Fontset for Windows Vol. 1 (4 disks) (4710) - 20+ additional fonts for Adobe Type Manager. Will work with all Windows applications. (Requires Adobe Type Manager.)
- AT3 Fontset for Windows Vol. 2 (4 disks) (4720) - 20+ additional fonts for Adobe Type Manager.
- Checkbook Manager for Windows (4595) - Two great programs to manage your checkbook.
- Chess for Windows (4539) - Play the great game of chess.
- Command Post 7.0M (4537) - Great file manager and menu system that is customizable to your needs & preferences.
- Fractals & Mandelbrot for Windows (2 disks) (4880) - Fascinating visual effects and starting graphics.
- Games for Windows 1 (4551) - Great games including Klitz (Tetris Close), Worm War (Compute clone), Asteroids, Lunar Lander, Checkers, Backgammon and more!
- Games for Windows 2 (4592) - Space Wars, Hectris, Mines, Tic Tac Toe and more!
- Games for Windows 2 (4538) - T-Sprites, Concentration, Tile, Arachnid. (CGA) (HD)
- Hyperdisk 4.11 (4539) - Make Windows run 2 to 10 times faster! Will also help other programs run faster.
- Items & Icon Editors (4 disks) (4560) - Over 2500 icons and 3 icon editors, so you can create your own! Also includes 2 icon viewers and an icon manager.
- PC Project 3.0 for Windows (4625) - A very nice project manager for Windows.
- Quotes of Windows (4596) - 5 great programs that will give you quotes for the day.
- Screen Savers for Windows (4615) - Five different screen savers for Windows!
- Toolbook Program Vol. 1 (2 disks) (4540) - Applications and utilities for the Windows Toolbook.
- Toolbook Games (4670) - A collection of games for the Windows Toolbook.
- Toolbook Tutor (2 disks) (4610) - Learn how to use the Windows Toolbook.
- Utilities for Windows (4 disks) (4510) - 40+ utilities that will help you get the most out of Windows, as well as making Windows easier to use.
- Wallpaper for Windows Vol. 1 (4 disks) (4520) - If you want a different background with Windows, this set offers over 75 different backgrounds.
- Wallpaper for Windows Vol. 2 (4 disks) (4680) - 75+ additional backgrounds for Windows.
- Wallpaper for Windows Vol. 3 (4 disks) (4675) - 75+ additional backgrounds for Windows.
- XFT Draw (4594) - Great drawing program.

(CGA) Requires Color Graphics Adapter (HD) Requires Hard Disk

If You Like Our Prices... You'll Love Our Guarantee!

If for Any Reason You're Not Satisfied with Our Product, Return It... Anytime, for a Full Refund!
E-Mail in Windows Word Processor

Ater composing your document with Professional Write Plus for Windows, you can activate an integrated E-mail function to send the file anywhere in a network without exiting the word processor. The program from Software Publishing uses technology licensed from Samna in a one-time deal to let you retain the file's formatting and graphics.

You can paste graphics or text on frames that you can drop anywhere on the page, with surrounding text wrapping around the frame. Software Publishing added document- and image-file filters to support its own applications, including Harvard Graphics and First Publisher. The E-mail front end supports any Message Handling Service-based system.

Price: $249.
Contact: Software Publishing Corp., 1901 Landings Dr., P.O. Box 7210, Mountain View, CA 94039, (415) 962-8910; fax (408) 980-0729.

Circle 1009 on Inquiry Card.

Check Your Government Style

The new version of Grammatik Windows 2.0, Government Edition, for Windows works within Microsoft Word for Windows and Ami Pro from Lotus, letting you check your spelling, grammar, and style without quitting your word processor. The spelling checker includes more than 1000 government-specific spellings and acronyms and a proposal proofreading style for government contractors, Reference Software says. The new version also locates thousands of additional errors, including redundant phrases, clichés, and syntactic mistakes.

The Windows version and the standard Grammatik IV 2.0 Government Edition, which are available for DOS, the Mac, and Unix, let you access the user spelling dictionary of most word processors, allowing the checkers to recognize words, acronyms, and other special words that you've already added.


Circle 1012 on Inquiry Card.

Correct Your Grammar in Windows

Keep your track of the players in the word processing market is like riding a merry-go-round. Lotus acquired Samna, but not before Samna licensed technology to Software Publishing. Now WordStar has bought Lifetree, maker of the Correct Grammar checker. Lifetree will become part of WordStar's new Writing Tools Division.

That division's first product is Correct Grammar for Windows, which was already available in DOS and Mac versions. By using Dynamic Data Exchange, Correct Grammar lets you check any text, in any application, on the Windows Clipboard, WordStar says. You can select and check just a portion of a document, such as a sidebar.

Price: $99.
Contact: WordStar International, Inc., Writing Tools Division, One Harbor Dr., Suite 111, Sausalito, CA 94965, (415) 332-8692; fax (415) 332-8780.

Circle 1010 on Inquiry Card.

Prepare Documents in Unix GUIs

Intended for technical and business users, Asterix 1.1 offers low-cost but powerful document processing, with capabilities falling somewhere between those of a high-end word processor and a full-blown desktop publishing system. The system for Unix workstations runs under Motif and Open Look on SPARC-based and DEC RISC systems, the Sun-3, the Hewlett-Packard 9000 series 300, and Mips RISC System workstations.

Asterix Words is a WYSIWYG word processor, with style guides, X Clipboard cut and paste, advanced formatting, and book production capability. Asterix Graphics lets you create, edit, and modify graphics. You can create drawings in the graphics module or capture Hewlett-Packard Graphics Language, TIFF, or Encapsulated PostScript screen images.

An optional spreadsheet module supports interspreadsheet data links, projected tables, goal seeking, and multiple views.

The Asterix application set has a common group of macro tools and a programming language. Other features include audio for voice annotations, color images, fax support via macros, and interprocess communications. The company is also developing E-mail capabilities.

Price: $695; with optional spreadsheet, $995.
Contact: Applix, Inc., 112 Turnpike Rd., Westborough, MA 01581, (800) 827-7549 or (508) 870-0300; fax (508) 366-9313.

Circle 1011 on Inquiry Card.
There is a new arrival in personal computing. Fujikama, a leader in the design and manufacture of high quality motherboards for major O.E.Ms, has given birth to a new line of upgradeable modular computers. Now, you can have exceptional performance at affordable prices. Never before has an opportunity existed for so much power and compatibility in a modular design.

Our 386SX and 386DX CPU modules utilize the Intel smart cache design to provide 10% more power over conventional cache memory design. The result is pure speed. Fujikama personal computers are available with Industry Standard Architecture (ISA) or Extended Industry Standard Architecture (EISA). Each features a modular design that is upgradeable so what you purchase today will not be obsolete tomorrow. When you are ready to upgrade or expand you replace only the CPU. There are no switches to set and your data remains intact. In less than five minutes you can increase your computer power from 286 to 486 with the snap of a new board. The cost for upgrading is just as easy. You pay only for the upgradeable board, not the whole computer.

Fujikama modular computers come in a desktop, middle or large tower model. They feature full technical support and service. Call now for more information on how we can fulfill your opportunity to own the new modular family of personal computers from Fujikama.

SEE US AT COMDEX/SPRING '91! Booth 3843

FUJIKAMA is a registered trademark of FUJIKAMA O.A. Distribution. All other Registered Trademarks and other Trademarks are of their respective companies.
New Clipper Library Supports Vector Objects

Flipper 5.0, the graphics library for Clipper developers, now lets you include vector objects (e.g., circles, polylines, and boxes) and text in a drawing. The library lets you create maps, facility layouts, and other CAD drawings to better display data in your application, ProWorks says.

The company improved Flipper's printing capability by adding a PostScript driver and a virtual print driver that lets you print at the resolution of the printer, instead of at the lower resolution of the traditional print screen, the company says. You can also place PCX files anywhere on the screen.

Other Flipper features include 2-D and 3-D graph types, auto-scale axis and log scales, and unlimited points on a graph.

Price: $295.
Contact: ProWorks, P.O. Box 1635, Hermiston, OR 97838, (503) 567-1459; fax (503) 567-8820.
Circle 1013 on Inquiry Card.

Analyze Paradox Scripts

ScriptView 2.01 provides Paradox users with an advanced tool for analyzing and documenting scripts, Farpoint says. The utility generates graphical diagrams and comprehensive reports, including action diagrams, hierarchical-tree flowcharts, procedure relationships reports, and extensive variable cross-references and tables.

The new version supports the new language extensions of Paradox 3.5, including the Structured Query Language commands.

Price: $149.95.
Circle 1015 on Inquiry Card.

Communications Library for Clipper

SilverClip SPCS (SilverWare Professional Communications Series), SilverWare's newest communications library, brings interrupt-driven control of asynchronous communications to Clipper applications. SilverClip SPCS lets you access an unlimited number of communication ports and comes with source code.

Features include support for a 115,000-bps baud rate. Supported hardware includes DigiBoard's 4-, 8-, and 16-port boards, the AST 4 Port, and the IBM Dual Async Adapter. Terminal emulation includes ANSI, TTY, VT100, and VT52. The library also supports XMODEM, YMODEM batch, and ASCII. Other features include interrupt 14 redirection, for LAN compatibility.

Price: $299.
Contact: SilverWare, Inc., 3010 LBJ Freeway, Suite 740, Dallas, TX 75234, (214) 247-0131; fax (214) 406-9999.
Circle 1115 on Inquiry Card.

More Than 90 Commands for xBASE

The xBASELIB command library enables you to perform low-level DOS and BIOS commands from the dot prompt, the FoxPro command window, and programs like FoxBase+, dBASE III Plus, and dBASE IV version 1.1.

Sparkle developed the library to help you support and install your application and to help your application communicate with the printer. If you include the GETPC-ENV.PRG program in the application, for example, you can quickly obtain information about your client's PC environment.

The xBASELIB commands are written in assembly. You can move the commands from one version of dBASE to another without modifying them, Sparkle says.

Price: $195.
Circle 1014 on Inquiry Card.

More Than 1000 dBASE Utilities

EMS Professional Shareware Libraries' dBUtility Library has more than 1400 public domain and shareware utilities designed specifically for dBASE language developers, including dBASE III/IV, FoxBase, FoxPro, Clipper, QuickSilver, and others.

The product includes a database and search program for these and 800 additional commercial dBASE-related utility programs. With the database, you can search by name, type, vendor, or any text string when you need to find a particular type of utility or code routine. This way, if you can't find the utility you need in the shareware library, you can find it in the database of commercial vendors. The dBUtility Directory also lists dBASE BBSes, journals, and other information sources.

Price: $99.50.
Contact: EMS Professional Shareware Libraries, 4505 Buckhurst Court, Olney, MD 20832, (301) 924-3594; fax (301) 963-2708.
Circle 1016 on Inquiry Card.
Windows 3.0 demands memory. STB's PowerMEG delivers. You get 32 megabytes with virtually any combination of expanded, extended or backfill memory configurations. For 80286 and 80386SX systems with limited RAM capability, STB's PowerMEG is the ideal solution. You get maximum memory performance, too. PowerMEG provides 0-wait-state operation and high speed, 16-bit memory access within the EMS window. Plus, when you use PowerMEG's xtra RAM for Windows, your PowerMEG makes the most of your RAM, providing 0-wait-state operation and high speed, 16-bit memory access within the EMS window. The PowerMEG显著 improves overall system performance with Windows 3.0.

More memory, better performance and compatibility with LIM 4.0 in both hardware and software...only from STB's PowerMEG. Make the most of Windows 3.0. Choose STB's PowerMEG.

For more information about STB's other Power Peripherals, contact:

STB Systems, Inc.
1-800-234-4334

STB Systems, Inc.
A High performance RAM Expansion Adapter

PowerMEG

STB Systems, Inc.
A High performance VGA Adapter

PowerGRAPH ERGO-VGA

Windows 3.0 deserves spectacular graphics and vibrant colors. STB's PowerGraph ERGO-VGA delivers 256 brilliant colors in resolutions up to 1024 x 768. Plus, the adapter fully supports VESA 72Hz refresh for 640 x 480 and 800 x 600 resolutions, and 70Hz refresh for 1024 x 768. That’s power performance VGA.

PowerGraph ERGO-VGA also provides 256 color support for OS/2 Presentation Manager, XII windows, AutoCAD, PC Paintbrush and many more powerful programs. And the VESA SuperVGA BIOS Interface is included completely in ROM for transparent operation.

STB is an authorized Microsoft Developer, and PowerGraph ERGO-VGA receives full support of VESA. Choose STB's PowerGraph ERGO-VGA.

Circle 571 on Inquiry Card (RESELLERS: 572).
Make Your Graphs Leap off the Page

You'll gain perspective on your graphical data when you use Bloc Publishing's chart maker to plot it. 3-D Charts To Go! is compatible with Windows 3.0 and lets you create pie, bar, ribbon, and area charts. Each chart can exhibit a value range of up to 15 by 150 units, and you can merge up to 10 charts into a single display. A split-screen function lets you see your data as you produce a chart.

3-D Charts lets you transfer data from Windows software (e.g., Excel and Wings) without leaving the program. You can also import directly from Lotus worksheet files.

The program offers 17 chart-drawing patterns, as well as eight foreground and eight background colors. It supports Windows Meta File, PCX, and Windows Bit Map formats, so you can add clip art to your charts. You can rotate, size, or move the charts in different dimensions and use different colors, sizes, and fonts for all text.

3-D Charts To Go! requires Microsoft Windows 2.0 or higher, a display adapter that supports Windows, 640K bytes of RAM, and a mouse or tablet. Price: $99.95.

Contact: Bloc Publishing, 800 Douglas Entrance, Executive Tower Penthouse, Coral Gables, FL 33134, (305) 445-0903; fax (305) 444-5010. 

Circle 1017 on Inquiry Card.

An Eyeful of Imagery for the Mac

New clip-art collections from Newton Technology and SoftAge Publishing bring finesse to your professional presentations.

Newton Technology's GEOvista creates color or black-and-white maps that display information graphically on the Mac. You can import data from text files, spreadsheets, or databases and assign it to the maps that are included in the program. GEOvista features pull-down menus, cut-and-paste editing, and interacts with most Mac word processors and desktop publishing applications. The program is CD-ROM-compatible.

Price: $249.

Contact: Newton Technology, Inc., 70 Walnut St., Wellesley, MA 02181, (617) 239-8202.

Circle 1018 on Inquiry Card.

Presentation Team Makes an Impact

Presentation Team lets you create, edit, and store images in a single file, letting you page through a series of visuals as you would a document. You can use Presentation Team to create overhead transparencies, 35mm slides, printed copy, and on-screen presentations. The package offers direct software linkup via modem with MAGI Corp, a company that will create presentation materials from your visual files.

Price: $495; each network site, $395.

Contact: Digital Research, Box DRI, 70 Garden Court, Monterey, CA 93942, (408) 649-3896; fax (408) 646-6248.

Circle 1020 on Inquiry Card.

ANIMaxx Brings Graphics to Life

ANIMaxx brings low-cost animation to your PC. The program runs under Windows 3.0 and is compatible with Autodesk Animator .FLI format. The program comes with eight animations, or you can design your own.

ANIMaxx features frame flipping, single frame stepping, and continuous cycle functions, and it will animate images at rates of up to 15 frames per second. The program supports up to 256 colors and works with 2-D graphics tools or 3-D shapes and volumes.

ANIMaxx will run on a 286, but a 386 is recommended. The program requires a VGA, Super VGA, EGA, or 8514A video board.

Price: $33.95.

Contact: North Coast Software, P.O. Box 343, Barrington, NH 03825, (603) 332-9363; fax (603) 332-2137.

Circle 1021 on Inquiry Card.

88MW-10 BYTE • JUNE 1991
CACHE SAVINGS

MYODA LT 5200 CD
TWO FULL 16 BIT EXPANSION SLOTS
"Flexibility of a Laptop, Power of a Desktop"
$3,495
386-25
32KB Cache
- Expandable memory to 8MB on board
- Gas Plasma VGA Screen
- 40MB Moma IDE hard drive
- Detachable 106 key keyboard
- 25, YP, YP, XCRT Ports
- Free carrying case
FREE: Windows 3.0 and mouse, and DOS

MYODA LT 3500
$1,495 LAPTOP BARGAIN
- Intel 80386-CPU w/o Wait State
- 6MB Memory, Dual Speed
- EGA Graphics display
- 1MB on-board 3MB hard drive
- 3.5MB 12MB 5.25MB drive
- 40 MB (30MB) Hard drive
- Two serial parallel CRT port
- Free carrying case

MYODA 486-33 $3.199
486-25 $2.899
- 4MB RAM
- 1.2 & 1.44MB drives
- 120MB (18 mb) hard drive
- 14" SVGA monitor 0.28 DP
- 16 Bit SVGA card 1MB
- 101 keyboard
FREE: Windows 3.0 and mouse, surge protector, software

MYODA 386-33 $2.395
"High quality and low cost with full compatibility"
- 8MB cache SRAM
- 4MB RAM
- 1.2 & 1.44MB drives
- 120MB (18 mb) hard drive
- 14" SVGA monitor 0.28 DP
- 16 Bit SVGA card 1MB
- 101 keyboard
FREE: Windows 3.0 and mouse, surge protector, software

MYODA NOTEBOOK
Call for price
- Weighs under 7 lbs!
- Intel 80286-SX 16MHZ
- Standard 3.5MB, 4MB max
- 18.5" TN or LCD screen w/CRT backlight
- 3.5MB 12MB 5.25MB drive
- 1.44MB 3.5" Drive
- 20MB 160, 40MB optional
- Mouse, AC/DC, 85, YP, YP, external ports
- 80 key keyboard
FREE: Panasonic Notebooks available (call for price)

MYODA
1053 Shore Road, Naperville, IL 60563
1-800-562-1071
Tech Support: (708) 369-5331
- One year warranty on parts and labor
- Positive technical support
- Custom configuration
- All systems tested and approved
- 100% Compatability: DOS, OS/2, Novell, UNIX, XENIX, & LIM 4.0
- 15 Day money back guarantee
- RAM required
- Price and availability subject to change without notice

Please see us at COMDEX'91
Booth # 4452

Call for free color brochure.

Circle 563 on Inquiry Card (RESELLERS: 564).
Sync Sound to Autodesk Animations

The MediaSync multimedia system for the PC lets you attach trigger points to spoken words and phrases or to other events in a soundtrack, synchronizing animations and images to sound. The trigger points can actuate an audio response from a video event or vice versa, Genesis says.

The program's Frame-Accurate Audio Scheduling feature lets you synchronize soundtracks, audio effects, and volume changes from one or more frames in an Autodesk Animator or Autodesk 3D Studio animation. With the system, you can assign voice annotations to key frames during a building walk-through and synchronize footsteps and other sound effects right in the PC, eliminating the need to manually dub audio to the video portion after you record it to tape.

The MediaSync system includes a digital audio capture and playback board that samples at 16 kHz, offers 10-bit resolution, and uses 500K bytes of hard disk space for 1 minute of digital audio. A professional version of the program lets you organize presentations into interactive, hypermedia applications. If you don't require full-fidelity audio, the company offers MediaSync: Sound Blaster for owners of the 8-bit Sound Blaster audio card who want to play . VOC files.

Price: $695; professional version, $895; Sound Blaster software, $199.

Contact: Genesis Development Corp., 15850 West Bluemound Rd., Suite 307, Brookfield, WI 53005, (414) 796-1005; fax (414) 797-0727.

Circle 1022 on Inquiry Card.

A Librarian for Your Floppy Disks

For that moment when you need a file but can't determine on which floppy disk the file resides, Stuart-Matlock developed Floppie Librarian V.

The utility helps you manage your floppy disks by letting you locate any file on any disk sorted by disk number, category, user code, and disk description title. The company claims you can categorize a disk in 3 seconds, or about 500 disks in 2 hours. When you put the floppy disk in its drive, the program seeks out and identifies executable, data, and other files to create the database. A memo pad lets you attach a description of up to 65,000 characters for each disk.

Floppie Librarian V generates five reports, including disk directory, evaluation, capacity, category, and comprehensive media information.

Price: $59.95.

Contact: Stuart-Matlock

Circle 1023 on Inquiry Card.

Two Disk-Duplicating Programs

FormGen's disk-copying utility offers companies, services, and publishers a way to quickly format and duplicate disks. The program manages the entire process, including formatting, serialization, duplication of program masters, and statistics gathering.

ProCopy requires a PC with an automatic disk-loading device. FormGen claims the program can reduce disk-duplication time to less than 10 seconds per disk.

Price: $295.

Contact: FormGen Corp., 13 Holland Dr., Bolton, Ontario, Canada L7E 1G4, (416) 857-4141; fax (416) 857-4531.

Circle 1025 on Inquiry Card.

Micro System Designs says its DiskDupe Pro can duplicate 62 disks per hour, and up to 200 disks per hour if they have been formatted. The company says the utility reads the master disk into memory and onto the hard disk drive, making as many copies as necessary without having to re-read the disk. DiskDupe uses the hard disk as a buffer without slowing down the copying speed, according to MSD.

Price: $179.

Contact: Micro System Designs, Inc., 4962 El Camino, Suite 204, Los Altos, CA 94022, (415) 964-2844; fax (415) 964-4529.

Circle 1026 on Inquiry Card.
A Big Cursor and Two Whisker Ticklers

Two companies, Fanfare and Numbers, have released utilities that can reduce the time you spend mouse-clicking. Fanfare's Magic Cursor! also diminishes squinting.

Fanfare's Right On!, a mouse utility for Windows 3.0, lets you make better use of the right and middle mouse buttons. You can set the right or middle button to simulate a left-button double-click, send any keystroke, or run any program. By simulating a left-button double-click with a single click, you can save time, Fanfare says. You can program up to eight different actions for the two buttons, for a total of 16 possible settings, Fanfare says. With the Magic Cursor!, you can enlarge and customize a standard Windows arrow, making it easier to see. Magic Cursor!, $49.95. Contact: Fanfare Software, 9420 Reseda Blvd., Suite 828, Northridge, CA 91324, (818) 886-8787.

Numbers' enhanced version 3.01 of Whiskers for Windows 3.0 lets you reprogram the middle and right buttons of the mouse and simulate a middle button on a two-button mouse. You can assign a left double-click to either the right or the middle button. You can also assign commands to the mouse, as well as instruct Whiskers to automatically turn itself off in applications that already use the right or middle button.

Developed for the two- or three-button mouse, Whiskers 3.01 works with any Windows 3.0 application. You can toggle Whiskers on and off. Price: $24.95. Contact: Numbers & Co., Route 1, P.O. Box 59A, Oroville, WA 98844, (509) 476-2216. Circle 1028 on Inquiry Card.

Automated Software Testing with the Elverex Evaluator

The Evaluator is a software test system which automates the hand testing and retesting of software. Software can now be tested unattended, 24 hours a day, seven days a week.

The Evaluator has a powerful, built-in test generator that eases the task of test development and execution. The Evaluator Test Control Language and C Test Library allows comprehensive tests to be developed from software specifications. Evaluator automatically generates a report for each test conducted, providing all the information necessary to maintain comprehensive test standards. Because Evaluator can test graphics and text mode applications using keyboard and mouse input, there are few applications Evaluator cannot work with. DOS, OS/2, Unix, Windows and Presentation Manager applications can all be tested. Using a PC in terminal emulation mode, Evaluator can test minicomputer and mainframe software just as well.

Evaluator is a non-intrusive, hardware-assisted software test system. No code is loaded with the software being tested, therefore Evaluator will not affect the behavior of the software being tested. You can rest assured that tests carried out using Evaluator are as valid as hand testing.

Testing with Evaluator means higher quality software, it means shorter development times, it means higher profits and greater market share.

C Language Library

A library of C functions is available which can be used in conjunction with the Learn Mode and TCL facility for complete flexibility in test development. Large scale test programs can be developed in C. Examples of applications are benchmarking, data retrieval from external databases and testing numerical software.

Supports Microsoft C, Turbo C, and C++

Eastern Systems Inc.

P.O. Box 310, 117 South St., Hopkinton, MA 01748
508-435-2151 FAX 508-435-2517

Circle 557 on Inquiry Card.
VGA Series - Color Portable
Imagine a 486 or 386 portable with a true and unlimited color display. Introducing the only desktop portable that offers a built-in color super VGA monitor, 5 expansion slots, 3 drive bays and plenty of processing power packed into a suitcase. The lightest and smallest VGA portable series - a truly professional computer. (Call for the Mono CRT Series).

PLV Series - The Flat Display Portable
A 486 to 386 based lunchbox style high contrast crisp and clear gas plasma portable with all the features of the VGA series.

NBV Series - Note Book
The perfect computer for the executives on the road or students. A battery powered computer that will fit nicely into your briefcase yet weight less than 5.8 pounds!

A fast processor equipped with a fast internal hard disk drive and a 1.44 MB floppy disk drive. The winning combination, the executive companion.

To Order:
Call 1-800-888-5369

Ordering Information:
Hours: Mon - Fri 8:30 am - 5:30 p.m. Pacific
VISA, MasterCard, COD and PO
One year direct factory limited warranty
All brandnames are trademarks of respective companies.

BI-LINK
BI-LINK Computers, Inc.
11606 E. Washington Blvd., Suite A & B, Whittier, CA 90606 • Tel: (213) 692-5345 Fax: (213) 695-9623 Tech: (213) 695-5166
Circle 553 on Inquiry Card (RESELLERS: 554).
A Tool for Manipulation

Adobe's TypeAlign for Windows lets you creatively control type by rotating and shaping words with type. You can also add color or gray-scale effects.

You can paste the typographic effect into a Windows word processor or desktop publishing package via the Clipboard or save it as an Encapsulated PostScript file. You can take a "snapshot" of the target document and use that as a template in TypeAlign. The type object you create will fit perfectly into the document.

From the tool palette, you can draw straight, oval, or curved freehand lines for entering text. The software calculates the path and puts the text on the line.

TypeAlign requires Adobe Type Manager for Windows (ATM).

Price: $99; ATM, $99.
Contact: Adobe Systems, Inc., 1585 Charleston Rd., P.O. Box 7900, Mountain View, CA 94039, (800) 833-6687 or (415) 961-4400; fax (800) 235-0078.

Circle 1029 on Inquiry Card.

FaceLift Gets a Face-Lift

Bitstream has answered the wishes of WordPerfect users who've been waiting for a version of FaceLift that supports on-the-fly font generation for dot-matrix and ink-jet printers.

FaceLift 1.5 for WordPerfect supports the Hewlett-Packard LaserJet series of printers plus the HP DeskJet, Canon BubbleJet, and other printers.

FaceLift 1.5 for WordPerfect ships with three Symbol typefaces plus the 13 typeface outlines provided in the original package.

Price: $99.
Contact: Bitstream, Inc., 215 First St., Cambridge, MA 02142, (800) 522-3668 or (617) 497-6222; fax (617) 868-4732.

Circle 1030 on Inquiry Card.
A Window to the World of DDE

The Dynamic Data Exchange method of passing information to and from Windows applications is a powerful, yet somewhat mysterious, communication technique. A tool for Windows 3.0 called DDEWatch lets you monitor DDE messages and validate DDE macros and programs.

DDEWatch lets you view any detail of a DDE message. It displays the message type, the name of the application, the topic, the item, and the symbolic name for each bit flag, TechSmith says.

DDEWatch also provides a list of all active sessions. You can use the utility to verify flag settings, memory allocation, atoms, and data.

TechSmith has also released Snaglt, a screen-and-capture program for Windows that can capture a partial or whole screen. Price: DDEWatch, $85; Snaglt, $79.

Contact: TechSmith Corp., 1745 Hamilton Rd., Suite 300, Okemos, MI 48864; (517) 347-0800; fax (517) 347-0230. Circle 1031 on Inquiry Card.

Windows Search Utility

Searcher lets you check multiple disks using a variety of techniques to find files or text. You can search for a file created before or after a certain date, for a file larger or smaller than a given size, or for a specific text string.

Files that match your criteria are displayed in scrollable list boxes, which include filename, path, size, date, file attributes, and location of the text string in the file.

When you find the file, Searcher lets you execute the file's application by double-clicking on the data file. Price: $14.95; site license, $29.95.

Contact: Cognitronix, 10750 Rickert Rd., Suite 5, San Diego, CA 92126; (619) 549-8955. Circle 1033 on Inquiry Card.

Four Utilities for Windows 3.0

The Gedys Windows-Tool File Management package offers four Windows utilities. TextSearch locates specific occurrences of text within files, directories, and networks. It supports wild-card and regular expressions.

MultiCopy lets you copy disks without swapping. The utility lets you copy a large application onto your hard disk, and it will split files when copying onto floppy disks. MultiCopy can also copy disks in different formats.

SystemInfo graphically depicts the amount of space occupied by programs, data, and directories. HexEdit lets you view and edit files in hexadecimal or ASCII format.

Price: $98.

Contact: Oxko Corp., P.O. Box 6674, Annapolis, MD 21401; (301) 266-1671; fax (301) 266-6572. Circle 1032 on Inquiry Card.
Microcom Computers
An HRW Technologies Company

Mouse for $19.99 with any system purchase

MICROCOM’S NEW 386SX/16 VGA NOTEBOOK (W/2 MB RAM)
- Intel 80386SX/16 CPU w/2 MB RAM Standard (Expandable to 6 MB)
- Backlit supertwist LCD Display w/VGA Resolution (640 x 480 in 16 Gray Shades)
- Rugged 20 MB Hard Disk & 3.5" 1.44 MB Floppy Drive
- Parallel, Serial, VGA Display & Keyboard Ports
- NIC card battery & AC power/auto recharging adaptor
- Weighs Only 6.3 pounds

SPECIAL: Non-Interlaced 1024 x 768 14" Hires Monitor w/1024 x 768-256 Color Graphics Card (1 MB)
- Flawless & Flicker-free Non-Interlaced Graphics at up to 1024 x 768 Resolution
- Utilizes Tseng Labs revolutionary ET-4000 Chip & 1 MB of Video RAM
- Adv. Drivers included for Windows 3.0, Autocad, WordPerfect & many others

Non-Interlaced 1024 x 768 14" Hires Monitor Features:
- Non-glare etched Screen w/0.28mm dot pitch
- Upgrade from Hires System Packages for $290

Standard Systems include:
- Choice of Teac 5.25" 1.2 MB or 3.5" 1.44 MB Floppy Drive
- 1:1 Interleave Hard Disk/Floppy Controller
- Enhanced 101-key Keyboard
- 2 Serial Ports
- Parallel Port
- Real-time Clock/Calendar w/Battery Backup
- Small Footprint Case (286-386SX-386/25) or Tower Case (386/33C-A386/40C-486/25C-486/33C)

Microcom Desktop Systems
Standard System - Hard Drive - Monitor & Video Card

<table>
<thead>
<tr>
<th>Hard Drives:</th>
<th>IDE</th>
<th>IDE</th>
<th>IDE</th>
<th>IDE</th>
<th>ESDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB/Ms</td>
<td>256/12 Mono VGA</td>
<td>$799</td>
<td>$999</td>
<td>$999</td>
<td>$1,299</td>
</tr>
<tr>
<td></td>
<td>256/12 Hiras Special</td>
<td>$1,149</td>
<td>$1,199</td>
<td>$1,149</td>
<td>$2,349</td>
</tr>
<tr>
<td></td>
<td>266/16 Mono VGA</td>
<td>$849</td>
<td>$999</td>
<td>$999</td>
<td>$1,349</td>
</tr>
<tr>
<td></td>
<td>266/16 Hiras Special</td>
<td>$1,199</td>
<td>$1,249</td>
<td>$1,149</td>
<td>$2,399</td>
</tr>
<tr>
<td></td>
<td>386SX/16 Mono VGA</td>
<td>$1,099</td>
<td>$1,249</td>
<td>$1,199</td>
<td>$2,499</td>
</tr>
<tr>
<td></td>
<td>386SX/16 Hiras Special</td>
<td>$1,449</td>
<td>$1,499</td>
<td>$1,399</td>
<td>$2,649</td>
</tr>
<tr>
<td></td>
<td>386/25 Mono VGA</td>
<td>$1,299</td>
<td>$1,499</td>
<td>$1,249</td>
<td>$2,649</td>
</tr>
<tr>
<td></td>
<td>386/25 Hiras Special</td>
<td>$1,649</td>
<td>$1,799</td>
<td>$1,549</td>
<td>$2,849</td>
</tr>
</tbody>
</table>

Microcom Tower Systems (Cache)
Standard System - Full-size Tower Case - Hard Drive - Monitor & Video Card

<table>
<thead>
<tr>
<th>Hard Drives:</th>
<th>IDE</th>
<th>IDE</th>
<th>IDE</th>
<th>IDE</th>
<th>ESDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB/Ms</td>
<td>386/33C w/464K Cache</td>
<td>$599</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A386/40C w/128K Cache</td>
<td>$899</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>486/256K Cache &amp; Internal 68K Cache</td>
<td>$1,299</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Microcom Tower Systems (Cache)
Standard System - Full-size Tower Case - Hard Drive - Monitor & Video Card

<table>
<thead>
<tr>
<th>Hard Drives:</th>
<th>IDE</th>
<th>IDE</th>
<th>IDE</th>
<th>IDE</th>
<th>ESDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB/Ms</td>
<td>386/33C Hiras</td>
<td>$1,299</td>
<td>$1,299</td>
<td>$1,299</td>
<td>$1,299</td>
</tr>
<tr>
<td></td>
<td>A386/40C Hiras Special</td>
<td>$1,699</td>
<td>$1,699</td>
<td>$1,699</td>
<td>$1,699</td>
</tr>
<tr>
<td></td>
<td>486/25C Hiras Special</td>
<td>$1,999</td>
<td>$1,999</td>
<td>$1,999</td>
<td>$1,999</td>
</tr>
<tr>
<td></td>
<td>486/33C Hiras Special</td>
<td>$2,349</td>
<td>$2,349</td>
<td>$2,349</td>
<td>$2,349</td>
</tr>
</tbody>
</table>

Introducing Microcom's A386/40C Tower System
A386/40C Tower System/128K Cache
Utilizing AMD's New Am386DX/40 CPU
- Fast 40 MHz Operating Speed using AMD's New Am386DX/40 CPU
- Over 9 MIPS (Million Instructions Per Second) Throughput
- Over 20% Faster Than 33 MHz 80386 Systems
- Standard System Features w/Full-size Tower Case
- 1 MB RAM Standard (Expandable to 32 MB)
- 128K Cache Standard for Optimal Performance (Expandable to 256K Cache)
- Please see Tower Systems Price Matrix for Pricing

Microcom Computers' Customers Include:

To Order - Call Toll Free 1-800-248-3398
Open from 9:00 A.M. to 6:00 P.M. PST, Monday-Friday

Prices are subject to change without notice. Not responsible for typographical errors. CA Residents, please add 7.00% sales tax. No surcharge on credit card purchases. Personal and company checks require 14 days to clear. All trademarks acknowledged. Microcom Computers reserves the right to substitute any and all items with equivalent or better parts. Prices do not include shipping & handling.

Circle 562 on Inquiry Card.
Background Images for All

ImageTects has released a CD-ROM disc with texture maps, images, and backgrounds for Amiga, DOS, Mac, and Unix graphics and desktop publishing applications.

The ImageCELs disc includes images and textures stored in subdirectories for the following file formats: TGA 16-, 24- and 32-bit; TIFF 8- and 24-bit; CEL 16- and 32-bit; Apple PICT 24-bit; Amiga IFF; GIF; PCX; 116 (for Intel DVI); and DIB 8-bit (Windows). The disc offers more than 1150 texture maps and images.

One of the benefits of the disc is that ImageTects has included a proprietary matching technology for the seamless integration of images in your drawing. For example, if you need to map a large wireframe model of a building wall with brick, the technology would merge four brick swatches so that it would appear seamlessly as one large brick surface.

On floppy disk, the company offers a people module ($99) and two modules of 160 textures ($149 each), each in DOS TGA 16-bit or PICT2 24-bit formats. The company has also released three modules of evergreen, deciduous, and indoor plant libraries for DOS TIFF and TGA 16-, 24-, and 32-bit files ($249 each). Price: ImageCELs CD-ROM, $395.

Contact: ImageTects, 7200 Bollinger Rd., Suite 802, San Jose, CA 95129, (408) 252-5487; fax (408) 252-7409. Circle 1034 on Inquiry Card.

Mo’ Better System 7.0

Of all software categorized, painting programs usually have a philosophy of more is better. SuperMac Software’s PixelPaint Professional 2.0 holds true to this dictum while compensating with logical and intuitive design. The company says it rewrote the product to take advantage of System 7.0. The program is the first from SuperMac Technology’s spin-off software company, formed in March.

The program sets out to provide approximations of real-world artist’s tools, such as brush and paper types, while supplementing these with capabilities only achievable on computers. Artists can duplicate the effects of watercolors, pastels, and charcoal sticks, for example. A PixelPaint feature lets you mimic painting on different mediums (e.g., linen, concrete, rice paper, and user-defined paper). PixelPaint Pro includes standard image-processing capabilities, like color correction and contrast controls.

The program supports the Wacom digitizer tablet and can use its pressure information to control the flow of ink on some of the tools. PixelPaint Professional supports type kerning and CMYK (cyan, magenta, yellow, black) color separation.

Price: $799.

Contact: SuperMac Technology, 485 Potrero Ave., Sunnyvale, CA 94086, (408) 245-2202; fax (408) 735-7520. Circle 1117 on Inquiry Card.
Two for the Road...

VDS International has done it's homework again! Providing you with one of the best 386SX Notebooks on the market today—the Everex Tempo LX!

"The best notebook PC yet... looks like other SX notebooks, EXCEPT this one deserves the award for best notebook PC yet!... even such famous names (Toshiba, Epson, IBM) will be hard pressed to top the TEMPO LX"
—PORTABLE OFFICE, May, 1991

"...Sharpest, crispest LCD monochrome VGA image we've seen...
—PC WORLD, May, 1991

32 bit Intel® 80386SX with 16Mhz, 1 MB RAM, 21MB Hard Drive and 10" VGA Display
- 1.44MB internal disk drive
- RAM expandable up to 5MB
- Hard Drive expandable up to 40MB
- Lightweight, only 7 lbs. including NiCad battery
- IBM® AT® compatible, with 82 keyboard
- Small foot print, only 2" x 10" x 12"

Not only have we carefully selected the Tempo LX as the perfect solution to your computing needs, we've added the Cannon® BJ-10e Bubble Jet® printer for a powerful two-for-the-road combination.

Extremely quite 64 nozzle Bubble Jet print head

One Great Package Price $2750

The “Two-for-the-Road” Package Includes:
- Tempo LX 386SX Notebook & Carrying Case
- Cannon BJ10E Printer and Carrying Case
- MS-DOS 4.01 and Printer connector cable

"Two-for-the-Road" Options:
- 24/96 Modem - the size of a pocket calculator
- 30 Page Auto Sheet Feeder - Adds no weight
- Combo Carrying Case

30 Day Money Back GUARANTEE

Your satisfaction is Guaranteed at VDS, no hassles, no justification required (valid 30 days from invoice date, only products with original materials apply).

VDS INTERNATIONAL...where our success is measured by your satisfaction.
**BET ON A DERBY WINNER. . .**

<table>
<thead>
<tr>
<th>286/12-40 PRO</th>
<th>386/SX-80 PRO</th>
<th>386/SX-100 PRO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intel 80386-12, 16-bit</strong></td>
<td><strong>Intel 80386 SX</strong></td>
<td><strong>Intel 80386 SX</strong></td>
</tr>
<tr>
<td><strong>2MB RAM</strong></td>
<td><strong>2MB RAM</strong></td>
<td><strong>2MB RAM</strong></td>
</tr>
<tr>
<td><strong>40MB Hard Drive, 19ms with 64K Cache</strong></td>
<td><strong>80MB Hard Drive, 17ms with 64K Cache</strong></td>
<td><strong>105 MB Hard Drive, 17ms with 64K Cache</strong></td>
</tr>
<tr>
<td><strong>1.2MHz 5 1/4” Drive</strong></td>
<td><strong>1.44MB 3 1/2” Drive</strong></td>
<td><strong>1.44MB 3 1/2” Drive</strong></td>
</tr>
<tr>
<td><strong>200K Max VGA, 1 MB</strong></td>
<td><strong>2MB Max VGA, 1 MB</strong></td>
<td><strong>4MB RAM, 64K Cache</strong></td>
</tr>
<tr>
<td><strong>CTX-1024h, Super VGA Color Monitor</strong></td>
<td><strong>CTX-1024h, Super VGA Color Monitor</strong></td>
<td><strong>CTX-1024h, Super VGA Color Monitor</strong></td>
</tr>
<tr>
<td><strong>2 Serial, Parallel, Game Ports</strong></td>
<td><strong>2 Serial, Parallel, Game Ports</strong></td>
<td><strong>2 Serial, Parallel, Game Ports</strong></td>
</tr>
<tr>
<td><strong>DOS 4.01 &amp; MS Windows 3.0</strong></td>
<td><strong>DOS 4.01 &amp; MS Windows 3.0</strong></td>
<td><strong>DOS 4.01 &amp; MS Windows 3.0</strong></td>
</tr>
<tr>
<td><strong>Microsoft Mouse, 400 ppi</strong></td>
<td><strong>Microsoft Mouse, 400 ppi</strong></td>
<td><strong>Microsoft Mouse, 400 ppi</strong></td>
</tr>
<tr>
<td><strong>Mid-size Tower Case</strong></td>
<td><strong>Mid-size Tower Case</strong></td>
<td><strong>Mid-size Tower Case</strong></td>
</tr>
<tr>
<td><strong>$1,595.00</strong></td>
<td><strong>$1,895.00</strong></td>
<td><strong>$1,995.00</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>386/25-80 PRO</th>
<th>386/25-100 PRO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intel 80386-25, 32-bit</strong></td>
<td><strong>Intel 80386-25, 32-bit</strong></td>
</tr>
<tr>
<td><strong>4MB RAM</strong></td>
<td><strong>4MB RAM</strong></td>
</tr>
<tr>
<td><strong>80 MB Hard Drive, 17ms with 64K Cache</strong></td>
<td><strong>105MB Hard Drive, 17ms with 64K Cache</strong></td>
</tr>
<tr>
<td><strong>1.2MHz 5 1/4” Drive</strong></td>
<td><strong>1.44MB 3 1/2” Drive</strong></td>
</tr>
<tr>
<td><strong>1.44MB 3 1/2” Drive</strong></td>
<td><strong>2MB Max VGA, 1 MB</strong></td>
</tr>
<tr>
<td><strong>200K Max VGA, 1 MB</strong></td>
<td><strong>CTX-1024h, Super VGA Color Monitor</strong></td>
</tr>
<tr>
<td><strong>CTX-1024h, Super VGA Color Monitor</strong></td>
<td><strong>2 Serial, Parallel, Game Ports</strong></td>
</tr>
<tr>
<td><strong>2 Serial, Parallel, Game Ports</strong></td>
<td><strong>DOS 4.01 &amp; MS Windows 3.0</strong></td>
</tr>
<tr>
<td><strong>Microsoft Mouse, 400 ppi</strong></td>
<td><strong>Microsoft Mouse, 400 ppi</strong></td>
</tr>
<tr>
<td><strong>Mid-size Tower Case</strong></td>
<td><strong>Mid-size Tower Case</strong></td>
</tr>
<tr>
<td><strong>$2,495.00</strong></td>
<td><strong>$2,595.00</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>386/33C-100 PRO</th>
<th>386/33C-200 PRO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intel 80386-33, 32-bit</strong></td>
<td><strong>Intel 80386-33, 32-bit</strong></td>
</tr>
<tr>
<td><strong>4MB RAM, 64K Cache</strong></td>
<td><strong>4MB RAM, 64K Cache</strong></td>
</tr>
<tr>
<td><strong>105MB Hard Drive, 17ms with 64K cache</strong></td>
<td><strong>210MB Hard Drive, &lt;15ms with 64K Cache</strong></td>
</tr>
<tr>
<td><strong>1.2MHz 5 1/4” Drive</strong></td>
<td><strong>1.44MB 3 1/2” Drive</strong></td>
</tr>
<tr>
<td><strong>1.44MB 3 1/2” Drive</strong></td>
<td><strong>2MB Max VGA, 1 MB</strong></td>
</tr>
<tr>
<td><strong>200K Max VGA, 1 MB</strong></td>
<td><strong>CTX-1024h, Super VGA Color Monitor</strong></td>
</tr>
<tr>
<td><strong>CTX-1024h, Super VGA Color Monitor</strong></td>
<td><strong>2 Serial, Parallel, Game Ports</strong></td>
</tr>
<tr>
<td><strong>2 Serial, Parallel, Game Ports</strong></td>
<td><strong>DOS 4.01 &amp; MS Windows 3.0</strong></td>
</tr>
<tr>
<td><strong>Microsoft Mouse, 400 ppi</strong></td>
<td><strong>Microsoft Mouse, 400 ppi</strong></td>
</tr>
<tr>
<td><strong>Mid-size Tower Case</strong></td>
<td><strong>Mid-size Tower Case</strong></td>
</tr>
<tr>
<td><strong>$2,895.00</strong></td>
<td><strong>$3,195.00</strong></td>
</tr>
</tbody>
</table>

**DERBY DELIVERS**

- One Year Warranty
- 72 Hour Burn-In Testing
- Life Time Toll Free Technical Support
- All Systems Built In the USA
- 30 Day Money Back Guarantee (Less any shipping charges)
- Shipping & Handling $45.00
- Same Day Shipping
- Optional On-Site Service
- No Surcharge on Credit Cards
- New sales hours: 9am - 6pm CST M-Sat.

**1-800-24-DERBY**

1-800-243-3729

Circle 555 on Inquiry Card (RESELLERS: 556).
I have major deadlines, so the phone is ringing. It never fails: whenever I have tight deadlines and try to write in the daytime, the phone rings. This time it was the Los Angeles Times wanting me to subscribe. The fact that I have been a subscriber for 25 years at this address means nothing to them. Their solicitor has a computer doing the calling, and apparently there is no one at the Times smart enough to have their computers cross-check with the subscriber list, thus saving me time and them the money they pay for both the phone calls and the solicitor. The solicitor isn’t allowed to cancel subscriptions; apparently, quite a few people get angry enough to try that. I’ve recently been getting two Times calls a week, and I’ve begun to fantasize about guerrilla warfare.

As it happens, I was the keynote speaker at CASE World yesterday, and while there I went through the exhibits. It looks to me as if there are plenty of companies who could sell the Times, at fairly low cost, computer-aided software engineering tools that would generate programs that could take the Times solicitor list and eliminate numbers corresponding to subscriber addresses. It wouldn’t even cost all that much. I wonder how I can get their attention so they’ll do that?

Arche and Friends
Years ago I was involved in studies of thinking; I believe that has since become known as cognitive psychology. An early giant in the field was Sir Frederic Bartlett of Cambridge, whose book Thinking (Basic Books, 1958) has an experimental study of strategies on how people approached intellectual problems. The studies involved various games in which you try to deduce rules from card layouts (a very simple rule might be one red, two black, and so forth; a more complex one might be one heart, two black, one diamond, one spade). The idea was to guess the rule at the earliest possible moment, and one of the studies was the effect on strategy caused by changing the cost of incorrect guesses.

When we get new machines here, we tend to fill them up with boards and use them as test-beds; this corresponds to the strategy of wild guessing, since, if something doesn’t work, it’s hard to know just why when you’re trying seven new things at once. On the other hand, it’s a lot of fun if things do go right.

When we got the Arche Legacy 486/33, we opened it up. The machine I have is the tower configuration. Getting it open required the removal of several obvious screws and digging around to find two more hidden screws. There’s nothing particularly wrong with this arrangement, but it does slow things down a mite when you want to make hardware changes.

The internal layout of the Arche 486 is logical and quite solid. The VGA card has 512K bytes of memory; it will hold more, but we didn’t have any handy, so I left it as is. There is one fan in the case, but all the hardware for a second fan has been included. I’m thinking of getting another fan because we stuffed the machine full of boards.

We installed a Corel Optical Disk Interface Board, which connects to a Pioneer DE-S7001 external optical disk drive; a Sound Blaster; an Artisoft LANtastic board; Intel’s Satisfaction coprocessor board; and a Microsoft Mouse on the COM2 serial port. I wanted to put in a CD-ROM board as well, but I didn’t have one handy. What I really want is to daisy chain the Pioneer six-pack CD-ROM drive to the DE-S7001; Corel says that’s possible, and they’ll send the drivers. More next column.

DOS Hang-Ups
When PC-/MS-DOS 1.0 was first developed from the Seattle Engineering rewrite of CP/M, it had major limits. One was the 640K-byte memory boundary: since existing machines could use only 64K bytes, surely going up a whole order of magnitude would be enough for decades, right? Another was the 32-megabyte disk partition size. In those days, hard disk drives were rare, and a 10-MB drive was a big one. Even so, they should have known better than to limit logical disk size to 32 MB. They didn’t, though, and we were stuck with the result.

The Arche 486 came with MS-DOS 3.3, so that the 348-MB hard disk drive was partitioned into logical
drives C through M. I used to prefer having a number of logical drives. Partitioning makes many disk operations faster. Search programs have fewer files to look through, and the disk heads have shorter distances to travel. On the other hand, partitioning can make finding things difficult. Over the years, I have come to the conclusion that the advantages of small partitions are outweighed by the disadvantages. Therefore, at some point I will probably reorganize my main machine to one big disk partition.

The question then becomes, what DOS will I use when I do that? The candidates are one of the extended MS-DOS 3.3 versions, MS-DOS 4.x, MS-DOS 5.0, and DR DOS 5.0. We can dismiss MS-DOS 4.x immediately. It's big, it's slow, and it has real problems. I don't recommend it to anyone.

The extended versions of MS-DOS 3.3 work pretty darned well, but their problem is that they tend to be machine-specific. The Compaq version seems to work on most other machines, but can you be sure it will work on yours? Compaq certainly isn't going to support its use on non-Compaq machines. Zenith's MS-DOS 3.3+ works fine on Zenith equipment, but it just plain doesn't work on most non-Zenith machines. Similar problems apply to every MS-DOS 3.3 extension I know of.

At present, MS-DOS 5.0 exists only in a beta-test version. That leaves DR DOS 5.0. Up to now, I had been reluctant to use DR DOS because it didn't work with LANtastic. I like LANtastic because it does about all I need a network to do and doesn't eat up all my RAM doing it. However, Digital Research now offers a "business upgrade" to DR DOS 5.0 that is supposed to work with LANtastic.

DR DOS has a number of advantages on a 386 (or 486): in addition to supporting enormous hard disk partitions, DR DOS stuffs the command kernel up into high memory, thus increasing memory available for programs. It comes with an EMS manager, so programs that know how to use that kind of memory can do so. It has a neat full-screen editor to replace the excrable EDLIN. There are a bunch of convenient commands, such as using up-arrow to go back through the most recent commands you've issued in case you want to repeat one. The old Norton Directory Sort works just fine with DR DOS. And so forth.

I wasn't sure that it would work with LANtastic, but I won't be able to link to the Arche 486 with LANtastic for a while anyway, so this seemed like a good opportunity to give DR DOS a try.

Lots of Memory
DR DOS installation is simple; just follow instructions. Optimizing the system to get a maximum temporary program area can be a bit more difficult, depending on what you've installed; in our case, with all those boards stuffed into the system, it took a while.

The biggest problem was the Corel software. For reasons not clear to us, the automatic installation didn't work. (It didn't work with the MS-DOS 3.3 the Arche 486 came with, either.) When we tried doing it by hand, we got a whole bunch of contradictory switches into the DEVICE= line in the CONFIG.SYS file. This greatly increased the size of the Corel driver, which made it impossible for DR DOS to stuff the driver into high memory.

Taking care of that problem required phone calls, which gave me a highly favorable impression of Digital Research's technical support. It's a toll call, but when you get someone, you get someone who really knows DR DOS. The Digital Research people even called Corel for us, which is how we found out that we had contradictory switches in the command line.

The result was that after a good bit of tweaking, I have the Arche 486 running the Satisfaction board, Microsoft Mouse, and Pioneer optical disk drive, with over 600K bytes of usable memory.

Optical Disk Drive System
The Pioneer drive takes two kind of cartridges: read/write and WORM (write once, read many times). Both hold 330 MB (per side if double-sided). The drive appears (on this system) as the N drive, and so far it seems to work fine. In read/write mode, I have copied stuff into it, copied that back off onto the hard disk drive, and checked that copy against the original; all's well. I've also reformatted the read/write cartridge a couple of times and done the tests again, with the same result.

It works, both as read/write and as WORM.

Having said that, let me add some cautionary notes.

First, when this box is used as a WORM drive, all's well. WORM technology is well understood, and once a file is written, the WORM record is as permanent as anything done electronically can be.

I'm not quite as certain about optical read/write files. Everything seems to work, but I want to do a lot more testing over a much longer period of time before I'll trust that as the only backup copy of
Finally, ESIX System V Release 4.0, the UNIX Operating System of choice is here. Based on AT&T® System V UNIX®, ESIX Release 4.0 is a stable, fully backward compatible and robust operating system with enhanced features and functionalities.

For all the current System V Release 3.2 owners, ESIX offers an easy upgrade path to ESIX Release 4.0. For more information about ESIX System V Release 4.0 product offerings, please call:
1(800) 821-0806 Ext: 2068 or (415) 683-2068

Fax: (415) 651-0728
48431 Milmont Dr.
Fremont, CA 94538, USA

Circle 106 on Inquiry Card.
an important file. It's a newer technology and requires a great deal more precision than WORM storage.

Incidentally, if you want an introduction and exposition on the whole optical-storage field, *A Guide to Optical Storage Technology* by John A. McCormick (Dow Jones-Irwin, 1990) is as good as anything I've seen—a good balance of readability and technical information.

Anyway, we did have one glitch. One way I test equipment is through visually intensive games, and one of the best for that is Wing Commander, which really flogs both the computing and visual-imaging capabilities of the machine. When we got DR DOS up and running, we tried Wing Commander, which worked (as did Sound Blaster with its game port). I then copied Wing Commander onto the N read/write optical drive and tried running the game from there.

The machine locked up tight, with hardware reset required. Moreover, the Pioneer drive was no longer accessible, and attempts to access it hung the system again. I had to turn the Pioneer drive off and back on, as well as reset the computer, to get things working properly. It wasn't the files: I copied the files from the N drive onto the K partition of the hard disk and ran the game off that copy; it worked fine.

Today I had occasion to call Alex Karahalios, Artisoft's technical expert, and we speculated about what could cause that to happen, but we couldn't come to any conclusions. "Timing errors" is one obvious phrase. "BIOS calls" is another; but what those mean isn't clear. More when I know more. Read/write optical is likely to be the wave of the future, and I'm glad to have the Pioneer DE-S7001 for testing; I'll let you know how it comes out. Meanwhile, my advice on read/write optical is, "Be not the first by whom the new is tried, nor yet the last to lay the old aside." Make a WORM copy of important files.

**Fooling Around**

Once I had the system working under DR DOS, it was time to experiment with Desqview. For a few years, my main machine has been the Cheetah 386/25 with a Distributed Processing Technology (DPT) hard disk drive controller. Some of you may remember that I also have a Cheetah 486/25 with a Perceptive Solutions, Inc. (PSI) controller and wonder why I don't use that as the main machine here.

The answer is that I probably will, but it's not as simple as you think. For some weeks now, my partner Larry Niven and I have been working on a pair of novels. One, *Fallen Angels*, is finished and ought to be in bookstores about the time this column comes out. The other, *The Moat Around Murcheson's Eye*, is about half done, and we're hard at work on it. Niven and I are often asked how we collaborate; we generally answer, in unison, "superbly," and let it go at that. But, in fact, it's a reasonable question: we have probably used every conceivable means, from talking things out and working alone to working in the same room with one looking over the other's shoulder.

Lately, a modification of that latter technique has been working very well: Larry has one machine, I have another. I write a chapter and put in block notes where I don't write scenes; he goes over that to convert notes into text and adds notes of his own; I go over it again; and so forth. That technique often produces a
Rainbow Technologies Protects Software Better.
In More Places.
For More Developers.
And For More Good Reasons.

For the most solutions, best support and worldwide availability in PC, MAC and LAN software protection, there's no reason to look further than Rainbow Technologies.

Rainbow Technologies features:
• DOS, OS/2, Windows, UNIX, XENIX and MAC compatibility
• Protection for SPX/IPX and NetBios networked software
• Algorithm and memory devices to suit your application
• The most drivers/interfaces for quick implementation
• Proprietary ASIC designs for confidentiality
• Proven reliability—more than 1.5 million keys installed
• Transparent operation for the end user

1-800-852-8569

Protect your revenues. Call toll free today to plug Rainbow Technologies into your software plans. Evaluation packages are available.

Rainbow Technologies provides:
• World class technical assistance
• Custom application engineering
• Toll free Hot Line support
• Delivery in 5 days or less
• In stock availability in 15 countries
• Clear and comprehensive documentation
• The broadest warranty coverage available

Copyright ©1991 Rainbow Technologies, Inc. All product names are trademarks of the respective holders.
More and more business people are making the same connection:

that for affordability, reliability and efficiency, LANtastic™ is the networking solution

Doctors, lawyers, accountants, butchers, bakers and pottery makers... more and more business people are connecting their PCs with Artisoft's LANtastic. In fact, our network has gained such a following that it was just awarded the 1991 LAN Times Reader's Choice for peer-to-peer network operating systems. And we couldn't be prouder.

After all, we designed LANtastic to make the productive power of a full-featured LAN accessible to anyone who wanted to streamline their computer operations. And whether you're connecting two PCs or 30 or 200, you can rest assured that you are buying into a product that will grow as you grow, with a commitment to developing innovative products that anticipate the needs of business people like yourself.

Just look at how smart our network is... While many networks gobble up huge amounts of your PC's RAM, which usually means that you'll have to purchase extended memory, LANtastic leaves you plenty of room for even your most RAM-hungry applications. In fact, it's the most RAM-efficient LAN you'll find — taking as little as a mere 12K per workstation and 40K per server.

LANtastic saves you money, too. For as little as $209* per PC, you'll have everything you need to get your network up and running. Plus, you can share all those expensive peripherals — not buy more of them. Better yet, because LANtastic is a peer-to-peer network, you won’t have to spend thousands on a dedicated server machine.

But most important, it makes networking so easy that you'll soon be taking it for granted. You'll be able to edit and proofread your coworker's documents without leaving your desk. Balancing your books will be easier because your entire accounting department can share the same data base. Inventory management will be completely streamlined because everyone on the network can access inventory records and track products from when they are received as raw material, to when they are shipped as finished products.

In fact, the only regret you may have after you buy LANtastic is that you didn't install it last year, last month, even last week. Don't wait any longer. Call 602-293-6363 or fax 602-293-8065 and put the power of LANtastic to work for you.

*Based on manufacturer's suggested retail price for a 10-computer LAN using LANtastic 386dx adapters. Cost is slightly higher for smaller networks.
©1991 by ARTISOFT, Inc. All rights reserved. LANtastic is a trademark of Artisoft, Inc.
full chapter a day from absolute scratch. It will generally be a good chapter, too, since each of us rewrites as he goes along, with the result that by the end of the day, the text is as polished as it’s ever likely to be.

The secret of this technique is two machines connected in some way: in our case, by “sneaker net,” in that we save off onto floppy disks and hand them back and forth. (This automatically makes a backup, it’s nearly as fast as any other network would be, and I don’t have to teach Niven anything new.) As it happens, I can’t stand to have anyone look over my shoulder while I work; while Larry rather likes an appreciative audience. Thus, he has grown quite fond of the big 19-inch VGA Hitachi monitor that goes with the Cheetah 486.

Of course, I could simply attach that monitor to another computer, but Larry is also used to the blinding speed of the Cheetah 486; in particular, the PSI controller saves even the largest text files so quickly that Larry will often save them twice, since he’s convinced it couldn’t have saved it the first time. Even when it writes the file to a floppy disk, that PSI controller does it faster than many older machines save to a hard disk.

The result is that the fastest machine in the house is, during the day, not much more than a dedicated word processor. At night, after Niven goes home, it becomes the perfect instrument for playing Railroad Tycoon, Wing Commander, and War Lords, all of which are spectacular on that 19-inch screen. The moral of this story is that it doesn’t matter what you use your computer for: once you get used to speed and power, you never want to give them up.

Which brings me back to the Arche 486. As you’d expect, this thing is spectacularly fast; Wing Commander, for instance, is simply unplayable unless you use AT-Slow (shareware available on BIX), a program that, as the name implies, will turn your fast machine into a slower one when you want to play the kind of game that’s affected by speed. The hard disk access isn’t so spectacular, but still, it’s fast enough. However, when I’d copy stuff from a floppy disk into the Arche 486, it seemed to take a lifetime. Finally, I got curious about that; what I found is an interesting lesson in personal psychology.

The Arche 486 doesn’t really access floppy disks slower than most other machines in Chaos Manor; it’s just that when you log onto the floppy disk, or ask for a floppy disk directory, nothing happens for long enough that you notice it; then, suddenly, it all happens quickly. This makes it seem as if it has taken longer. So it goes. As to copying from floppy disks, the Arche 486 has about the same speed as the Arche, Premier, and Zenith 386s. Alas, that’s considerably slower than my Cheetah 386 with its DPT controller, and a lot slower than the Cheetah 486 with the PSI controller. Once again, when you get used to speed and power, you don’t want to let go.

However, I have a new DPT controller, which the company swears is as fast as the PSI controller (I love it when two good companies compete in technology rather than lawsuits), so there’s an obvious remedy to the situation; indeed, the DPT controller is a SCSI device, and I’m told that I can daisy chain the Denon CD-ROM drive to it, thus saving a slot.

**Tweaking the System**

If the Arche 486 ever does replace the Cheetah 386 as my main system, it will...
have to run Desqview. I may one day switch over to Windows, but not just yet. For now, Desqview seems quite stable and very useful.

For instance, as I write this, I have the Norton Commander MCI Mail Manager off uploading several MCI letters and downloading any mail I may have, and all that happens invisibly. In another Desqview window, I have Samuel Butler’s The Way of All Flesh up on the Library of the Future CD-ROM, and I can change over to that (or to any CD-ROM I like) almost instantly. Info Select is waiting for notes. Norton Commander is available if I want to do file management and can run in the background to do long backup copies to the WORM drive; and switching from one of those windows to another takes less than a second. I can open a second Q&A Write window, a Sidekick window, or whatever I might want in seconds. This is convenience I simply will not give up.

The question is, then, does DR DOS work with Desqview? The answer is yes, but a story goes with it.

First, if you use Desqview, you will probably want to use QEMM-386, Quarterdeck’s 386 memory manager, rather than the EMM386 that comes with DR DOS; even Digital Research’s technical support people advise this, since QEMM and Desqview have some secret handshake that other memory managers can’t use. The easiest way to get that running is to use the Desqview installation program, which does the job nicely.

Next, you have to edit CONFIG.SYS to remove all the DR DOS EMM386-specific commands and drivers. One way to do that is to preface each line with a question mark. DR DOS has the nifty feature that if it sees a statement in CONFIG.SYS preceded by a question mark, it asks you if you want to do that, and if you say no, it skips it. This feature can be an extremely handy one when you’re tweaking the system, as well as a way to let you configure the system for special purposes.

What I did was to REM-out everything nonessential and boot up with QEMM; after which I put back in the Corel and Intel drivers, the mouse, and all the other stuff, and let QEMM’s Optimize take over. I was also careful to keep a boot floppy disk because Optimize is notorious for hanging up your system, and, sure enough, it managed to do that a couple of times. Eventually, though, that stabilized. Then I used DR DOS’s HIDOS.SYS to stuff the DR DOS kernel up into high memory. When you do this sort of thing, make liberal use of the question-mark preface to CONFIG.SYS statements, and fool around until you’ve got what you want; and if that doesn’t seem like very precise advice, it’s still about the best I can give.

Eventually, I had a system with over 600K bytes of free memory before loading Desqview and 560K-byte Desqview windows, with the mouse, the Pioneer optical N drive, and the Satisfaction coprocessor board accessible to any of them. This is as large a Desqview window with that many resources as I’ve ever achieved with any system. That’s the good news.

The bad news is that sometimes when I try to quit Desqview, I manage to hang up the system and have to reset. Now understand, that’s hardly a fatal problem. After all, if you’re dumping out of Desqview, you’ve presumably saved all your work, since anything ongoing will quickly, it also communicates clearly. The 9600EX knows when data is being garbled and automatically retransmits, so your data arrives error free.

Plus, the 9600EX features full-compliance with V32 and is downward-compatible with slower modems. And, like our entire family of modems, the 9600EX comes with a full, five-year warranty.
 Certainly be lost when you exit. Still, it’s annoying, and I haven’t figured out just what’s going on. Something is clearly overwriting something else, but that’s like saying “timing errors”: it’s probably true, but it’s not a useful diagnosis. Eventually, I expect I’ll figure out what is happening, and until then I’ll just keep on playing with the system.

What I do know is that if I adapt the Arche 486 by installing the DPT controller and then hang the CD-ROM and Pioneer optical drives on a remote network server accessed by LANtastic, I ought to have enormous Desqview windows as well as a very fast machine. More on that next month.

Meanwhile, my tentative conclusion on DR DOS is that it’s quite solid for single-application users and very likely solid under Desqview. I had a similar problem with Desqview hanging up the Cheetah 386 (under PC-DOS 3.3) until I put in the statement $X=C600-C7FF in the QEMM CONFIG.SYS line (i.e., exclude memory locations C600 to C7FF from the area managed by QEMM). Since then, this system has been as solid as a rock, and I make no doubt that something similar will do the job with the Arche 486 under DR DOS.

Next week, I’ll test DR DOS and the Arche 486 with LANtastic. I’ve been assured by Digital Research management that if this update version of DR DOS doesn’t work with LANtastic, they’ll keep on working until it does; but, in fact, I’ve heard from people I trust that this one does. More as things develop, but my first impression of DR DOS 5.0 (with the business update revision) is quite favorable indeed, and I’m likely to use it on my main machine, whatever that turns out to be.

Digital Research Grows Up

I recall my astonishment, back in 1979 or 1980, when a famous columnist said, “Pournelle in BYTE has pronounced CP/M the new standard, and that seems to settle that.” It was the first intimation I’d had that anyone in the industry took me seriously, and since my first “official” pronouncement was about Digital Research, it left me fond of the company. Lately, though, it hasn’t been the leader it once was.

I’ve always been impressed with Digital Research’s technical capability, but the marketing left a little to be desired; in past years, its idea of marketing was to develop good products and wait. If you deserved to have anything that good, you’d find out about it and buy it; if you didn’t find out, it served you right.

Digital Research president Dick Williams is changing all that. He’s got an aggressive marketing strategy that takes advantage of his company’s small size and thus quick decision times, as well as the staff’s high technical abilities. I think we can look for good things from them once again.

Sound Blaster

One of the boards we installed in the Arche 486 was Sound Blaster. With its associated software, it has quietly (no pun intended, but what the heck) become the standard sound system for advanced PCs. The Roland board has much higher sound quality for a higher price, but for anything short of professional music quality, Sound Blaster is good enough.

One use, of course, is games. Sound Blaster comes with a game port, making it nearly ideal for Wing Commander.
Some days you have all the time in the world.

When the pressure is on, pour on the speed. With Hewlett-Packard's new LaserJet IIISi printer. A powerhouse that delivers at a throughput speed of 17 pages per minute.

With the LaserJet IIISi, you're up to speed the moment you give the "print" command. HP's RISC-based formatter and the PCL5 printer language, with vector graphics and on-the-fly typeface scaling, yield fast results. This printer also represents a new standard for I/O performance with optional Network Printer Interface cards for either Ethernet or Token Ring.

The LaserJet IIISi is specifically designed for shared-use environments. Its high-volume paper handling features include two 500-sheet input trays and a monthly duty cycle of 50,000 pages. HP offers software-selectable language switching between PCL5 and optional Adobe PostScript. For added versatility, your options include

Adobe and PostScript are registered trademarks of Adobe Systems Inc. in the U.S. and other countries.
And some days you need the new 17ppm LaserJet III Si.

an envelope feeder and two-sided printing.

Beyond speed and efficiency, the LaserJet III Si delivers the sharpest 300 dpi print quality yet. In fact, HP's revolutionary combination of Resolution Enhancement technology and new microfine toner challenges the print quality of many 600 dpi printers.

The price of the new LaserJet III Si, just $5,495*, is as impressive as the work load it handles. If you're ready to pick up the pace, call 1-800-752-0900, Ext. 2067 for more information on the fastest LaserJet printer and the name of your nearest authorized HP dealer.

*Suggested U.S. list price. © 1991 Hewlett-Packard Company PE12101
For more serious work, you can get the MIDI Connector Box from Brown-Waigh Publishing. This is a tiny thing that plugs into Sound Blaster’s game port. It has a joystick port continuation (so you can still play Wing Commander), one MIDI input, and five Thru MIDI outputs. It also has considerable music software. The result is that your PC with Sound Blaster becomes a kind of music studio. I’ve had a lot of fun with the included software, and, no, I haven’t at all given up the idea of writing an opera someday.

There are lots of other accessories you can get for Sound Blaster, including musical instrument software and a voice editor. Sound Blaster has become the standard sound board, if not for the industry, at least here at Chaos Manor. Recommended.

**Satisfaction**

I’ve mentioned Intel’s Satisfaction co-processor board before, so it suffices to say it works fine under DR DOS. Satisfaction will take a file, which can include PCX graphics, and send it out as a fax. This means you can send letterheads, diagrams, scanned images, and the like, all created on your PC. Moreover, the board, having its own coprocessor, will send and receive in the background or send your messages in the dead of night (assuming you leave your computer on, of course).

The manual is extraordinarily complete and clear, making it quite easy to set this system up. I do find it more convenient to send text-only faxes through MCI Mail (using the Norton Commander MCI Mail Manager feature), but you can use the built-in 2400-bps modem on Satisfaction to do that. All in all, this board is a great bargain. Recommended.

**Language Systems FORTRAN**

About a year ago, I was the keynote speaker for a conference of supercomputer users. I doubt they learned much from me, but I sure learned a lot from them. One thing I learned is that using supercomputers boils down to writing FORTRAN programs. Big FORTRAN programs. As one fluid-dynamics scientist put it, “After you’ve written 60,000 lines of FORTRAN, you no longer care much about your original problem.”

All of which is probably true, but FORTRAN remains the Language That Will Not Die, and I just know that 20 years from now, we’ll be programming the Connections Machine version 22, with 5 million parallel processors, by feeding it a half million lines of FORTRAN generated with computer assistance. Seriously: anyone contemplating going into science should be familiar with FORTRAN, because a very great deal of work is done with it. I’d rather work with Macsyma or Mathematica, the symbolic algebra programs, but I don’t have to try to model fluid dynamics or large weather systems, which strain the capacity of the largest supercomputers.

I don’t say you have to learn FORTRAN, but it can’t do any harm to have some familiarity with it; and if you have any desire to do FORTRAN on your Mac, whether to learn the language or do serious work (or both), there is the Language Systems FORTRAN compiler, which, according to Language Systems, works on any Mac with 2 MB of RAM and a hard disk drive. The compiler accepts ANSI 77 FORTRAN and most large computer extensions, including VAX. It has lots of switches for optimization. Tools and libraries are included.

If I seem vague, I am: I haven’t done much with FORTRAN since Z80 days, when MacLean and I experimented with RATFOR, the Rational FORTRAN pre-compiler. I don’t have anything against FORTRAN, it’s just that I don’t have a great deal of need for it. Others, however, do; and if you have a Mac and want FORTRAN, this is, so far as I can tell, about as good a compiler as you’ll get. It comes with lots of tools to access the Mac interface and about a foot of manuals. You can also get MPW as an option.

**Say What?**

You say you want to do some OS/2 applications programming, but you can’t stand C? You say you got the OS/2 Developer’s Toolkit but you never get around to writing the programs you planned? Is that your trouble, Bucky? Cheer up. Help is at hand. An Italian company, Artel Informatica, has developed Pronto! PM, a set of drawing tools for the Microsoft BASIC 7.0 compiler for OS/2.

Pronto! PM includes dialog boxes, radio button status inquiries, and tools for drawing lines and boxes. You write your source code in Microsoft BASIC, include the Pronto! PM library, compile, link, and then—well, and then you sort of have to understand the OS/2 and Presentation Manager (PM) developer tools after all, more’s the pity. You aren’t totally liberated from C.

Still, this toolkit can go a fair way to taking the sting out of PM programming.

---

**USER’S COLUMN**

**For more serious work, you can get the MIDI Connector Box from Brown-Waigh Publishing. This is a tiny thing that plugs into Sound Blaster’s game port. It has a joystick port continuation (so you can still play Wing Commander), one MIDI input, and five Thru MIDI outputs. It also has considerable music software.**
Spikes. Surges. Overvoltage. Undervoltage. Brownouts. These things happen. And they can do irreparable damage to your equipment and data. Unless you’re protected with Minuteman Uninterruptible Power Supplies.

Minuteman protects all your equipment and data. All the time. In fact, in the event of power failure, it will safely and automatically shut down your network, using your operating system or our own software. Even if you’re not there.

There’s a Minuteman to fit your needs, large or small. Including 220-volt international models. And we ship orders the same day they’re received.

So call us. You can’t stop disaster from striking. But you can keep it from hurting you.

1-800-238-7272

See Us At

COMDEX
Spring Booth #576

and

PC EXPO

<table>
<thead>
<tr>
<th>STANDBY UPS MODELS</th>
<th>UNATTENDED SHUTDOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 VA to 2300 VA</td>
<td>Via your operating system or our software, interfacing:</td>
</tr>
<tr>
<td>Sinewave output: 1 msec Transfer</td>
<td>Novell 286 VAP and 386 NLM</td>
</tr>
<tr>
<td>ON-LINE UPS MODELS</td>
<td>ELS Level II</td>
</tr>
<tr>
<td>500 VA to 10,000 VA</td>
<td>AIX for IBM RS6000 Version 3.1 &amp; up</td>
</tr>
<tr>
<td>Static by-pass standard</td>
<td>AIX for IBM RT Version 2.2.1 &amp; up</td>
</tr>
<tr>
<td>True on-line sinewave outputs</td>
<td>3COM</td>
</tr>
<tr>
<td></td>
<td>LAN Manager</td>
</tr>
<tr>
<td></td>
<td>Banyan Vines</td>
</tr>
</tbody>
</table>

| AT&T 382 |
| AT&T UNIX 386 |
| Version 3.2 |
| SCO UNIX 386 |
| Version 3.2 & up |
| SCO XENIX 386 |
| Version 2.3.2 & up |
| SCO XENIX 286 |
| Version 2.2.1 & up |
| Sun OS Sun 4 Version 4.03 & 4.10 & up |
| Sun SPARC Version 4.03 & 4.10 & up |

| SUN OS Sun 3 |
| Version 4.01 & up |
| DEC VMS Version 5.1 & up |

Custom configuration any system

© Para Systems, Inc. 1455 LeMay Drive, Carrollton, Texas 75007 Phone: 214-446-7363 FAX: 214-446-9011

Circle 231 on Inquiry Card.
live without it. Then came Desqview. After that, there was no need to have a TSR program to give access to a calendar, notebook, and address book/telephone dialer because you could always use Desqview task switching to go to a program tailor-made for the particular purpose. Tornado, GrandView, Time Line, and so forth each worked better for its particular purpose than Sidekick did at any one of them.

There was an update to Sidekick, but I had a lot of trouble installing it, and I never used it; and over the years, I stopped thinking about Sidekick, although Borland says there are still 3 million people using it.

Now it's back, and this time it's a bit different. First, Sidekick 2.0 uses the Paradox engine. Paradox is, in my judgment, the relational database of choice for PC users; that is, if you can manage with a simple flat file manager, Q&A is simpler to set up and learn, but if you really need full DBMS capabilities, get Paradox.

Sidekick 2.0 will also interact with Quattro Pro, which is the spreadsheet of choice, in my book anyway. The new Sidekick will allow data exchange with Quattro Pro and Paradox files. It will also import all your Sidekick 1.0 and Plus files simply and easily.

So far, of course, there’s not all that much reason to use Sidekick as opposed to Paradox and Quattro Pro with Desqview; but Sidekick 2.0 was designed in part to work with notebook computers, most of which don’t have and can’t use Desqview. The new Sidekick Time Planner is easy to use, what with windowing and pull-down menus and suchlike, and about the right thing to put on a Poqet or other PC palmtop machine. There’s also the Reconciler, a program for reconciling schedules, as, for instance, when you’ve got one copy of Sidekick on the road and another on the base machine back home. That has always been one of my major problems with any scheduler, and I’m very happy to see this.

I was once a Sidekick fanatic; this new version may convert me again because I sure need help managing my schedule. Sim Everything

I expect everyone knows about SimCity. At the Los Angeles Science Fantasy Society, it got so popular that we had to forbid people playing it on the club machines on meeting nights; they’d get involved with their “city” and want to take it home, which, of course, we can’t allow, and all kinds of arguments would start.

I now have two more SimCity templates, Ancient Cities and Future Cities, and I can say instantly they’re worth getting. SimCity is a lot of fun, provided that you understand it’s a game and not a lesson in urban planning. (Having been involved in city management, I assure you that trash removal, which isn’t in SimCity at all, weighs very heavily on the mayor’s mind. . . .) The Ancient Cities packages are even less realistic, but they are colorful and just plain fun. The Moon Colony in Future Cities is also fascinating.

The versions I have are for the Amiga; there are versions for the Mac and PC, but I don’t have them.

I do have SimEarth for the PC; as my son Alex says, it’s the only game program that ought to come with a one-week seminar on how to use it. That’s actually meant as a compliment: this program is

---

ABC Flowcharter for Windows

“Simply the easiest way to document procedures.”

ABC Flowcharter™ makes drawing and editing flowcharts easier than ever. It’s loaded with features that help you make and edit charts in a fraction of the time needed with other flowcharting or drawing programs.

ABC Flowcharter’s advanced link feature lets you break complicated procedures into smaller, more manageable steps. Just click on a shape to display a sub-chart or procedure. It’s that easy.

Ask your dealer for a demonstration or call 1-800-227-0847 for more information. See for yourself why ABC Flowcharter is quickly becoming the standard flowcharting tool for the Fortune 1000. Retail price $295.

Roykore™

2215 Filbert St.
San Francisco, CA 94123
415-563-9175
BIG IS OUT.

SMALL IS IN.

Introducing the Falco Infinity Desktop Computer. The Smallest 386SX Desktop.

If you're sizing up desktop computers, you'll immediately see the advantage of the Falco Infinity™ Desktop. It gives you 386™SX power and performance without dominating your desk space.

Half the size of a standard PC, the Infinity Desktop has everything you need on-board: Peripheral interfaces like disk controllers. Memory expansion. Communication ports. And VGA™ level graphics up to 1024 x 768 resolution. Plus, two AT™-compatible, 16-bit expansion slots.

It runs DOS™ 4.0, UNIXTM, OS/2™ and Microsoft® Windows 3.0. What's more, you can choose from four configurations, including a diskless network node and a full-featured model with 1.44MB floppy and the option of 40, 100 or 200 MB hard drive.

The only thing we left out is the noise. The Infinity Desktop runs so quietly, you'll hardly know it's on.

Whether you work in close quarters or spacious surroundings, the Falco Infinity Desktop covers all your needs. Without covering your desk. And that's about the size of it. To get one for your desk, call us today.

1-800-FALCO4U

© 1990 Falco Data Products, Inc

440 Potrero Avenue, Sunnyvale, CA 94086-4117

Circle 107 on Inquiry Card.
complex. The best way to learn about its features probably isn't to take classes, though: just start it up and let it run. Nothing will be harmed, and as you begin fooling around with things—ever want to make continents drift? send a monolith down to aid in the development of intelligent dinosaurs?—you learn what you can and can't do. At least, that's what I did.

Once again, it's a game, not a real simulation; but it's a pretty instructive game, even so. Just the thing to get bright youngsters interested in science, as well as a good way to relax after getting a column written. Recommended.

Winding Down
The final draft of Go Tell the Spartans (Baen Books, in bookstores as you get this) is due this weekend: Jim Baen is doing the final editing and typesetting in-house. The Great Hall is a wreck, with the Arche 486, and unopened mail, and software boxes, and cables and wires, and just general junk filling all the available space. My desk is a disaster. I'm going to file this column and run off to the beach house, where I hope to do some fiction.

The game of the month is War Lords from the Strategic Studies Group. This features up to eight human players, but the computer will play all but one (or even all for that matter) part. It's a medieval fantasy, and it's strangely fascinating, even when played as one human against seven computer players. I fiendishly gave a copy to the British author Terry Pratchett (if you haven't read his Discworld novels, you are in for a treat). The computer books of the month are the Que Quick Reference series: I have them for AutoCAD, Q&A, and a dozen other popular programs, and they're better than the quick reference guides that the software publishers furnish. It's worth having one for anything you use a lot.

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.”
Ventura Publisher lowers prices.
Ours. And theirs.

Now you can get the long document power of Ventura Publisher® at substantial savings. We’ve lowered the list price of our PC Editions a full $100, from $895 to $795. And for a limited time, we’re also giving you a lower price on extra software that will expand your desktop publishing productivity. Buy any Ventura Publisher Edition from your local dealer and use the coupon below to save money on another valuable package.

Ventura Publisher’s automated features make short work of long documents. That’s why the more you have to do, the more you need Ventura. To do even more—for less—act now to take advantage of this Special Offer.

Buy our Windows 3.0 Edition, save $376 on CorelDRAW!


Buy our OS/2 3.0 Edition, save $376 on CorelDRAW!

---

**Order Form**

<table>
<thead>
<tr>
<th>Ventura Publisher Edition Purchased</th>
<th>Special Offer Package</th>
<th>Special Offer Price</th>
<th>Qty Ordered</th>
<th>Subtotal (Price x Qty)</th>
<th>Circle Disk Type Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP Windows 3.0</td>
<td>CorelDRAW!</td>
<td>$319</td>
<td>#</td>
<td>$115</td>
<td>5 1/4&quot; 3 1/2&quot;</td>
</tr>
<tr>
<td>VP Macintosh 3.0</td>
<td>CDR-36/Type Gallery PS</td>
<td>$479</td>
<td>#</td>
<td>(3 1/2&quot; only)</td>
<td></td>
</tr>
<tr>
<td>VP DOS/GEM 3.0</td>
<td>VP to the Max/Softkicker</td>
<td>$119</td>
<td>#</td>
<td>$119</td>
<td>5 1/4&quot; 3 1/2&quot;</td>
</tr>
<tr>
<td>VP OS/2 3.0</td>
<td>CorelDRAW!</td>
<td>$319</td>
<td>#</td>
<td>$115</td>
<td>5 1/4&quot; 3 1/2&quot;</td>
</tr>
</tbody>
</table>

Total Price All Special Offer Packages Ordered $1,143

Add tax* in AZ, CA, CT, DC, FL, GA, IL, MA, MI, MN, MO, ND, NY, PA, TN, VA, WA, Canada $78

Shipping/Handling: add $20 per each Special Offer (125 lbs. Canada) $20

Total Price All Special Offer Packages Ordered $1,191

Please enclose full payment & U.S. only. AMOUNT: $1,191

Good on products purchased April 15-July 31. Coupons must be postmarked by August 15. Allow 2-4 weeks for delivery. This offer cannot be combined with any other promotion and does not apply to purchases of upgrades or Network Nodes. Good in USA and Canada only.

*Please omit sales tax or there may be a delay in processing your order.

ByT91

Ventura Publisher® is a trademark of Ventura Software Inc., a Xerox company. XEROX® is a trademark of XEROX CORPORATION. All other product names and trademarks are the property of their respective owners. © 1991, Ventura Software Inc.

Circle 345 on Inquiry Card.
The new MINIX 1.5 operating system developed by Andrew Tanenbaum, world renowned computer scientist and author, is system call compatible with Version 7 of the UNIX operating system. Versions of MINIX 1.5 are available for the IBM-PC/AT/386, Macintosh, Atari ST, and Amiga computers. All versions contain the complete source code for the operating system (125,000 lines of code) as well as: a Kernighan and Ritchie compatible C compiler, over 175 utilities, more than 225 library procedures, a shell that is functionally identical to the UNIX Bourne shell, and a collection of ANSI C library procedures for standard I/O and string handling. The package is accompanied by a 688-page documentation manual with a listing of the source code. MINIX 1.5 is available at the following stores.

<table>
<thead>
<tr>
<th>Store Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts</td>
<td></td>
</tr>
<tr>
<td>SoftPro</td>
<td>VineBrook Plaza, Burlington, MA 01803</td>
</tr>
<tr>
<td>Harvard Coop</td>
<td>1400 Massachusetts Avenue, Cambridge, MA 02238</td>
</tr>
<tr>
<td>Quantum Books</td>
<td>1 Kendall Square, Cambridge, MA 02399</td>
</tr>
<tr>
<td>Programmer's Shop</td>
<td>90 Industrial Park Road, Hingham, MA 02043</td>
</tr>
<tr>
<td>Micromuse Inc.</td>
<td>124 Boston Post Road, Sudbury, MA 01776</td>
</tr>
<tr>
<td>Maryland Book Exchange</td>
<td>4500 College Avenue, College Park, MD 20740</td>
</tr>
<tr>
<td>University Book Center</td>
<td>Stamp Student Union, 1000 East Clayton Road, Cincinnati, OH 45237</td>
</tr>
<tr>
<td>University of Maryland College</td>
<td>20720 E. Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>University of Maryland Co-op</td>
<td>5151 Industrial Avenue, Cincinnati, OH 45227</td>
</tr>
<tr>
<td>Cincinnati Bookstore</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Bookshop</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>400 East Main Street, Cincinnati, OH 45226</td>
</tr>
<tr>
<td>Cincinnati Technical College</td>
<td>1000 East Main Street, Cincinnati, OH 45226</td>
</tr>
</tbody>
</table>

Circle 255 on Inquiry Card.
One of the biggest problems with business travel is that you leave your office behind. Of course, this may also be one of the biggest advantages of business travel, but that depends on what your office is like. In any case, in addition to your office and its telephones, you leave your company's computer system, along with the information that's stored on the file servers, the notes in e-mail, and the scheduling information in the groupware package. While it's nice to do without telephones from time to time, it's hard to do business without the support system you've become used to having.

A few of the better hotels have started to cater to the computer user, providing extra phone jacks and power outlets in rooms. A few places, such as United Airlines' Red Carpet Clubs, even provide personal computers for the use of travelers. These services are helpful, but without access to information you need, they're not as useful as they might be otherwise.

The problem is that traveling doesn't go all that well with a fixed installation such as a LAN. Just what are you supposed to do when you're on the road with your laptop computer, or even when you're visiting another of your company's offices? In the past, you were out of luck, but now, at least, there's some hope.

Now that portable computers will fit into your briefcase, and facilities exist away from home to support them, a few products have arrived that are good enough to cement your relationship with your office, even from a distance.

You still need to use a modem, of course. But where once you dialed the company VAX and emulated a VT-100 terminal, now you can log onto your LAN and work as if you were really attached. The difference is new software designed specifically for this purpose, such as DMA's pcAnywhere IV. While packages that mirror keystrokes and screen images have been around for years, only now are they good enough to use in a serious business setting.

When you arrive at some business locations, you have exactly the opposite problem. There you are in the office with your computer, and there's a LAN in the office, but because you have a laptop computer, you're out of luck. Fortunately, hooking your laptop computer to a LAN has also gotten easier over the years.

**Anywhere, Anytime**

There was once a time when setting up a remote communications facility for a LAN was difficult and expensive. You needed special software from the LAN operating-system manufacturer, and you needed a lot of dedicated hardware. A typical dial-in installation would be based on an asynchronous communications server, which in turn would use something like Novell's WNIM+ card. This card supports four RS-232 ports to which you connect modems.

Then, using a package such as Novell's NetWare AnyWare, coupled with Novell's Asynchronous Communications Server software, you could have remote dial-in communications. The problem with this approach is that it required both a dedicated communications server and a dedicated workstation for each user who wanted to call in. In other words, a user calling in with a laptop computer was using three computers to run a single LAN session: the laptop itself, the communications server, and the workstation on the LAN that was serving as a host to the communications session.

As you might imagine, this hardware-intensive approach met with some resistance. Customers who wanted to dedicate a high-end communications facility needed a way to do it without tying up a room full of computers. Low-end users just wanted a gateway that was simple to set up and easy to use.

The NetWare Access Server was the first realistic solution to the requirements of high-end users. Quarterdeck Office Systems teamed with Novell to create a server that could have up to 16 DOS sessions running at the same time. The multitasking Desqview kernel formed the basis for the Access Server. Each session supported communications software developed by Novell. The Access Server required a standard 386-based system with as much as 12 megabytes of memory to support its 16 sessions, but it was (and continues to be) effective.

You don't have to give up your LAN while you're on the road.
The Access Server is a good solution to dial-in access, but it's far too expensive for small users who just want a one-line gateway. For these people, DMA's pcAnywhere IV/LAN is just the answer. It lets you create an asynchronous communications gateway anywhere you've got a computer and a modem connected to a network. This means that the network users can have access to a PC's modem as a background process, so the PC's user doesn't have to stop working to free up the workstation for communications use.

The pcAnywhere IV/LAN solution allows both dial-out and dial-in use on the network using the gateway. For a small company that needs the capability to access its LAN without spending a lot of money, this works well. Remote access to the gateway is via the remote version of pcAnywhere IV.

With either pcAnywhere IV/LAN or the Access Server, you can run the same software remotely that you could run on a workstation if you were actually there on-site with the LAN. But there are some limitations. Because screen updates are limited to the speed of the modem you're using, you might want to avoid complex user interfaces, simply because of the time it takes to update the screen at modem speeds. This is less of a problem with 9600-bps modems, but with slower speeds, screen updates can be excruciating.

Unfortunately, virtually all portable computers give you a choice of a 2400-bps modem or one that's even slower. Some machines, such as those with PC-style expansion slots, can accept a high-speed modem card.

One final complication is the screens that are available for most portable computers. I used a Toshiba 1200XE to test the items you're reading about here. The Toshiba has a very nice backlit LCD, but it's only CGA resolution. While this is supported by both the Access Server and pcAnywhere IV, it still looks pretty sad when trying to deal with screens that have a high graphics content.

**Portable Connections**

Once you've reached your destination, few things are more frustrating than being in an office with a perfectly good computer but being the only person there who can't get on the LAN. As you've probably noticed, once offices begin to accept the LAN, nearly all the peripherals become LAN resources. No longer can you print the results of a spreadsheet calculation by unplugging someone's printer and attaching it to the back of your portable. Now that printer belongs to the LAN, and unplugging it will bring the wrath of the other LAN users. On some LANs, the network is the only way you can print, communicate with the mainframe, or have access to other peripherals.

Two years ago, a small company in California, Xircom, invented a network interface card that would plug into your parallel port and therefore support nearly any laptop computer. The Xircom Pocket LAN adapter has become so popular that I've seen it used in areas far removed from portable computers. One popular use is to give LAN connectivity to computers without expansion slots, such as the Zenith Z-148 desktop.

The only problem with the Xircom adapter is speed. The parallel port is used as the communications channel, and it is limited to about 300,000 bps. For many routine uses, this is entirely adequate, but if you really have to move a

---

**How To Keep Your LAN From Crash Landing.**

You bought a file-server to serve your needs. Now protect that investment with a Sola UPS.

Sola offers power protection equipment that ranges in size from 70 VA to 5000 VA. That means there's an intelligent Sola system that's just right for your LAN operation. And it also means that you won't have to experience the cost and frustration of LAN downtime caused by electrical disturbances.

Try Sola. They're the UPS people who will lend a hand to your LAN.

Sola offers power protection equipment that ranges in size from 70 VA to 5000 VA. That means there's an intelligent Sola system that's just right for your LAN operation. And it also means that you won't have to experience the cost and frustration of LAN downtime caused by electrical disturbances.

Try Sola. They're the UPS people who will lend a hand to your LAN.

Sola offers power protection equipment that ranges in size from 70 VA to 5000 VA. That means there's an intelligent Sola system that's just right for your LAN operation. And it also means that you won't have to experience the cost and frustration of LAN downtime caused by electrical disturbances.

Try Sola. They're the UPS people who will lend a hand to your LAN.

**Sola**

708/439-2800
800/TRY-SOLA

---

**NOVELL, 3Com,**

Microsoft.
"If only we could use UNIX\textsuperscript{*} for our realtime applications..."

Dennis Ritchie, legendary developer of the UNIX Operating System, puts it very simply: "The reason the original UNIX operating system was so small and elegant was because we did things that we really wanted to do."

Although conventional UNIX has grown (literally) beyond Ritchie's original vision, many people still look to this classic OS to do what they want to do.

But not if they want realtime performance. UNIX has unequaled power as a development tool, but you can forget about running realtime apps on conventional UNIX systems. They're simply too big and too slow.

Until now.

Presenting QNX 4.0. The UNIX system that's responsive enough for realtime apps, small enough for PC platforms, flexible enough for transparent networking, and modular enough for the most demanding configurations.

**POSIX Means Portable**

UNIX systems come in more flavors than ice cream. Which is why IEEE's POSIX standard is now such an important safeguard of portability.

At Quantum, we're committed to the POSIX standard, and we've rewritten QNX to give developers a standard OS interface they can depend on. As a result, QNX is now a true UNIX operating system—but not a conventional one.

**Performance At Run Time, Design Time, All The Time**

Only QNX combines the performance of a dedicated realtime executive with the time-saving benefits of a rich UNIX development environment—including a host of utilities, an award-winning C compiler, and an optional OPEN LOOK\textsuperscript{TM} GUI package.

**QNX is Distributed**

The QNX operating system lets you extend the limits of any one microprocessor. Whether you're running a network of four or 400 machines, QNX makes it all feel like a single computer.

Interprocess communication is network-wide, so every process can transparently access every resource—programs, files, devices, even CPUs—anywhere on the network. And you can set up your network using any mix of Intel-based PCs.

**Responsive Tech Support**

Only QNX's support hotline can put you in direct contact with the Technical Development team itself. And you'll have access to our 24-hour online conferencing and update system, where the response time to your questions is almost like real time.

"If Only..."

Wherever computers do serious work for serious people, the UNIX operating system has made possible a lot of the "things we wanted to do." But people who want realtime solutions have been waiting a long time to share in the benefits. The wait is over.

What UNIX was meant to be.

For more information, please phone (613) 591-0931.

Quantum Software Systems Ltd. • 175 Terrence Matthews Crescent • Kanata, Ontario, Canada • K2M 1W8

Circle 265 on Inquiry Card (RESELLERS: 266).
lot of data, then you'll notice the difference. This is where cards like the Ethernet and Token Ring adapters from Megahertz are handy.

Megahertz makes a pair of external cards for Toshiba laptop computers. Unlike the LAN adapters from Xircom, the Megahertz devices attach to the Toshiba expansion bus connector that is accessible from the rear of each Toshiba portable. You do this by removing a metal plate and simply plugging in the 100-pin connector on the LAN adapter. The connector is made fast by tightening a pair of thumbscrews. You can remove the adapter in seconds when you're ready to go on the road.

The most important difference between the Megahertz cards and the Xircom adapters is speed. The Megahertz adapters operate at the full speed of the LAN, which is 10 megabits per second for Ethernet or 4 Mbps for Token Ring. This is possible because the Megahertz adapter connects directly to the expansion bus and isn't restricted by the speed of the parallel port. On the other hand, the Megahertz adapter works only on Toshiba portable computers, so you lose a lot of flexibility. In addition, installation of the Xircom adapter is easier, since on most networks the shell is already configured, so you just have to plug and play. Installing the Megahertz adapter is more like installing a standard network interface card.

Both Ethernet adapters work well. As might be expected, using the Megahertz adapter isn't any different from using any other Ethernet card on another computer. For most uses, the Xircom adapter isn't any different either. The speed limitation of the parallel port isn't obvious in routine use unless you're moving some very large files.

Otherwise, the differences between the Xircom and Megahertz adapters are mostly in the way they attach and in their physical size. The Xircom adapter is hardly larger than the plug on a printer cable and attaches directly to the printer port. The Megahertz adapter is somewhat larger, about two-thirds the size of a Hayes modem, and it has a very short length of stiff ribbon cable permanently attached to one end.

Unlike the Xircom adapter, which uses an external power supply similar to the ones used by calculators, the Megahertz adapter draws power directly from the Toshiba to which it's attached. Both approaches have disadvantages. You have to find an electrical outlet for the Xircom. You'll probably have to find one for the Megahertz as well, since the extra power requirements aren't going to help the Toshiba's battery life, and the larger Toshibas don't have batteries anyway.

The Xircom adapter has a very successful history behind it. When the U.S. Army went looking for a way to use Ethernet in the desert, it found that the Xircom Pocket Ethernet Adapter was one of the few computer peripherals that would function in the heat and harsh environment of the Saudi desert. That it could be changed between computers in seconds, and would work with everything from Zenith laptops to Compaq 486 desktop machines, quickly made it a favorite.

Either way, once you have your portable adapter card, you're ready to hook up to the office LAN at your destination. There are a few catches, such as convincing the local LAN administrator to let you in. You're on your own there.

continued
MaynStream®. It’s the DAT your data deserves.

Looking for the ultimate backup for Local Area Networks or standalone workstations? The MaynStream DAT system from Maynard is the answer. It’s the only True Computer Grade DAT™ backup system.

**MaynStream DAT for Networks.**

Our DAT systems include Novell-certified MaynStream software for DOS and OS/2 to back up your entire network, including file servers and all workstations. On-disk tape cataloging quickly locates backed up files and restores them to any network location faster than ever before. And it’s the perfect backup for NetWare 286 and 386, 3Com and more.

**MaynStream DAT for Reliability and Performance.**

Unlike other DAT products which use adapted audio mechanisms, MaynStream DAT’s design actually extends the life of your tapes and drive through special electronic control of tape speed, motion and tension. This advanced design also increases reliability by eliminating drive belts and mechanical mode changes. With MaynStream systems, your backup doesn’t become a backlog—it can transfer at an amazing 11 megabytes per minute, and using the fast file restore feature (FFR), search for files at 200 times normal tape speed.

**MaynStream DAT for Capacity.**

Finally, MaynStream DAT stores up to 2 gigabytes of data on one 90-meter, computer grade, DDS standard, DAT cassette.

For demanding backup requirements, your data deserves MaynStream. From the company that’s backing you in every way. For more information, call Maynard.

**(800) 237-4929**

Maynard Electronics, Inc
Marketing Communications
36 Skyline Drive
Lake Mary, Florida 32746
(407) 263-3500 (USA)
(44) 494-473-434 (UK)

Circle 182 on Inquiry Card (RESELLERS: 183).

MaynStream DAT is a trademark and Maynard and MaynStream are registered trademarks of Maynard Electronics, Inc. True Computer Grade DAT is a trademark and Archive is a registered trademark of Archive Corporation. All other product names herein may be trademarks or registered trademarks of their respective companies.
BUSINESS CONNECTION

The Portable Office
Meanwhile, the communications capabilities of portable computers continue to grow. Worldport now has a pocket-size fax modem that will support normal 2400-bps Hayes-compatible communications; plus, it will work as a 9600-bps fax card. AST Research will now install a similar fax modem inside its Premium Executive notebook PC.

It used to be that you could wait until you returned to the office after a trip before you did the paperwork. Now there's no excuse, unless you stay in hotels so sleazy that there's no way to plug in your modem. Tough choice, isn't it?

The Office Portable

Frank Mara was looking for a different sort of solution to his portable computing needs. Frank has headed development of some SQLWindows applications, and he needed a machine on which to demonstrate them. Because the machine had to support both a database engine and the Windows front end, he didn't think that a 386SX-based computer was adequate. He also had plans to use OS/2 for some future applications and wanted the portable computer to support those as well.

For a while, Frank tried shipping his IBM PS/2 Model 70, but it was developing a disturbing tendency to be inoperative when it reached the other end of the trip, which made running demonstrations difficult. Clearly, another solution was needed. Initial looks at Compaq and others showed them to be bulky, heavy, and expensive. Toshiba portables were out, due to a heavy government client list. Finally, on the suggestion of BYTE editor Rob Mitchell, we looked at the Micronics Mport 325.

The Mport 325 weighs only 13 pounds and is a fully functional 386-based machine. While it's certainly no notebook-size computer, it's lighter and slimmer than the competition. Equally important, it supports a 120-MB hard drive and has VGA graphics and an AT-compatible expansion slot for things like LAN cards. We're going to bring it up to 12 MB of RAM and load the hard disk with both DOS and OS/2. It looks like the perfect machine for traveling demonstrations. I'll let you know how it does after we've tried it out under actual field conditions for a while.

Next month: A look at the real world of network management.

Wayne Rash Jr. is a contributing editor for BYTE and a principal and technical Director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He consults with federal and private sector clients on microcomputers and communications, and he is coauthor of two books for business network users: The Executive Guide to Local Area Networks and The Novell Connection. You can contact him on BIX as "wayne rash," or in the to. wayne conference.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.
There is something new under the Sun...
Way under the Sun!

$10,095*

"CompuAdd's SS•1 looks, feels, and, for all intents and purposes, is the original 12.5-million-instruction-per-second SPARCstation 1 . . ." Byte, December 1990

Compare the CompuAdd SS•1 with the competition and you'll see why it's the new star among workstations. • Why its stellar low price, brilliant 19" Sony Trinitron® monitor, precise opto-mechanical mouse and three red hot internal drive bays make a world of difference between the SS•1 and other workstations.

• The SS•1 has the same scorching speed, multitasking, graphics and networking capabilities as the original SPARCstation™. In fact, it's 100-percent binary compatible with Sun® workstations. But the SS•1's extra features take it light years beyond the systems it's modeled after!

Whatever your use — CAD/CAM, desktop publishing, mapping, networking or other intensive computing operations — the SS•1 can take you there. • CompuAdd is famous for bringing affordability to PC design and manufacture. Now we've done the same for workstations.

• It's no wonder the SS•1 burns brighter than the competition.

*CompuAdd SS•1 configured with 8MB RAM, 210MB hard drive, 3.5" diskette drive and 19" color monitor.

Image generated by IDL® scientific visualization software package from Research Systems, Inc., Boulder, CO.
Elevation = X-ray density
Shading = Blood perfusion

; Make cursor visible

Loading table STD GAME-II

psed = 105, Waiting = 146, Executing = 39
Don't feel sheepish if you can’t tell the SS•1 and the SPARCstation apart. Neither can SunOS 4.1... No smoke and mirrors here; the SS•1 aces all the tests.” Byte, December 1990

That’s right. There are no tricks with the CompuAdd SS•1 workstation. It’s 100-percent binary compatible with the Sun® SPARCstation 1™ and 1+. With the SS•1, you get proven RISC architecture in the box. And big differences all around:

- The price. Our SS•1 costs thousands less than a comparable Sun workstation.
- The monitor. For more precise control over your graphics, the SS•1 features a 19” screen — instead of the 17” you get elsewhere.
- The mouse. The SS•1’s three-button opto-mechanical mouse is more precise than the optical mouse supplied by other vendors.
- The drives. The SS•1 has three internal bays that can be configured to hold up to three 3.5” SCSI devices or one 3.5” and one 5.25” SCSI device. Still another advantage the competition can’t claim.
- So whether you’re expanding your network or beginning a new one, the SS•1 is the right workstation.
- Because there’s no doubt with CompuAdd.

CompuAdd SS•1

Customer driven, by design.

Call 800-456-6008 [Key Code 814]

SS•1 Features
- SPARC® 20MHz processor
- 8MB DRAM expandable to 64MB
- 64KB SRAM cache memory (write-through)
- Three 32-bit 5-bus expansion slots
- Two internal and one external SCSI ports
- Two serial ports
- Ethernet AUI port
- Audio port and speaker
- High-performance 19” monochrome monitor with frame buffer
- Sun4-compatible 107-keyboard with reduced footprint
- Three-button opto-mechanical mouse
- 100-watt Sony power supply
- Sun SPARCstation 1 and 1+ compatible
- Licensed version of SunOS 4.1, including SunView graphical interface software

SS•1 Base Configuration
$5995 (66770)
Lease as low as $208/mo.

SS•1 Featured Configuration
$10,095 (66772)
Lease as low as $345/mo.

Products bearing the SPARC trademarks are based on an architecture developed by Sun Microsystems, Inc. SPARC is a registered trademark of SPARC International. FCC Class A for use in business environments only. Not for sale to home consumers.

Circle 70 on Inquiry Card.
Roundtable is a forum in which BYTE editors, columnists, and contributors debate key issues that affect how you purchase and use hardware and software. The “conversations” take place on BIX, where you can participate in the roundtable conference.

KEN SHELDON: This month, BYTE has several articles on graphical user interfaces. In the course of pulling them together, a question occurred to me: Does a GUI really make a computer easier to use? Case in point: I was one of the first people at BYTE to get a Macintosh (a 128K-byte model) because I was enthralled by the GUI concept. Do I use a Mac now? Only occasionally, usually if I have to do something graphically oriented. And I've no great need to move to a DOS-based GUI like Windows, since all I really need is access to lots of memory, and task-switching ability.

So the question remains: Who needs a GUI? Do they make computing any easier?

DON CRABB: Do you need a GUI? Do you need oxygen to breathe? Microsoft didn't come out with Windows 3.0 because it hadn't done its market research. Regardless of what high-power users might think, most Joe and Mary average computer users work smarter and faster under a GUI—any GUI—than under a command-line interface (CLI). Using a GUI to control your computer has absolutely nothing to do with the need for doing “something graphically oriented.”

The whole point to a GUI is interface consistency. Learn one application and you have learned them all. The other point to a GUI is simple command availability. Want to delete a file? Drag it to the trashcan. GUls are proving that graphical computing metaphors aren’t only for graphic artists or desktop publishers.

The bottom line is accessible power. Some people who grew up with CLIs will always find them more palatable and programmable, no matter what the GUI. But that’s simply not the majority of people who have to get real work done each day with a computer. Even some power users, like me, find that the consistency of the Mac’s GUI (along with some third-party programmability hacks) makes the Finder the interface of choice.

SHELDON: I got tired of the endless hand-holding, the prompts, and so on. It was like going to the city with a strong-willed, very opinionated (though well-meaning) maiden aunt: “Oh, you don’t want to go over there, you want to go over here. Are you sure you want to do that?”

I suspect that the issue has largely to do with who will be using the machine. Novices will find that a GUI makes a computer much easier to use. Those who are already wedded to a CLI, however, have fingers that are conditioned to type in certain phrases. (It always amuses me to hear a Unix whiz say, “Oh, I can do that. I merely switch my root directory to /foo and redirect the output to LPT1: and type Ctrl-Alt-Del while holding my left hand over my head and . . .”)

And sure enough, he usually can do it as fast as I can with a “friendlier” utility, because he has been doing it so long.

FRED LANGA: What a can of worms, Ken. I wonder if there really aren’t two separate elements to your question. First, I’ll admit it: Little frills like scissors and pastepot icons drive me nuts. I tried and ultimately abandoned a GUI-based word processor. I like to see as much text as possible when I’m writing, and any interface that starts encroaching on the text display has a major strike against it.

But my wife loves her Windows-based WYSIWYG word processor and uses it nearly exclusively in her consulting business for everything from simple all-text memos to complex reports with embedded graphics. But she’s not a professional writer, and that may be a key difference.

So, maybe there are two separate things going on here, Ken. A GUI may not be an obvious win when all you’re doing is substituting “click-on-an-icon” for “press-the-function-key.” But if clicking on an object
Hassle-Free Printer Sharing
for the HP LaserJet II, IID, III and IIID

"The ServerJet is the smoothest and most practical way I know to share a LaserJet." —Frank J. Darfler, Editor
PC Magazine, 1/15/91

Here's how you and your co-workers can have your own HP LaserJets without breaking the corporate budget.

It's called SimplaN ServerJet.

Simply plug the ServerJet into the 'Optional I/O' slot of your HP LaserJet. Stretch phone cable, up to hundreds of feet, to each computer. Then, 12 people can simultaneously whoooshhh documents to the LaserJet at speeds as fast as 115,200 baud.

No more wandering down the hall with floppy in hand.

Or borrowing someone else's LaserJet.

Or wasting time waiting to print.

The ServerJet is available in a variety of models with up to 4MB of buffer memory. And because your office may have printers other than HP LaserJets, ASP Computer Products offers a complete line of printer sharing solutions.

To order your ServerJet or for more information call ASP at:
800-445-6190

ASP COMPUTER PRODUCTS, INC.
1026 W. Maude Avenue, Suite 305
Sunnyvale, California 94086
Phone: 408-746-2965 • Fax: 408-746-2803

I'm still trying to figure out what some of those cute little icons mean.

LARRY LOEB: GUIs help remove what I refer to as the human-executed code in a program. That's what you expect the user to do when you give him or her a prompt of some sort; but you may count on them to remember the name of the file ("remember and type") as opposed to selecting it from a scrolling list ("point and click").

Less strain on the user to point and click doesn't mean that people who wish to program in assembly should be forced to use a GUI to do that unless they want it. Generating the G in GUI takes lots of code. It's not for everyone. But it seems to widen the usage base.

JON UDELL: There's GUIosity within applications and GUIosity between applications—a distinction that's often lost.
The latter is why Windows makes sense as an environment, even with a heavy mix of DOS applications: You can have that wonderful Chooser-like interface to, for example, network printer queues.

The former depends on the application. I have no use for GUI-type features while writing. Text is streamlike, not chunklike. It presents nothing I want to point at and click on. I type like the wind; give me EMACS and to hell with menus, buttons, and the mouse.

But spreadsheets and databases are chunky; they create landscapes that (for me) are much more usefully navigable with a mouse. So here's the irony: I'm still waiting for a good EMACS for Windows. Meanwhile, I get lots of use out of the GUIosity of FoxPro running under Windows, even though it isn't a Windows application, because even in character mode (in fact, bit-mapped versus character has little to do with this aspect of GUIosity) I can navigate that chunky landscape (columns, rows, partitions)
THE WORLDWIDE LEADER IN DATA PROTECTION OFFERS THESE FOUR EXCITING PRODUCTS

ICELOCK
IceLock is an exclusive software protection device which allows any software reseller—from developers to distributors to corporate users—to protect the programs they sell or use from software piracy. IceLock is a small "dongle" which plugs into any serial or parallel port on the computer—and yet still leaves the port open for peripherals. Software can be used like a book: copies of programs can be be kept in many places but only run on computers that have the exclusive ICE device. IceLock encodes existing EXE and COM files.

POWERWATCH
PowerWatch works with any UPS to provide guaranteed software and hardware shutdown during a power failure before the UPS batteries are exhausted. This eliminates the possibility of UPS failure when battery time is exceeded. It saves you files, exits your programs and logs out of the network. Available to MS-DOS, XENIX and UNIX users. Compatible with all major networks.

FILELOCK
Filelock is a combination of hardware and software to protect sensitive data. Filelock inserts into any serial or parallel port to allow secured data to be accessed from within an application. Filelock maintains a library of secured files and it compresses secured files.

TRACKER™ FIVE
Tracker™ Five is an "intelligent" cardfile system which dramatically simplifies the storage, retrieval, updating and access of information on clients, customers, and contacts.

And, because Tracker™ Five can be a TSR (terminate and stay resident) system, it means that no matter what else you're working on, one hot-key brings Tracker™ Five to the screen, ready to help you write a note, schedule an appointment in your calendar, or retrieve a vital piece of information in an instant.

See us in America at COMDEX'91 Booth 705

Distributorships available, call or fax:
313 R/E Ltd. 43 Argow Pl. Nanuet N.Y. 10954 Tel. 1 (800) UD 313 RE
Tel. 1-(914) 623-1630. Fax (914) 623-7180

WORLDWIDE SUPPORT

Australia: (62) 310728 Fax (62) 961815
Belgium: (013) 771902 Fax (013) 777372

Denmark: (042) 804200 Fax (042) 604131
Italy: (02) 6698 1094 Fax (02) 6700 705

Malaysia: (03) 719 8299 Fax (03) 747 6558
Netherlands: (020) 5861 411 Fax (020) 5861568

United Kingdom: (0600) 5829 Fax (0600) 72179

Circle 8 on Inquiry Card.
far more effectively with a mouse than without.

MARTIN HELLER: I wonder if the issue isn’t that GUIs give you the visual and text elements more effectively than any other program. People have to learn to use icons and mice. No one ever says “I hate the computer keyboard.” I’ve used both GUI and character-based programs. I’ve also used GUI programs that were delightful, and GUI programs that were a royal pain in the butt. Same for character-based programs.

I hate being forced to point and click endlessly once I know the score.

GUIs aren’t exactly intuitive, either. People have to learn to use icons and mice—some never can. But the general structure of good Windows and Mac programs is pretty easy to learn and wears well: You can explore the menus easily, you can learn the accelerator keys as you go, and so on.

I think the key point is that once you do learn how to point-and-click, how to drag and double-click and drag, and you can pick up almost any program that follows the conventions without reading any manuals.

STAN MIASTKOWSKI: I’m getting the idea that people have to learn to use icons and mice—some never can. But the general structure of good Windows and Mac programs is pretty easy to learn and wears well: You can explore the menus easily, you can learn the accelerator keys as you go, and so on.

I think the key point is that once you do learn how to point-and-click, how to drag and double-click and drag, and you can pick up almost any program that follows the conventions without reading any manuals.

TOM THOMPSON: I can do all the things on my Mac that other people can do with Desqview on their PCs: I can download in the background, print in the background, and write in a word processor window. My word processor window has very few icons: These icons manage text alignment, word wrap, and line spacing. They’re up and out of the way, and I get a full screen of text to work with. It works, and it’s fast. I can grab a chunk of text from my word processor and paste it to BIX through the display window. Or I can grab a screen of BIX messages and drop it into a document.

Sure, the screen can get a little complicated; that’s the equivalent of sorting through all those DOS commands, but a lot easier. I like my add-ons. They’re useful, and they augment the Mac’s capabilities much like that DOS add-on, Norton Commander, does for a PC. Finally, there’s stuff that the mouse makes easier: drawing graphics and laying out pages. Computers are used more than text. If you want to discuss the capabilities of a GUI, you must consider all computer users, not just writers or number crunchers.

UDELL: In the great either/or GUI/CLI debate, the real answer is that we need both. I love the facts that I can pick up almost any of the Mac applications (and many Windows applications) by poking around, without documentation. I hate being forced to point and click endlessly once I know the score. I especially hate the lack of universal transapplication scripting that would make automating my work easier.

The Mac’s the worst culprit here; no CLI at all. Unix has a great CLI, but little integration of that with the GUI. Windows isn’t much better yet: weak CLI, some integration with the GUI possible (e.g., Bridge Batch). Give me a good CLI and a good GUI, and have uses for both.

But most of all, give me a universal script language that spans the two domains comprehensively and cleanly. It’s fun to lasso a bunch of files in Windows’ file manager and then delete them. It’s fun once. But after that, give me “del *.obj” More important, give me ways to say “del *.obj when date < value, every Thursday night at 11.”
We are about to satisfy your deepest desire...
Introducing the DBMS runs like a mainframe.

Admit it.

Don't you get just a twinge of envy when you see a Mac user having fun while getting the job done?

You're not alone.

Millions of users who needed the power of the PC but wanted the ease-of-use of a Graphic User Interface (GUI) just splurged on Windows and the expensive hardware needed to get the most out of it.

But you don't have to do that.

Because now there's FoxPro*2.0.

Why should the rich have all the fun.

FoxPro 2.0 gives you the ease-of-use of a Graphic User Interface on your character-based DOS PC.

Use pull-down menus to open multiple windows (in DOS) and see all the data you need to see at once. Build easy-to-use screens for entering and viewing data just by picking-and-clicking to place menus, buttons, checkboxes and scrolling lists anywhere you want them. Create sophisticated, elegant reports without the usual pain. Then assemble
that acts like a Mac and
In DOS.

everything into your own
custom applications.
Without writing a single
line of programming code.

But that's only the tip
of the iceberg.

Beneath its Mac-like
interface, FoxPro delivers
all the power and
technology needed for your database
management systems in the 1990s.

Our new memory man-
agement techniques let
you work with the
memory you have now
while speeding up your
applications.

Our new compound
indexes are less than a
quarter the size of those
in competitive products
and far, far faster.

Our new Relational
Query-By-Example
(RQBE) is a simpler, inter-
active interface to the
information you need.

Our new Rushmore™ query optimization
accesses that information two orders of
magnitude or more faster† than ever before.

You'll like being able to seamlessly use the
SQL SELECTs that RQBE creates in any of
your applications. (And the new UPDATE,
INSERT and CREATE TABLE commands, too.)

And you'll love the fact that to the rich
development environment we've always had,
we've added a project manager that keeps
track of all the needed files and any changes,
then automatically builds your application or
.EXE files. An API that lets you dynamically
link to libraries you write in C or assembler
with a single FoxPro command. A BROWSE

FOR that's the basis for an
entire application itself.
Fourth Generation Language
(4GL) tools that make adding event-
driven code to fully relational screens,
menus, reports and labels a snap.

And we've made our networking even
better than when NSTL said:* "... mult-user
databases fall into two general performance
categories: FoxPro/LAN and all the others ..."

There isn't a DBMS in existence with the
power of FoxPro.

The bigger your business,
the bigger your investment.

So we've maintained downward
compatibility with your existing
systems, and you can use FoxPro 2.0
to run your current dBASE (and Fox)
applications on your present
character-based DOS PCs.

While you develop better, faster
database management systems using
all the advanced power of FoxPro
2.0 to satisfy your future information
processing needs.

To get the most out of your
investments, call and ask about our
Upgrade-Any-DBMS-for-$195 offer.

Call now for your FREE demo disk.

FoxPro 2.0 runs on a 512K XT yet in extended
mode uses every bit of power in a 386 or 486.
To try it yourself, call Fox Software for a free
copy of our fully-featured demo or the name
of your nearest dealer.

You'll be amazed at what FoxPro 2.0 can do
for you. In DOS.

Call 1-800-837-FOX2 today.
(Ask for Offer BYT-701)

FoxPro 2.0
The complete power trip.™


Circle 117 on Inquiry Card.
Window Wars

Which GUI is for you? We stood the leading contenders side by side and compared their most important features.

KENNETH M. SHELTON, JANET J. BARRON, AND BEN SMITH

The term graphical user interface seems to be an unlikely candidate for the Buzzword Hall of Fame. Use the acronym GUI around someone who doesn’t already know what you mean, and you’ll probably get a glazed look. When discussing such systems, it’s easier to resort to what has become a standard analogy and simply say they are “like the Macintosh.”

“Like the Macintosh” means, of course, that you use a mouse, point to icons that represent programs and files, pull down (or pop up) menus of commands, and do this within separate windows on the display screen. There are variations on the theme, but these four elements (codified in yet another unappealing abbreviation, WIMP—for windows, icons, menus, and pointing device) are the basic tenets.

The history of the GUI doctrine is legend by now: Xerox’s Palo Alto Research Center pioneered the concept. Steve Jobs thought it was “insanely great” and enshrined it in the Apple Macintosh. Bill Gates agreed, and his vision—though taking longer to catch on—culminated in the marketing and development juggernaut, Windows 3.0. Along the way, the entire computing world went GUI in one form or another, including such unlikely operating-system converts as Unix. (IBM—with its Common User Access—is even trying to drag mainframes and minicomputers, kicking and screaming, into the act.)

All this inevitably leaves the average person with a lot of questions: What’s the difference between all the GUIs now available? Which features do I need, and which ones can I do without? Which GUI is best?

To help answer these questions, we take a close look at the GUIs available for the major categories of personal computers: IBM PC compatible, Macintosh, Unix, and Amiga. First, we look at them from a user’s perspective, comparing the features that might make you choose one over the other. Then, we look at them from a programmer’s perspective. (See “Tools for Window Workers” on page 139.)

Applications: The Chicken and the Egg
You can plan a great party, but if no one attends, it will be a bust. On the other hand, once people hear about a good party, everyone wants to go to it.

That’s the way it is with a GUI: Developers don’t want to spend time developing programs for an interface that no one uses; yet, unless a lot of programs run...
on it, you're not likely to buy it. On the other hand, if the interface is introduced with enough fanfare, it will convince developers to write software before there's a guaranteed market.

That's what happened with Windows 3.0. Microsoft was able to sell developers on Windows 3.0 before its introduction, and the number of Windows programs released since then, according to Dataquest, is approaching 1200. This figure includes some of the nicest applications that run on PCs, such as Word for Windows, Excel, and Wingz. Compare that situation with OS/2, Windows' older sibling. According to IBM's National Solutions Center in Austin, Texas, which is compiling an applications guide for it, OS/2 has accumulated only about 100 Presentation Manager (PM) applications.

Ensemble is another PC-compatible GUI that's wrestling with the chicken-and-egg problem. Because it runs on older systems (such as the XT) and comes bundled with a number of applications (such as GeoWrite, GeoDraw, and GeoComm), Ensemble has been called the "poor man's Windows." However, only two companies other than its publisher, GeoWorks, have released programs that run under Ensemble. More may come; and if you're happy with the GeoWorks programs, you may not care that the most popular word processor, spreadsheet, or database program doesn't run on it.

In the non-DOS world, early Macintosh users can remember when there were exactly two Macintosh applications: MacWrite and MacPaint. Today, according to Dataquest, there are over 8000 applications for the Mac. Similarly, there are thousands of applications for the Amiga's Workbench. Don Hicks of Amazing Computing estimates that there are over 2100 commercial programs, with public domain programs bringing the total to over 4300. (By the time you read this, Commodore will have released Amiga OS 2.0, which will provide an all-new look to the Workbench interface.)

GUIs for Unix systems have slowly been adding to their stable of available applications. The leading contenders are Open Look—developed by Sun Microsystems, AT&T, Xerox, and others—and Motif, from Open Software Foundation (OSF). These two GUIs are currently in an applications race, and it is difficult to say which one has more programs running under it. Both run on top of the X Window System, so any commercial X application will run under either Open Look or Motif. (Evidently, it isn't that difficult for a software publishing company to create a GUI interface for one program if it has already worked on the other. For example, there are versions of WordPerfect for both.)

A fair count for Motif versus Open Look should include only applications that exclusively use the "widget sets" of one or the other. Ideally, only applications that conform to the style guide should be counted. (The Motif Window Manager doesn't do this.) There are certification checklists, but they are just now being approved by the respective companies.

When it comes to installed base, far more Unix vendors sell their systems with the Motif Window Manager (and development tools) than with Open Look. But Sun Microsystems is the leader in workstation sales, so more RISC-based workstations will probably be sold with Open Look. Open Look is also the default GUI with AT&T Unix System V release 4, although several SVR4 vendors ship Motif (e.g., Commodore's Unix system, the Amiga 3000UX, comes with SVR4 with Open Look, while the Sony Microsystems' News workstation BYTE recently reviewed ran SVR4 with Motif). There has been a great market for 386 Unix stations, and if these get a GUI, it tends to be Motif.

OSF claims that there are 200 Motif applications, but a close look at this list indicates that many of the programs don't use the Motif toolkit, which means they would run under any X manager, including Open Look. Sun estimates that there are currently 30 genuine Open Look applications.

While the Next computer is, technically, a Unix-based system, the Next user interface, NextStep, is in a class of its own. It is not X Window-based and does not support X protocols or applications, and, thus, will not run any X applications.

Still, there are roughly 80 commercial applications available for Next computers, including some popular applications like Mathematica, WordPerfect, Wingz, and FrameMaker. This is probably because prototyping on the Next computer is easy (see "Tools for Window Workers" on page 139), so the Next is often the first platform developers choose to evaluate the porting of an application to Unix.

NextStep is also available for the IBM RISC System/6000, and Next estimates that approximately 10 percent of those systems are being shipped with NextStep. The rest, if they are running a GUI at all, are running Motif.

## Getting Along: Compatibility

Having all the applications in the world won't do you any good if they don't run well or get along with each other. Sometimes this has to do with the programming guidelines laid down by the GUI's developers: If the guidelines are mandatory, the programs are likely to look alike and be "well behaved" (i.e., not likely to crash or interfere with each other's operation).

Macintosh programs, for example, tend to be very similar in appearance and quite stable, since Apple maintains strict guidelines for developers. (You can almost always count on File and Edit to be the first two options on a Mac menu.) Usually, if the application isn't built to the specification of the GUI, it won't work at all; half-baked applications just won't work.

Like the Macintosh, the Next computer requires strict adherence to its guidelines to make an application function. The Next's excellent software development tools and toolkits (NextStep) make it almost foolish to "roll your own" user interface design for a Next application. As a result, Next applications tend to be stable and robust.

OS/2 PM also has fairly strict developers' guidelines, which can mean headaches for developers but tends to make OS/2 PM programs very compatible with each other. They may be slow, but they are generally robust and stable, and they don't crash.

Windows applications, on the other hand, can be a mixed bag. Some run perfectly, while others crash frequently. You'll generally have more trouble trying to run Windows 2.0 applica-
**X for the Desktop: Desqview/X**

Steve Carpenter

As this article was being prepared, another GUI contender entered the ring: Desqview/X, from Quarterdeck Office Systems (Santa Monica, CA), provides a full client/server X Window System for MS-DOS systems.

Quarterdeck’s previous product, Desqview, is a nongraphical environment that lets you multitask MS-DOS programs. This background gave the company a running start on Desqview/X, since the X Window System requires multitasking. (Without multitasking, other X Window System products running under DOS can only implement the X Server to handle the local display. This means that you can only access X client applications available on the network, much like an intelligent terminal. In a sense, the network provides the “multitasking” capability that the local system can’t.) Desqview/X also gives you access to the applications available on a multitasking DOS system—even to local DOS clients written to use the GUI capabilities of toolkits running over the X Window System.

Besides the X Server and Desqview Window Manager (DWM) software, Desqview/X includes Desqview and QEMM software, which means it will be as hard (or easy) to install as those products are in stand-alone mode. A network can raise the installation complexity even more, depending on the type of network you use.

GUI/window systems eat memory and processor cycles, so Quarterdeck recommends that you have a minimum of a 286-based system with 2 megabytes of memory. Although an 8088/8086 is sufficient to get Desqview running (the X Server, a 20-MHz 386 system with 4 MB of memory should be a solid platform for Desqview/X).

Desqview/X will let you take advantage of the X Window System in three ways. First, on a stand-alone system, Desqview/X provides a complete GUI environment. Desqview plus X can support applications written to use buttons, sliders, menuls, and the rest of the GUI paraphernalia. DWM even gives Desqview users a bonus of a three-dimensional graphical “look and feel” around windows containing conventional DOS applications. You can also add window managers like Open Look and Motif to Desqview if you want a different look and feel.

Second, on a PC LAN, Desqview/X lets you transparently access applications running on another MS-DOS system. Networked users who can’t yet bear to part with their 16-bit 286 systems but want to use a 32-bit application like Paradox/386 have an economical solution with Desqview/X. Just one 386 system on the network gives everyone a window to the applications on that system.

Third, on a TCP/IP LAN, Desqview/X lets you share all resources in the enterprise, from supercomputer to word processor, and not just other MS-DOS systems. The configuration possibilities are endless.

Desqview/X has the potential of being the PC GUI/window system of choice for networked users. The question is: can Quarterdeck win a marketing war with Microsoft?

Steve Carpenter is an independent consultant specializing in event-driven software and open systems technology. He can be reached on BIX as “scarpenter.”

---

**tions in Windows 3.0, and some programmers just don’t follow the rules, regardless of the environment they’re programming in. But as developers get used to the environment, Windows applications are getting better, and the majority of them now run fairly well.**

Guidelines for developing programs for Amiga Workbench-, Open Look-, and Motif-based systems are all optional. Thus, the compatibility and consistency of applications is dependent on the design of each application. (In fact, you can sometimes run a Motif application in an Open Look window, or vice versa. They just won’t look right.) In general, GUI-based Unix applications are as robust as the underlying implementation of the X server, some of which are a little flaky.

**Up and Running**

How hard is it to get a GUI up and running? That depends largely on the hardware you’re using. The easiest way is to buy a system that comes bundled with a GUI. The Mac and Amiga each walk you through a simple installation procedure that involves putting in floppy disks and pressing the Return key. The Next computer is even easier: Turn it on, and you’re ready to go. (The first Next systems loaded their operating systems from an optical disk, a procedure that was easy but took hours.)

Things are more complicated in the DOS and Unix worlds. You can buy systems from third-party vendors that have preinstalled Windows, OS/2 PM, Motif, or Open Look on their machines. But if you want to install one of these on a machine you already own, life could get interesting.

Windows has a good setup program that simply requires you to answer routine questions. If, however, you have an odd clone or an older AT and a CGA display, or if you have a lot of RAM-resident programs running, installing Windows 3.0 may be impossible. In the best-case scenario, installation is easy and takes about 20 minutes. In the worst case—call a consultant. OS/2 PM’s installation procedure is similar to that of Windows. Although the setup software presents you with some esoteric questions, the manual helps you with most of them. Technically, you can run OS/2 PM on a 286, but it will be slow.

For older systems, Ensemble may be the GUI of choice. Installation takes a while—you have to copy seven 360K-byte disks—but the process is relatively painless. The installation program makes it easy to select and test all the appropriate drivers for the screen, mouse, and printer.

Loading Open Look or Motif is no more difficult than loading any other Unix program. For an experienced system administrator, the process might take 5 minutes.

**Have It Your Way: Customization**

Once you get a GUI running, you can usually adapt it to suit your own tastes, changing things such as the background color and pattern. However, the degree of changes and how easy they are to make vary from system to system.
The Best of GUls; the Worst of GUls

Every graphical user interface has its good and bad points. Here, in a nutshell, are the pros and cons of the major GUls.

Windows 3.0

BEST POINTS
• many applications available
• runs older DOS applications and new Windows-specific programs
• in enhanced mode, can multitask DOS applications
• macro and task-automation capabilities included
• provides on-line help
• relatively inexpensive to buy (but see below)

WORST POINTS
• requires a lot of hardware and memory to take full advantage of features

Macintosh

BEST POINTS
• system is integral to machine; easy to install
• many applications available
• applications are stable and compatible with each other
• network capability built in

WORST POINTS
• cooperative multitasking is only as good as worst-written program

Open Look

BEST POINTS
• multitasking capabilities built in from the ground up
• network capability built in
• easy to configure for personal preferences

WORST POINTS
• no macro or task-automation features included
• developer guidelines not mandated; applications may not appear consistent

Ensemble

BEST POINTS
• inexpensive, easy-to-use package
• runs on older-model 8088 machines
• includes a number of basic applications that work well together
• multitasking capabilities built in from the ground up

WORST POINTS
• lack of “power” applications, such as database, spreadsheet, or heavy-duty word processor
• no macro or task-automation features included
• no programmer’s tools
• no network capabilities included
**NextStep**

**BEST POINTS**
- system is integral to machine; comes already installed
- applications are stable and compatible with each other
- multitasking capabilities built in from the ground up
- provides on-line help
- network capability built in
- good support for interprocess communication

**WORST POINTS**
- only available on the Next computer and the IBM RISC System/6000
- few applications available
- no macro or task-automation features included

---

**Motif**

**BEST POINTS**
- multitasking capabilities built in from the ground up
- network capability built in

**WORST POINTS**
- no macro or task-automation features included
- no file manager included
- developer guidelines not mandated; applications may not appear consistent

---

**OS/2 Presentation Manager**

**BEST POINTS**
- applications are stable and compatible with each other
- multitasking capabilities built in from the ground up
- provides on-line help
- macro and task-automation capabilities included

**WORST POINTS**
- sold only through IBM dealers, and many don't sell it
- few applications available

---

**Amiga Workbench**

**BEST POINTS**
- system is integral to machine; easy to install
- many applications available
- easy to configure for personal preferences
- multitasking capabilities built in from the ground up
- macro and task-automation capabilities included
- good support for interprocess communication

**WORST POINTS**
- lack of consistency across applications
- lack of 8- and 24-bit color
- no network capabilities included
Almost all GUIs let you change the background screen—the "desktop" upon which your files and program icons are located. Windows comes with a Wallpaper menu option. OS/2 has more-limited color choices, and choosing them is more difficult (e.g., there is no wallpaper).

Some GUIs—the Amiga Workbench and Windows 3.0, for example—let you choose the font the desktop uses. (You can change Macintosh Desktop fonts, too, but it isn't easy.) In fact, the Amiga could win a "user-configurable award," with its 13 Preference Editors that let you change such options as font, mouse speed, color, and resolution of the Workbench screen.

With Open Look and Motif, everything is customizable, but you have to be a bit of a hacker to make changes. The menus and environment variables are described in a text file called .Xdefaults and several initialization, configuration, and menu files that you can have in your home directory. Open Look makes things a little easier than Motif: You can change some configuration parameters, such as background color, directly through the window manager. On some Open Look systems, you can even customize your menus through menu operations.

Here is where the Next environment falls short of the other window managers and GUIs. Like the Macintosh environment, you can do little more than show which applications you want to have immediately available to your user account and how the icons will stack. The benefit is that the few configurable resources are configurable with window manager utilities. All changes can be made through utilities that are part of a window manager, and most of these operations can be done with mouse motions and clicks.

Make It Easy
You win some and you lose some with a GUI. Some tasks get easier, while others—like creating macros or scripts to repeat commonplace procedures—become difficult or impossible.

Longtime PC-DOS users invariably have a host of batch files, keyboard macros, and other time-savers that depend on receiving a steady stream of ASCII characters rather than a bit-mapped image. Transferring that capability to Windows means using a utility like Macro Recorder, an accessory that comes with Windows and lets you record keystrokes and mouse motions so that you can play them back automatically. The Macintosh interface comes with a similar program called MacroMaker, and you can also purchase Apple's MPW, which offers good ways to manipulate files.

For more sophisticated users, a couple of GUIs provide scripting languages that let you automate procedures. OS/2 PM version 1.3 comes with Rexx, a powerful, interpreted-scripting language, and AmigaDOS provides a version called ARexx. (See "Rexx in Charge," August 1990 BYTE.) The Unix-based GUIs and PC-compatible Ensemble do not have built-in macros or scripting facilities.

Doing Double Duty
Multitasking—the ability to run more than one program at a time—is often a main reason to get a GUI. However, multitasking is largely a function of the operating system on which the GUI is built, and not all systems handle multitasking the same.

Some operating systems use cooperative multitasking: When the system isn't busy with the application you're currently run-
When (say, between keystrokes), it can give attention to background tasks, such as downloading a file. The “gold standard” for multitasking, however, is called preemptive multitasking. In this approach, the system divides processing power into time slices and allocates portions to each application. The advantage of preemptive multitasking is that it tends to isolate tasks; if one application crashes, the system won’t necessarily come down.

Operating systems like Unix, OS/2, and the Amiga Exec employ preemptive multitasking, so GUIs that run on them have more-advanced multitasking features. Even the entry-level Ensemble is built on an operating-system layer (PC/GEOS) that provides preemptive multitasking.

Interestingly, the system that started the GUI revolution—the Macintosh—uses cooperative multitasking in its MultiFinder (a multitasking version of the Finder that comes with the system). The disadvantage of such a system is that it is only as good as the best-behaved application that you’re running.

Similarly, Windows uses cooperative multitasking, unless you are running in enhanced mode on a 386 system. If this is so, you can run multiple programs—including DOS—in “virtual” 386 systems, and the programs are protected from each other’s quirks. Without a 386, you can run only one DOS application at a time, and you can’t run it in the background while running a Windows-specific application in the foreground.

Talk to One Another
If you’re running more than one application, you might want to pass information back and forth between them. This could be something as simple as copying text or graphics into a “clipboard,” exiting the application, opening another application, and copying the data from the clipboard to the new application. Almost all GUIs allow this kind of data transfer.

Beyond that is interprocess communications, a more active kind of data swapping. For example, if you have a communications program that’s receiving a constant stream of data about your stocks, the program passes that data to a spreadsheet, which alerts you if prices fall below a certain point.

This kind of linkage is easier for operating systems with preemptive multitasking (and GUIs built upon them), because the applications are running as truly separate tasks. Thus, it should be easier for programmers to write applications that share data under OS/2 PM, Open Look, Motif, NextStep, and the Amiga Workbench.

Unfortunately, only a few programs take advantage of interprocess communications. Lotus’s 1-2-3/G and Freelance Graphics, which run under OS/2 PM, are notable exceptions. In fact, the two programs actually load some of the same code when you start them up. OS/2 PM uses a technique called Dynamic Data Exchange to pass information between applications (see “Hot Links to Go,” November 1990 BYTE). Windows 3.0 uses a slightly different technique for DDE (in part, because its multitasking model is different), but the end result is the same: You can establish “links” between programs to perform tasks such as automatically updating databases and spreadsheets or downloading E-mail.

Microsoft recently announced a new technology based on DDE, called object linking and embedding, which will go beyond linking and let you combine various types of data in a

Sure, you’re into computers, but how do you get your dog, or your house, or your company into one? A Canon Still Video Imaging Kit may provide your answer.

As easy as taking a snapshot, it lets you convert any three-dimensional object into a digitized image, ready for use in programs like PageMaker, Quark, Photoshop, and Persuasion.

Impressed? Call us for a free brochure and dealer locations at 1-800-221-3333 ext. 313.
A GEM by Any Other Name

Janet J. Barron

In 1985, Digital Research, Inc. (DRI), released a graphical user interface system software called GEM. At that time, GEM ran on top of the operating systems for the Atari ST and PC-compatible machines. Since then, Atari has continued its own development of the software, and GEM is now built into the ROMs of all Atari ST computers. The company continues to upgrade both the base operating system and the Atari version of the GEM interface. It releases its new ROMs through retail outlets.

On the PC-compatible side, GEM has largely been superseded by Windows and OS/2. As a result, DRI is leaning away from the GEM name and original concept and choosing instead to release new applications that overlay and use some of the former GEM functionality. These include Presentation Team 2.0, a $495 presentation program available as a stand-alone package or as a network server version, and Artline, a graphics illustration program available only as a stand-alone package for $595.

Interestingly, the types of features that OLE offers have been available for some time from Hewlett-Packard's NewWave, a sort of "super-GUI" that sits on top of Windows. So far, however, the only applications that run under NewWave have come from HP. That leaves NewWave users in the same boat as the lower-end Ensemble users; thanks to preemptive multitasking, Ensemble has the capability to provide true interprocess communications. Until developers create programs to take advantage of that capability, though, it won't do you much good.

Another issue is how strong the links are between two applications. Under Windows, DDE links require one document to remember the location on the hard disk of another document. If you reorganize your hard disk, change a path name, or delete a file, the link breaks. That isn't true of NewWave, which tracks files more carefully.

On the Amiga Workbench, the ARexx macro language lets you share data between two or more Amiga programs equipped with ARexx message ports. (Such ports have lately become de rigueur on Amiga applications.) ARexx lets you create "meta-applications" using stand-alone Amiga programs.

Networks and Windows

These days, more and more of our personal computers are connected to other systems via LANs. Another consideration about GUIs is, therefore, how well they work with networks. Ideally, a GUI should let you attach to a network easily and should thereafter treat network resources (e.g., hard disk drives and printers) as if they were peripherals attached to your own machine.

We have to recognize two different approaches here: X Window System and the rest of the world. The X approach is inherently network-oriented, so GUIs based on it will operate over networks more easily and efficiently.

In the non-X world, the ease or difficulty of attaching to a network varies. Of course, you first must have the right hardware installed. The software can, however, make it easier to change networks or reconfigure the network you're attached to. The Macintosh's Chooser menu lets you select a network, enter your passwords, and go on from there. Windows 3.0 provides the same capabilities through its control panel and print manager. OS/2, on the other hand, doesn't provide those kinds of user-friendly network reconfiguration tools. (Note that the only network software currently available for OS/2 is LAN Manager.)

The Amiga Exec doesn't provide specific support for networking. Each network implementation and application must provide its own hooks into the operating system. However, Commodore is currently developing a layer for Exec called the Standard Amiga Network Architecture, which will provide a common application programming interface for networking functions. SANA will make it much easier to network Amigas.

Ensemble has no network capability at this time, although GeoWorks has indicated that it plans to support networks in the future. And although NextStep is not X-based, it is heavily dependent on networks and servers, and all Next applications have network capability built in.

Getting Help

GUIs are so easy to use that you don't need manuals or support, right? Right. But just in case, you'd better have a manual handy, and on-line help would be nice. It makes sense to be able to ask the interface for help, rather than having to look up what you need to know in a book.

Unfortunately, on-line help seems to be the exception, rather than the rule, for GUIs. Only OS/2 PM, Windows 3.0, and NextStep provide such help. All of them are good, fairly extensive on-line help systems. The Windows help facility is a hyper-text system that includes graphics. Vendors can add help information on their own software for the system. The Next computer's help system is a separate, launchable documentation application.

Although the Macintosh doesn't currently provide on-line help, System 7.0 includes a help facility called Balloon Help. When you activate this feature, passing the cursor over any item on the screen will bring up a cartoon balloon-like graphic con-
Introducing Borland's ObjectVision.
Now, Anyone Can Build Business Applications for Windows

There has never been anything like ObjectVision. For the first time ever, nontechnical business professionals can develop and maintain their own software applications—quickly and easily.

Imagine the benefits:
- Get new Windows programs up and running quickly
- Build database front ends easily
- Connect to corporate databases and other Windows applications
- Reduce the time needed for user training
- Eliminate the programming backlog

Visual Programming
With ObjectVision, Borland introduces a revolutionary concept in software—visual programming. Now, if you can picture your application, you can create it yourself:

1. Decide what you want your application to look like.
2. Draw the decision tree that controls the logic of your application.
3. Add spreadsheet formulas for calculations. Or, link your program to other Windows applications or databases.
4. The uses are limitless.

Special, Limited Time Offer*
With our introductory price of only $99.95 ($495 suggested retail price) and a 60-day, money-back guarantee, now is the time to look at ObjectVision.

See your dealer, or
call NOW
1-800-331-0877

ObjectVision is also available in a Run-time version that allows you to distribute ObjectVision applications to other users.
Introducing a completely different way to create business applications:

**GIVE YOUR COMPUTER A BRAIN.**

The Brain is an incredible new system that will save you hours and hours of time and trouble in the creation of DOS business applications. Now you can forget about using high level languages in development and execution. With the Brain, you simply use plain, everyday English with no need for complex codes, testing, debugging or modifying. Programmers and non-programmers alike will be amazed at how much more your computer will do for you once it has a Brain. Call, write or FAX Ingenuity today at (404) 441-1547 (FAX 404 441-1703) for a demo disk.

---

**WINDOW WARS**

...taining a brief description of the item. (For more on System 7.0, see “Seven’s a Success” on page 42.)

Whether or not you can get on-line support, you can sometimes get telephone support for GUIs. Microsoft has a 900 number (i.e., you’re charged for the call) for its phone support. Commodore provides phone support, but, again, you pay for the call. GeoWorks provides support for Ensemble via America Online, an electronic conferencing service, and a help phone line (not toll-free). Sun provides support for Open Look—also for a fee.

**Bottom Line**

What does it cost to add a GUI to your system? Some—like those that come with the Macintosh, Amiga, and Next computers—are bundled with the system and don’t require you to add additional hardware. Looked at one way, those GUIs are free; conversely, they cost as much as the whole system.

GUIs for PC-compatible systems tend to be sold separately. OS/2 costs $340, and Windows 3.0 lists for $149, although that price doesn’t take into account the cost of any additional hardware you may need. (You can run Windows 3.0 on a 286 machine, but you won’t be able to multitask DOS programs. If you only need to switch tasks easily, though, it should suffice. If you need true multitasking, you’ll need a 386 system.)

In contrast, Ensemble—at $199.95—will run on any PC-compatible machine (even an XT) that has 512K bytes of RAM, a hard disk drive, and a CGA display. Ensemble also comes with several applications.

Motif and Open Look are usually included when you purchase a workstation. You can buy them separately, but most people don’t. As with DOS-compatible GUIs, you may need to buy additional hardware; the minimum configuration is a 386 system with a VGA display, 8 MB of RAM, and the X Window System server software (although monochrome workstations and X terminals will also work). Then there’s the cost of the GUI—an insignificant $10 for Motif, but $295 for Open Look.

**Who Needs ’Em?**

You’ll probably never know if you need a GUI until you try one out. It’s usually a matter of personal taste; your level of computer expertise isn’t necessarily a criterion. At BYTE, some of the most technically knowledgeable staff members swear by GUIs; others just swear at them.

If you already own a computer and you want to add a GUI, your choice is essentially a trade-off between performance and applications—and cost. If you have an older system, and you can live without the latest and greatest applications, Ensemble may be the GUI for you. If you want to run more programs and you need more features, check out Windows or OS/2. You’ll probably be interested in Motif or Open Look only if you’re already a Unix user.

If you don’t own a system and ease of use is a priority, the Macintosh, Amiga, or Next systems with a built-in GUI may be a good choice. The Macintosh has more programs available, but the Amiga has some more advanced features that might make it attractive for certain applications. The Next interface is powerful and seamless and has great features, but there aren’t many application programs available for it yet.

Kenneth M. Sheldon is a senior editor and Janet J. Barron and Ben Smith are technical editors for BYTE. They can be reached on BIX as "ksheldon," "neural," and "bensmith," respectively.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.
Wouldn't it be nice to run Windows and never run out of room!

The 9ms Hardcard II XL gives you enough room, speed and power to run Windows to the hilt.

Windows™ 3.0 is a great idea. But it needs the right hard drive to take it to the limit.

Well, here's a way to really open it up.

Hardcard II XL™, a 9ms hard drive for 286/386 computers. XL comes in 50 or 105 MB capacities, and runs 8 to 9 times faster than your current hard drive thanks to a staggering 1.4 MB per second sustained transfer rate. And it costs about the same as any standard 28ms drive.

It also installs easily. You only need a few minutes to get the XL up and running.

That's all it takes. The Hardcard II XL will transform your cramped, crowded PC into a big, powerful Windows machine with a whole lot more room.

For more information, call 1 800 624-5545.

Circle 252 on Inquiry Card.
Your Ethernet LAN is not one of them.

Motorola introduces Altair™ wireless network—connectivity for your Ethernet LAN that gives you all the advantages of wire, without the wire.

An Ethernet LAN should be flexible, responding to your every movement. But with rapidly changing office communications needs, you may find your wired network isn’t so responsive.

That’s the beauty of Altair wireless Ethernet. It can give your existing wired networks greater flexibility. Its modular, wireless technology is compatible and expandable with your current wired LANs. The Altair network moves when you move. So changing, adding to or moving your
Ethernet LANs is almost effortless. And unlimited flexibility means you can put LANs where they couldn't go before. Motorola's patented technology makes Altair wireless Ethernet a secure, transparent and reliable communications solution.

See for yourself. Call 1-800-233-0877 for more information and the name of an Altair wireless LAN representative near you. It's time you stopped playing around with wire.
YOUR HARD DISK.

If you need more megabytes than your hard disk can swallow, don't buy a new drive. Stretch it with Stacker.

Stacker is the fastest, most economical way to safely double your hard disk capacity. Without sacrificing DOS compatibility. It's the new standard in real-time data compression. And it's the only product of its kind available in both software and coprocessor versions.

- Increase storage 100%
- Compatible with DOS 3.x, 4.x
- Industry's fastest real-time data compression
- Includes disk caching
- Fastest, easiest installation
- Toll-free technical support
- 90-day money-back guarantee

And when you add the Stacker coprocessor card you also get the fastest data compression in the business.

No wonder there are already over a million satisfied users of Stac's compression technology.

So call today and double your disk capacity tomorrow. You can purchase the Stacker software-only version—perfect for laptops—for only $149. Or get the entire Stacker high performance system with software and coprocessor card for just $229.

Order today. Visa, MasterCard, American Express cards accepted.

1-800-522-7822
Or see your local computer/software dealer.

STACKER™

© 1990 Stac Electronics, Carlsbad, CA

Stacker is a trademark and Stac a registered trademark of Stac Electronics.

Without appropriate programming tools, building window applications is difficult. Now there are development systems to help generate the popular graphical user interfaces.

MARTIN HELLER, PETER WAYNER, AND BEN SMITH

Making applications more appealing and easier to use means adding complex structures and functions: windows, menus, buttons, scroll bars, icons, colors, and so forth. What might be five lines of programming code as a text-based program becomes 105 lines as a window program.

At first, developers had to build their own windows and menus from scratch. Libraries and toolkits for PC compatibles became available, but each was different. Only Macintosh applications showed consistency, largely because the interface was built into the operating system.

Since then, however, some popular and powerful standard window systems for MS-DOS, OS/2, and Unix have appeared. None of these window systems is simple. Most of the designs use concepts from object-oriented programming (OOP), such as object classes and inheritance. Building your first application in any of the major window systems takes a substantial amount of study and many lines of code. It has become clear that the acceptance of any window system takes more than the demands of users; it requires good tools that shorten the learning curve and slim down an expanding development schedule.

Today there are tools, toolkits, libraries, graphical user interface- (GUI-) based development systems, and you-name-it for programmers developing in any of the now-standard window systems. There are even tools for developing in all window systems at once. (See the text box “A GUI for All Systems” on page 144.)

PRESENTATION MANAGER AND WINDOWS
Martin Heller

One hallmark of a mature technology is that there are lots of third-party add-on products. At least, there are lots of these products for Windows and OS/2 Presentation Manager, but are they mature? Maybe not—but they’re growing up. If you want to develop software for Windows or PM, now you actually can pick and choose your tools. Microsoft and IBM development kits and compilers are still good choices, but there are lots of competing products.

Veteran Windows programmers still use Microsoft C and the Microsoft Software Development Kit, because that’s what they’ve been doing for the last eight years. You really do not need to do the same thing. One alternative to Microsoft C that supports Windows (but still requires you to have the Windows SDK) is Zortech C++. The major advantage
TOOLS FOR WINDOW WORKERS

of ZTC over Microsoft C is ... well, that is C++., so you can make your code object-oriented. ZTC comes with a few relatively simple examples of classes for Windows: The hierarchy descends from a root class "WBase" to classes for list boxes, menus, buttons, and file-selection list boxes (descended from the list box class). Because Windows is highly object-oriented, it makes sense to program it in an object-oriented language. Once the class hierarchies are developed, building applications becomes much simpler.

If you want to build a full-blown class hierarchy for Windows 3.0 starting with the Zortech examples, you may still be working on it when Windows 3.1 ships. Fortunately, several vendors have already done the work for you. Glockenspiel of Dublin, Ireland, has developed CommonView (distributed in the U.S. by ImageSoft). CommonView now works with ZTC as well as Glockenspiel’s own implementation of CFRONT.

For those who are unfamiliar with C++., CFRONT is the AT&T front end that generates C code from the C++ source. The C code must then be run through a compiler, such as Microsoft C. ZTC combines the steps and produces object code directly from the C++ source.

Another set of class libraries for Windows comes from CNS. Its C-Talk/Views has its proprietary C-Talk language preprocessor along with its Views class library and requires a C compiler; C++/Views implements Views for ZTC.

For those who prefer the Turbo approach to languages, Borland will shortly be shipping versions of Turbo Pascal and Turbo C++ that support Windows. My understanding is that Borland will ship a resource compiler and #include files that will enable you to build Windows programs without owning the Microsoft Windows SDK. You may, however, want to buy the Microsoft Windows SDK manuals; they’re available at most computer-oriented bookstores and software stores.

Modula-2 enthusiasts will soon be able to write Windows programs, too: Jensen & Partners International (JPI) currently has a version of its TopSpeed Modula-2 program that works with Windows in beta test. Rumors from the beta testers have been encouraging.

On to Presentation Manager

Strangely, there are actually more language choices for OS/2 PM than there are for Windows. You need the IBM Programming Tools and Information (PTI), the Microsoft Programming Tool Kit, or the Microsoft SoftSet. The SoftSet is inexpensive but lacks manuals and examples. You can buy the manuals at bookstores, but you might miss having examples to copy.

As you’d expect, the IBM and Microsoft C compilers are compatible with the tools. So are the OS/2 version of ZTC and JPI’s TopSpeed C.

FORTRAN fans can find OS/2-compatible compilers from Microsoft and Ryan McFarland; Modula-2 devotees will find offerings from Logitech, Stony Brook, and JPI. Last but not least, Ryan McFarland offers a COBOL compiler with PM support.

For the Faint of Heart

Not everyone needs to write programs from scratch. Not everyone wants to. Not everyone can: The learning curve for Windows and PM programmers is pretty steep. One shortcut for beginners is to use an application generator. Many of these programs call themselves computer-aided software engineering (CASE) tools or even expert systems, but I don’t think most of them qualify in either category.

The limitation of application generators is usually that they get you only 80 percent to 90 percent of the way toward having a usable program. You still have to write code to make an application work properly. In addition, some of the tools will not preserve your additional code, so be careful and keep lots of backups. Nevertheless, you may get substantial benefit from using one of these tools, compared with learning to write Windows or PM programs from scratch.

The list of GUI application generators, which seems to grow more every week, currently includes WindowsMaker and WindowsMaker Professional from Candlelight Software, Instant Windows from WinSoft, CASE:W and CASE:PM from CaseWorks, ProtoView and ProtoGen from ProtoView Development, GUI 3-in-1 Prototyper, and GPF from Microformatic. Application generators can sometimes let you generate code for several different GUIs from a single design. CASE:W and CASE:PM claim to do this, and many other vendors have this capability or are working on it. Generators claim to produce efficient code, too. Caveat emptor: There is more than enough hype in the Windows market to go around.

Development Systems

You may not need the speed of a compiled language: If you are building a prototype or an interface to a “workhorse” program, you might prefer an interpreted system. Of course, ToolBook from Asymetrix) has received plenty of media coverage. It’s a nice HyperCard-like system with some definite advantages over C code in terms of ease of development but marked disadvantages in terms of execution speed.

ToolBook isn’t the only object-oriented environment in town. WindowCraft by Echelon Development is another HyperCard-like “multimedia toolkit.” Spinnaker Plus boasts the ability to develop and run custom information management systems on Windows 3.0, PM, and Macintosh platforms.

Then there are the object-oriented language systems. The granddaddy of them all, of course, is Smalltalk, and Digitalalk has versions of Smalltalk V for both PM and Windows. Or, you can go for Actor (from Whitewater Systems), recently enhanced with Actor Object Graphics.

If you are more comfortable with C++ syntax than with Smalltalk, you might prefer Object/1 from database vendor MDBS, also for Windows and PM. Object/1 has the distinction of coming with a full relational database system (derived from Knowledgegeman) built in; it also has built-in interfaces to SQL Server and to the vendor’s own high-performance transaction-processing database, MDBS IV.

Databases Galore

On the PM side, three more development systems boast database interfaces: Easel (from Easel Corp.), Application Manager (from Bower’s Development), and Mozart (from Mozart Systems). These systems tend to know a lot about IBM’s OS/2 Extended Edition database module and about DB2, HLLAPI, EE Communications Manager, and all that Blue stuff. Mozart
Here Are Six Things You Should Know About Windows Development

MDICREATESTRUCT, @WM_NCLBUTTONBLANK, hdig, ItemD, @WMmsg, wParam, lParam.

These are examples of the obtuse data types, messages and system calls you need to learn to develop Microsoft Windows applications. But with the right tools, the pain and difficulty of Windows development can be eased.

So, if you’re thinking about developing for Windows, here are some things you should know...

1. Develop FAST — In Standard Languages!

Forget long learning curves. Forget unfamiliar languages. CASEW™ is a development tool that lets you create Windows applications fast, using programming languages you know, like C, C++, COBOL, and others.

You design the interface with a WYSIWYG-level prototyper. Then CASEW generates tight, well documented code — in standard languages — like you’d write yourself. Since CASEW builds the code for your interface, you can concentrate on the application logic. By using a knowledge-base that experts liken to having a Windows specialist at your side, CASEW cuts Windows development time as much as 80%. And there are no run times or royalties to pay.

2. Develop It for Windows Today, Run It On OS/2 Tomorrow

Windows, OS/2, PM, Motif... C, C++, COBOL, XVT... straight-forward or complex GUI development... Your development tools need to adapt to your corporate strategy — today and tomorrow. That’s why CASEWORKS™ offers a wide variety of products that provide the platform and language independence today’s changing computing environment demands.

Interfaces designed using CASEWORKS products can be migrated among platforms and languages, preserving your development investment as your environments change. This interface interoperability makes CASEWORKS the leader in standard language GUI development tools.

3. Say Goodbye to Development Restrictions

The role of an application development tool is to improve your productivity without introducing unnecessary restrictions or limitations. That’s why it’s easy to merge your logic with the CASEW generated code. And why you can add code directly to the CASEW generated code, and save the changes through our re-generation facility.

4. Microsoft Chose CASEW

CASEW is a strategic and easy way to develop Windows applications. That’s what Microsoft discovered when it searched for a Windows development tool to market with its QuickC compiler. And that’s why you’ll find QuickCASEW™ in every package of QuickC for Windows™ Microsoft sells.

5. The Press Picks CASEW

You don’t have to take our word (or Microsoft’s) that CASEW is the best Windows development tool around. PC Magazine said “...every Windows development group should have a copy.” And PC WEEK lauded “It’s hard to imagine that GUI development could get any easier.”


Discover how easy Windows development can be by ordering CASEW today. Or, ask for our comprehensive guide... "What You Need To Know To Develop Windows Applications Now!" It includes a step-by-step description — including sample code — of how an actual Windows application was developed.

Circle 64 on Inquiry Card (RESELLERS: 65).
has the distinction of running under DOS (in character mode) as well as under PM.

Of course, if you’re working with a database, you may not need to look further than your database vendor. Omnics applications can be ported transparently between Macintosh and Windows and are relatively easy to design. Superbase 4 offers its own programming environment, and dBASE users wanting to move to Windows. dBFast claims also to offer complete portability to the Macintosh.

If you speak Structured Query Language, you might like Gupta’s SQL/Windows front end. For performance, dbVista (from Raima) and MDBS IV run under Windows and can give you excellent results as long as you understand Codasyl and Network database models. I’ve built applications with both databases, but I write my code in C and use the bare Microsoft toolkits, too.

AI

One of the more striking things about last fall’s American Association for AI meeting was how many of the exhibitors had products for Windows, both in the expert-system and neural-network areas. Kappa PC from IntelliCorp combines OOP with a frame-based expert system; this is a major-league product, but it also has a major-league price: $3500. For that, you can buy about five copies of Knowledge Garden’s KnowledgePro, which combines hypertext with an expert system. And I can’t even list all the neural networks that run under Windows.

Bridging Applications

If you want to build a workstation from several Windows applications, you might want to look into the Bridge Tool Kit or Bridge Batch, both from Sofbridge. Or you can use the macro languages built into Word for Windows, Word for PM, Ami Pro, or Excel as your starting point and spin a web between applications with Dynamic Data Exchange.

BUILDING FOR THE MACINTOSH USER INTERFACE

Peter Wayner

When Apple introduced the Macintosh, it didn’t announce just a computer but an entirely new way of programming. The machine not only had a CPU and memory, but it also had a ROM chip filled with routines that would do much more than access the disk files. Every Macintosh program interacted with you through these standard Toolbox routines for creating windows, menus, radio buttons, and sliders. Apple wrote guidelines for the user interface that specified the right way for all Macintosh software to look and operate.

Unfortunately, all the easy life of the user mandated plenty of work by the programmer. The Toolbox routines for manipulating the user interface were well designed and extremely modular; but at the beginning, programmers found it almost impossible to start writing software for the Macintosh without having first learned a large fraction of the Toolbox. That has changed. There are now several different approaches to programming with the Macintosh toolkit that blend different amounts of OOP, graphical programming, and compiler and interpreter techniques. Each of them makes it easy to build simple Macintosh applications in a day. Doing more complex work, though, still requires a certain amount of diligence.

Closet Secret

The skeleton application was the first solution developed by programmers to handle the complexity of the Macintosh. Many standard applications contained the same basic code for dispatching the mouse and keyboard events to the proper procedures. Programmers quickly realized that these common routines could be abstracted and stored as a code skeleton. Writing a Macintosh program was accomplished by making a copy of the skeleton code and adding the new code for handling the different parts.

There may be as many skeletons as there are dedicated Macintosh programmers, but some of the most popular ones are in the public domain and distributed freely. Transkel is one popular skeleton, and it comes in two versions: for picture and text. It can be found in archives and user-group libraries around the country. (It is also available on BIX.) Many power programmers still swear by skeletons, because they can generate the cleanest code. Of course, only power users can achieve this nirvana.

Objectify Me

Apple also realized that programming the Macintosh often involved many repetitive processes that could be abstracted. They distilled these standard fragments of code into a set of objects called MacApp, which run in the MPW. This system is substantially more sophisticated than a skeleton, because the entire structure is designed in an object-oriented way. Thinking of the Toolbox and the user interface with the object-oriented metaphor makes programming much simpler. In this view, the controls—like radio buttons, menus, or slide bars—and the windows are enchanted objects that accept orders from one another. MacApp passes these messages around in the background, and the programmer, in theory, needs to worry only about hooking up the correct button to the correct procedure for handling it. MacApp does the rest.

Before, a programmer who wanted to add a window would need to duplicate the code for opening the window, updating it, and controlling the buttons and gadgets on it. A programmer using MacApp would just issue the command to create a new window object and add the objects for the buttons and controls. The standard code for manipulating a window’s drag bar, its scrollers, and its other features would be automatically bundled in by the compiler. MacApp would also bundle the code for handling all the different buttons and controls. The programmer does not need to even know about skeletons or worry about doing most of the work.

Symantec has also added a set of objects, called the Think Class Library, to its popular C and Pascal compilers. These are quite similar to MacApp, and they provide much of the same support in the same object-oriented style. Some nuances are different, but the basic theme and usage are the same. These libraries are included with the latest versions of the company’s compilers (4.0 for C and 3.0 for Pascal) in a reasonably priced package.

To programmers, the one great advantage of these object-oriented systems is that it is easy to add to them and share each other’s code. One company, Lexington Software Design, is selling by subscription a product called Prepare() for extending the Think C Class Libraries. You get six issues as they emerge from the shop, and each contains a number of different useful objects. The first issue, for instance, contains a sophisticated list-manager object and a directory browser that is modeled after ResEdit’s structure. Those who subscribe to Prepare() will find it easy to build these into their own code. At the present time, three issues have been published, and the
Here's what the experts are saying about the hottest high performance graphics board available—the Hercules Graphics Station Card!°

"At $1,024, the Hercules Graphics Station Card is state of the art at an exceptional price."

"...1024 x 768 non-interlaced 256 colour mode is the only way Windows should ever be run."
Personal Computer World, Guy Swarbrick, Hercules Graphics Station Card, June 1990, UK

"If you do a lot of different kinds of graphics but don't want to spend too much, the Graphics Station Card is for you. Highly recommended."
CADalyst, Ralph Grabowski, August 1990

"The Hercules Graphics Station Card combines an extraordinary set of features designed to handle your most...well...Herculean graphics tasks."

"...Hercules will have proved, twice, that you don't have to be IBM to set standards."
Personal Computer World, Guy Swarbrick, Hercules Graphics Station Card, June 1990, UK

To find out where you can buy your Hercules Graphics Station Card, call 800 532-0600, ext. 745.

For People With High Standards!
I magine writing one interactive, graphical application and having it compile without and source code changes—not even conditional compilation—on all the major graphical user interface/window systems: Open Look, Motif, Presentation Manager, and the Mac. Sound unlikely? This is exactly what Extensible Virtual Toolkit (XVT) by XVT Software of Boulder, Colorado, offers: a programming interface featuring source code portability between all these window systems. (See "A Virtual Toolkit for Windows and the Mac," March 1989 BYTE, and "Bridging Troubled Waters," April 1990 BYTE.)

You could say XVT is a generic window system. Therefore, any developer in an organization that's concerned with protecting software investment should become familiar with XVT. Not surprisingly, one such concerned organization is the U.S. government. XVT is on the government's list of recommended application portability technology.

Another such organization is BIX, which recently contracted Softwords to develop a user-friendly graphical front end to its on-line conference system (see the photo) using XVT. BIX director Stephen Laliberte says, "BIX subscribes embrace every imaginable type of computer, and we wanted to have the same functionality across a variety of platforms." According to Laliberte, the new interface will be available for PC compatibles, Macs, Amigas, and other systems. It will let users point and click to join conferences, read mail, edit messages, and perform other previously command-oriented functions.

XVT implements a single, layered interface with a set of libraries (one per target GUI) and a common C language header file. Each library and header file combination, with accompanying utilities, tutorials, and documentation, forms one XVT product. Together, the library and header file present you with C functions that transparently invoke the native functions of the target GUI.

This approach might suggest that XVT supports only those functions common to all the target GUI/window systems. This is not so. If a function does not exactly map into all the target GUI systems, XVT makes the layer "thicker" to support a higher level of function abstraction. For example, since type fonts are often different between systems, XVT handles user font changes internally for each target GUI system. Your program does not have to handle the particulars of the font you select, but just an abstract change of font.

Does this mean XVT applications work slower than native GUI applications? I compared a native drawing application with a drawing application that used the XVT interface XVT-Draw. After a painless XVT installation on a Mac Plus and compilation with Symantec's Think C, I noticed no difference in performance between XVT-Draw and the native MacDraw.

There are other issues to consider: Some GUI/window systems have functions not provided on other systems. If you need those functions to do your job, then XVT is not for you. XVT also requires particular versions of tools on target platforms. On the positive side, XVT looks easier to program than Microsoft Windows does. Comparing an XVT Hello World program and the Hello, Windows program in Charles Peizold's Programming Windows, 2nd Edition, shows that similar functions can be programmed with fewer XVT statements. Whatever makes notoriously complex GUI programming easier is a boon to programmers!

Steve Carpenter is an independent consultant specializing in event-driven software and open systems technology. He can be reached on BIX as "scarpenter."

A GUI for All Systems
Steve Carpenter

BIX needed a friendlier, more graphical face that would look and feel the same on a variety of computers. The company contracted used XVT to develop this look, which will be available for Windows, Macintosh, Amiga, and other systems.

other three should come out during this year. After that, all six will be available as one package.

Draw Me
Even though OOP is an easy way to think about the Macintosh, it is still very textual. The GUI is created in MacApp with words, not pictures. Many people asked, "Why not write a graphical program that lets a programmer draw an interface on the screen and create Macintosh interfaces the Macintosh way?" Several companies have done just that: Smethers Barnes markets Prototyper, and Bowers Associates sells AppMaker.

Both let you build menus, windows, and control objects and
THE MICROSOFT WINDOWS 3.0 DEVELOPMENT TOOL THAT DELIVERS FROM START TO FINISH.

"C++/Views" is a development tool for C++ programmers that not only reduces the complexity of Microsoft Windows 3.0 but also slashes development time by up to 75%.

Delivers on the promise of Object-Oriented Programming (OOP).
Encapsulates more MS Windows 3.0 functionality than any other tool on the market today. Get MS Windows applications off to a fast start with a framework of over 75 tested and ready-to-go C++ classes.

Has the most complete C++ class library for MS Windows Development.
Get started with graphical user interface classes such as windows, views, bitmaps, dialog boxes, menus, popup menus, graphics, regions, pens, brushes, controls, buttons, listboxes, valuebars, editors, printers and much more. Organize your data with foundation classes such as containers, collections, sets, dictionaries, files, strings, streams and so on. Use other classes to manage the persistence of objects across files, to perform serial communications, and to activate timed events.

Provides support for the entire project.
Comes with a complete OOP development environment including the first fully functional C++ class hierarchy Browser. Also includes an Interface Generator for building C++ dialog classes and a Documentor for automatically producing high quality documentation of your classes.

Integrates leading-edge technology.
Combine C++/Views with Borland C++ or Zortech C++ for a cost-effective and highly productive development environment for building your next-generation software systems.

Pays for itself on even the smallest project.
Only $495.00 with no royalties. Comes complete with source code.

C++/Views from CNS, Inc.
CNS, Inc., Software Products Dept
1250 Park Road, Chanhassen, MN 55317
(612) 474-7600 • FAX (612) 474-6737
© Copyright 1988 CNS, Inc. All rights reserved. Microsoft is a registered trademark of Microsoft Corporation.

Circle 68 on Inquiry Card.
then move, shrink, and grow everything on the screen with the mouse until it looks just right. Prototyper lets you simulate how the buttons interact, but this is limited to simple operations like opening or closing a window. AppMaker and Prototyper can “compile” these descriptions of the application into either C or Pascal. The C or Pascal compiler converts these languages into the basic machine code and Toolbox calls to build the user interface on the screen. AppMaker’s code generator produces code for the Think Class Libraries. Smothers Barnes says it will have a Think Class version available soon.

AppMaker and Prototyper have a basic skeleton inside as well as skeletons for each of the possible window, menu, or control objects. When compilation begins, Prototyper or AppMaker customizes the various skeletons and glues them together in the right way. The result, however, is a hollow facade — it can only move the controls on the screen. You must create all the interior code for manipulating data and doing the actual work. In many cases, you must also provide the additional functionality for making an object work. When I created a list with Prototyper, the software generated a comment that sent me poring through Inside Macintosh. AppMaker lets you solve these problems once and for all, because you can edit these skeletons and glue them together.

The software is useful for an expert programmer who wants to save time, or an experienced programmer who doesn’t know anything about the Macintosh Toolbox. The absolute beginner, though, will quickly get lost when trying to modify the intermediate C or Pascal code.

Apple’s version of Allegro Common Lisp also comes with graphical software for creating GUIs. This development environment is a hybrid of object-oriented approaches like MacApp and graphical techniques. The software has a nice graphical editor for creating windows and controls, but it spits out objects, not skeleton code. People who use Lisp should find this perfectly acceptable and expected. These objects are customized for your particular windows. When you attach the rest of the program for handling the internal logic, you can do it within the object-oriented metaphor of message passing. The windows are just additional objects in the structure.

Interpret My Lips

Everything described so far could properly be called compilers. The GUI is created by drawing or writing specifications, and the software converts these specifications into machine code directly or via an intermediate compiled language like C or Pascal. Another class of software tools includes what are essentially interpreters. These programs, which include the famous HyperCard (now distributed by Claris), the newer Serius (from Serius), and Prograph (from The Gunakara Sun Systems) have their own intermediate languages for describing the user interface. These descriptions are interpreted when the software is run by another program. The latest version of Prograph, 2.0, includes a compiler for creating object code.

HyperCard and the similar SuperCard (from Silicon Beach Software) are software programs that interpret “stacks” of cards. Each card can contain a number of controls, edit boxes, and picture windows. The software interprets mouse-clicks by looking at the instructions for the controls and then calls the right routines. For some reason, it doesn’t seem natural to include HyperCard with the rest of these tools, but this may be because the system is aimed at every Macintosh user, not just the programming aficionado. These programs are, though, two of the fastest ways to get an interface working on the Mac. The downside is that you need to be running the same program.

Serius and Prograph are two of the more ambitious approaches to Macintosh programming. Everything, from the creation and location of the controls to the instructions that describe them, is described graphically. Everything is a picture. You don’t type out lists of instructions, but you create icons for operations like addition and subtraction and string these icons like pearls. The data flows out of the windows and controls and down the lines between these operational icons, which change the data. Ultimately, it reappears at the other end to be displayed by a window. These pathways act like variables containing the data.

Serius, however, stresses that its program should not be thought of as just a graphical language. The software comes with a wide variety of objects that handle the standard functions as well as some of the newer ones. There are objects for files, numbers, and text as well as CD-audio and network communications. This spring, the company plans to introduce a spreadsheet object that lets naive users put a spreadsheet interface to whatever they want. There is also a complete set of functions for handling a database of objects and files. The sample functions contain a mail program with a few simple specifications. The tricky details of communicating with AppleTalk and passing data are handled behind the simple facade of icons and pathways. If the wide range of standard functions and objects is not sophisticated enough, you can create your own in Pascal if you follow the proper interface specifications. To do this, you need the special developer’s version of Serius.

When the program performs as you want, Serius creates a stand-alone application containing an interpreter and the instructions distilled from your icons. This production adds an additional overhead so that even simple applications will require over 100K bytes of disk space. If you use this software, you trade cleanliness and efficient code for the ability to develop an application quickly.

Prograph is another visual programming language with a sophisticated concept. It is not so much a set of objects to be strung together as a completely new OOP language for handling all problems. Serius could probably be described as a sophisticated interface-building system. If you want to do anything original or different, you need to build your own objects in a traditional language like Pascal. Prograph, on the other hand, is a pictorial data-flow language that contains icons for handling base operations like strings, lists, arithmetic, and practically anything else you could want. There is no need ever to fire up the Pascal compiler again. If you want to create something special, there are special icons you can use to call any Macintosh Toolbox routine. If these still aren’t enough, you can attach C code resources as Prograph primitive icons.

Prograph contains the standard number of tools for creating good user interfaces. These are interpreted by the system, which contains nice facilities for debugging a program. The compiler will also generate fast code. Dataflow languages like Prograph are popular with researchers examining parallel processing, because they make it easy to split jobs into bits that can be done at the same time. This feature really doesn’t mean anything to Macintosh users, but it is conceivable that it may come to be valuable when the Macintosh starts running several processors together.

XVT is a toolkit built for programmers who need or want to run their software on the Macintosh, Microsoft Windows, PM, and Motif. (See the text box “A GUI for All Systems.”)

A Wide Range

There’s no question that a wide range of products exists for creating GUIs for the Macintosh. The object-oriented extensions like the Think Class libraries and MacApp and the simple visual editors like AppMaker and Prototyper are probably the
best items for accomplished programmers. They are quite useful tools, but they often require a bit of tweaking to get things perfect. The reward for this, though, is efficient code. The complete systems like Serius and HyperCard are much more accessible for the beginner. These systems often find more use in custom programming environments like corporate computer shops. The systems make it easy to get something running quickly, and the trade-off may be in the efficiency and size of the code.

These systems will not, though, absolve you from the need to think logically. They might be better described as new, more powerful computer languages. The hype for these products might imply that someone who can’t program a VCR will magically be able to create Macintosh applications, but this is simply not true. The systems make life easier for programmers, but they will not do everything.

THE NEW UNIX LOOK
Ben Smith

Although later than Macintosh, DOS Windows, and PM in establishing some serious standardization on window environments, the Unix community has pretty much decided that the X Window System is the basis of its GUI. The exact appearance and behavior of that interface, however, are still open to question: Will it be Open Look (from AT&T and Sun Microsystems), or will it be Motif (from the Open Software Foundation)?

Writing applications that use X Window is notoriously difficult for programmers coming from the text-based Unix world. Before you can do anything specific to your user interface, you must, at least, do the following:

- establish interprocess communications to the X server
- define a window
- communicate the window properties to the window manager
- create the resources (user-definable application properties)
- map the window to the screen
- set up the event-handling
- start the event loop
- generate graphical output in response to events
- shut down the application properly when done

Although each of these steps can be as simple as a few lines of source code (with higher-level library functions, some are reduced to a single line), there are nearly 200 X-specific functions and variables to work with.

Working with X Window at this level gives developers tremendous freedom to create applications with any style they want. But they must define that style. The potential danger is the same anarchy and dissimilarity that exist in the user interfaces of MS-DOS applications. True, companies such as DEC and Hewlett-Packard have strongly reinforced style guides for X applications, but each is different. Most applications are being developed outside of these mega-companies.

At the same time that X Window was starting to gain acceptance as the possible common user interface, Sun was becoming a popular graphics workstation. Yet Sun’s GUI—SunView—didn’t use X Window. It is based on a completely different protocol and graphics model—a proprietary one. So
when Sun and AT&T became partners, much of the rest of the Unix community reacted by forming the Open Software Foundation, and Motif was conceived as OSF's first product. (See "OSF/Motif," page 230, May 1989 BYTE.)

Motif is a standard for X applications; it has a well-defined appearance and behavior for applications. Not only that, but it follows much of the style of PM, and it was accepted by a majority of the major Unix companies, including IBM, DEC, and HP. (Motif won an award of excellence from BYTE for its political achievements as much as for its good looks.)

The AT&T and Sun relationship spawned a competing GUI: Open Look. This one also runs on X Window but has much the same style as SunView. (See "Face to Face with Open Look," December 1988 BYTE.)

Open Look and Motif offer the developer the tools to follow their appearance and behavior guidelines. Both provide OOP utility, and both involve a level of programming with greater complexity than simple X Window (an oxymoron if there ever was one).

Motif offers the User Interface Language (UIL) for describing the use of the widgets and gadgets that make up a Motif application. AT&T (actually, Unix System Laboratories) has XView—really just a set of tools designed to facilitate porting from SunView to Open Look, but also used to build any new applications that are compliant with Open Look. No matter which might be the better user interface (see "Window Wars" on page 124), neither was going to gain dominance (let alone lack of Next dominance in the Unix environment, Lotus proponents would pick NextStep because of Next's state-of-the-art spreadsheet, lmprov. (See "What's NeXT After 1-2-3?" October 1990 BYTE.)

The AT&T and Sun relationship spawned a competing GUI: Open Look. This one also runs on X Window but has much the same style as SunView. (See "Face to Face with Open Look," December 1988 BYTE.)

Open Look and Motif offer the developer the tools to follow their appearance and behavior guidelines. Both provide OOP utility, and both involve a level of programming with greater complexity than simple X Window (an oxymoron if there ever was one).

Motif offers the User Interface Language (UIL) for describing the use of the widgets and gadgets that make up a Motif application. AT&T (actually, Unix System Laboratories) has XView—really just a set of tools designed to facilitate porting from SunView to Open Look, but also used to build any new applications that are compliant with Open Look. No matter which might be the better user interface (see "Window Wars" on page 124), neither was going to gain dominance (let alone acceptance) until there was an easier way to build applications than hand-coding the user interface.

**Solutions**

Companies such as IXI of London, U.K., were eager to develop Motif applications. They realized that the quickest way to make programmers productive in this rich and complex environment was to first develop a Motif program for developing Motif programs. IXI's Motif development system is for its own in-house use, but the final result of its effort is X-desktop, the Motif application most commonly bundled with Motif.

Integrated Computer Solutions of Cambridge, Massachusetts (its offices are just a few blocks from OSF central), has produced the Builder Xcessory, a GUI-based user interface builder and testing system for Motif applications. It can read in and generate Motif's UIL as well as generate C code. You drag and drop icons of Motif widgets and stretch and move them on your parent window, change the attributes and resources, and view the class relationships of your elements. You then create program stubs for the C code that will perform callbacks that widgets will use. Development, testing, and management of these underlying routines must be done outside of the Builder Xcessory. (ICS also provides libraries for X Window System 11, Motif, and Open Look.)

On the Open Look side of WYSIWYG user-interface builders, Sun has produced the OpenWindows Developer's Guide (DevGuide—Guide is an acronym for Graphical User Interface Design Editor). You use DevGuide in a similar way to ICS's Builder Xcessory: dragging widget icons onto a window and defining their attributes and actions. As with Builder Xcessory, DevGuide only goes as far as the user interface.

Visual Edge of St. Laurent, Quebec, Canada, is the developer of UIM/X, one of the first of the Motif Style Guide—consistent application builders to provide WYSIWYG application-building tools for X Window. With UIM/X, every facet of the Motif toolkit is available to the developer. The design is consistent with the normal process of creating a GUI application. The complexity of developing an X Window-based application is greatly simplified by this design and development system.

The developer's interface is a fine example of NextStep programming: a combination of a GUI, a graphics application (the interface builder), and some pretty standard utilities that are hidden from view. (Martin Heller, a contributing editor for BYTE, develops software in Andover, Massachusetts, and is writing an advanced Windows programming book to be published this fall by John Wiley & Sons. You can reach him on BIX as "mheller." Peter Woyner, a consulting editor for BYTE, is working toward a Ph.D. in computer science at Cornell University. You can contact him on BIX as "pwoyner." Ben Smith is a BYTE technical editor and the author of UNIX Step-by-Step (Howard W. Sams & Co., 1990). You can contact him on BIX as "bensmith.

The first step is the layout of an application's windows. You select the widgets and gadgets from menus and drop them on the windows. The action of selection, placement, and resizing of widgets is consistent, since UIM/X is, in itself, fully compliant with the Motif guidelines. As you create the look of an application, you can change the properties of each widget individually or as a group, because the organization of all the elements follows the philosophy of OOP: child widgets inherit the properties of the parent.

The second step in creating an application with UIM/X is attaching behavior to action to the widgets. Not only can you specify Motif toolkit (Xm) actions and behavior, but you can also reference any X intrinsics (Xt) and X function calls, or even write your own.

The third phase is testing. Because UIM/X has a built-in C interpreter, you can test any C routines that you may use as callbacks.

Unlike the Next Interface Builder, with UIM/X, you must drop into a standard shell to create and run the project management utilities such as make and socs. UIM/X does not use Motif's UIL but instead has its own tables and runs and generates C source code.

If you plan on developing for Motif and Open Look with UIM/X, you're in luck. Visual Edge has an Open Look version for developing Open Look applications.

**What's Next?**

Running counter to the X trend is the NextStep user interface, which doesn't support X Window (as yet), let alone run under it. Also, it is available only on the Next system and the IBM RISC System/6000.

However, NextStep shouldn't be discounted; developers who have a free choice will often pick NextStep because of Next's Application Kit and Interface Builder. For example, despite the lack of Next dominance in the Unix environment, Lotus programmers began with Next when they developed their state-of-the-art spreadsheet, Improv. (See "What's NeXT After 1-2-3?" October 1990 BYTE.)

The Interface Builder is more than the name implies; more appropriately, it should be called the Builders Interface, because it is the front end to all the steps of developing an application for NextStep: designing, coding, and debugging, as well as managing the collection of source and object files that are part of a complex project.

The most visual of all the elements of Interface Builder are the tools for designing the user interface and associated icons. The Next libraries contain all the classes, methods, and functions of the Application Kit. You link in the tools for sound and music. And you can create your application using Objective-C as well as C.

The developer's interface is a fine example of NextStep programming: a combination of a GUI, a graphics application (the interface builder), and some pretty standard utilities that are hidden from view.
The ideal 16-inch ergonomic monitor for professional graphics and business applications. Maximum performance for CAD/CAM, spreadsheets, databases, WYSIWYG word processors and desktop publishing. Designed for PCs and Macintosh II.

1024 x 768 resolutions. Supporting the new, higher refresh rate of 70Hz and above for a flicker-free display. No distortion. Sharply focused. Bright images across the entire screen.

An anti-static, non-glare screen. Low magnetic radiation. No interference between two monitors separated by a mere six inches, for dual-display applications.

Microprocessor-controlled configuration for your applications, memorizing size and position of the screen settings you prefer.

Other monitors compete against the standards, FLEXSCAN® sets them.

FLEXSCAN 9080I
16" (15V), 0.28mm-dot pitch CRT
1024 x 768 Super high resolution with 70Hz high refresh rate
Scan Frequency: Automatic Adjustment
H: 30-64KHz V: 50-90Hz
VGA, 8514A and Mac II Compatible
Bend Us. Shape Us. Any Way You Want To.

As long as you love us, it's all right. And love us you will. Statistical software from SPSS is designed to work the way you work. By giving you the power to enter, edit, manage, analyze and present data on virtually every type of PC, workstation, minicomputer and mainframe. By giving you better decision-making ability through the most comprehensive set of statistical procedures available. And by giving you a choice of options to meet your specific data analysis needs. So if you're thinking about statistical software, think about flexibility. Because flexibility means value. And when it comes to value, we top the charts.

The Accessibility of SPSS makes it ideal for beginners and advanced users alike. With its straightforward menus and context-sensitive help and statistical glossary, SPSS gets you started fast. And with the help of our time-saving programming facilities, including macros and a matrix language, you'll have the power to go deeper even faster. And regardless of your experience with statistics, you'll be supported by the documentation and training that's set the industry standard for over 25 years. Documentation that INFOWORLD calls "The Best in the Business."

The Statistical Procedures in SPSS give you the power to examine data more thoroughly, revealing patterns that might otherwise go unnoticed. We offer the most in-depth group of statistical procedures available, including univariate and multivariate descriptives, model building, hypothesis testing, clustering and classification, survival analysis, time series and perceptual mapping. No matter what your question, SPSS provides the flexibility to find the answer.

The Data and File Management capabilities of SPSS give you unparalleled flexibility when preparing data for analysis. With SPSS, information can be quickly reorganized, cleaned and transformed, regardless of size or structure. Multiple missing values for nonresponses can be defined and labeled according to your specifications, while built-in controls easily manage information stored in complex file formats, including custom file formats. Self-documenting portable files give you the freedom to move your analysis from one computing environment to the next, saving time and resources. And because SPSS supports most popular microcomputer file types including Lotus®, DBF and SYLK, and offers free interfaces to such leading SQL-based database management systems as Informix®, ORACLE® and Sybase®, there's no need to re-enter data or write out intermediate files.

So if you're in the market for statistical software, keep an open mind. Go with the value of SPSS, suppliers of statistical solutions to over 2 million users worldwide. Because when you have the advantage of flexibility, the chances are you'll still be a hit tomorrow.

Call 1(800)543-5835 or FAX (312)329-3668.
# RESOURCE GUIDE

## Graphical User Interfaces

The following companies, referenced in the preceding articles, supply hardware and software that provide graphical user interfaces. This list is not intended to be all-inclusive.

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
<th>Telephone</th>
<th>Fax</th>
<th>Circle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple Computer</td>
<td>20525 Mariani Ave.</td>
<td>(408) 996-1010</td>
<td>(408) 996-0275</td>
<td>1226</td>
</tr>
<tr>
<td>Bowers Development</td>
<td>P.O. Box 9</td>
<td>(508) 369-8175</td>
<td>(508) 369-8224</td>
<td>1228</td>
</tr>
<tr>
<td>Blyth Software</td>
<td>1065 East Hillsdale Blvd., Suite 300</td>
<td>(408) 438-8400</td>
<td>(408) 438-8696</td>
<td>1229</td>
</tr>
<tr>
<td>Blyth Software</td>
<td>1065 East Hillsdale Blvd., Suite 300</td>
<td>(408) 438-8400</td>
<td>(408) 438-8696</td>
<td>1229</td>
</tr>
<tr>
<td>Borland International</td>
<td>1800 Green Hills Rd.</td>
<td>(408) 369-8175</td>
<td>(508) 369-8224</td>
<td>1228</td>
</tr>
<tr>
<td>Blyth Software</td>
<td>1065 East Hillsdale Blvd., Suite 300</td>
<td>(408) 438-8400</td>
<td>(408) 438-8696</td>
<td>1229</td>
</tr>
<tr>
<td>Clarois Corp.</td>
<td>5201 Patrick Henry Dr.</td>
<td>(408) 727-8227</td>
<td>(408) 987-7447</td>
<td>1233</td>
</tr>
<tr>
<td>Commodore Amiga, Inc.</td>
<td>1200 Wilson Dr.</td>
<td>(215) 431-9156</td>
<td>(215) 431-9156</td>
<td>1235</td>
</tr>
<tr>
<td>Digital Research, Inc.</td>
<td>70 Garden Court</td>
<td>(408) 464-3896</td>
<td>(408) 464-6248</td>
<td>1236</td>
</tr>
<tr>
<td>Easel Corp.</td>
<td>25 Corporate Dr.</td>
<td>(617) 221-2100</td>
<td>(617) 221-3099</td>
<td>1238</td>
</tr>
<tr>
<td>Echelon Development Corp.</td>
<td>6 New England Executive Park</td>
<td>(617) 229-2740</td>
<td>(617) 273-0749</td>
<td>1239</td>
</tr>
<tr>
<td>Gensoft Development Corp.</td>
<td>(formerly Bumblebee Software)</td>
<td>(800) 772-0001</td>
<td>(415) 644-0928</td>
<td>1241</td>
</tr>
<tr>
<td>GeoWorks</td>
<td>2150 Shattuck Ave.</td>
<td>(800) 772-0001</td>
<td>(415) 644-0928</td>
<td>1241</td>
</tr>
<tr>
<td>Hampshire</td>
<td>2745 Dutch Village Rd., Suite 200</td>
<td>(902) 455-4446</td>
<td>(902) 455-2246</td>
<td>1242</td>
</tr>
<tr>
<td>Hudson Technologies, Inc.</td>
<td>1040 Marsh Rd.</td>
<td>(415) 321-5471</td>
<td>(415) 967-3288</td>
<td>1243</td>
</tr>
<tr>
<td>Intellicorp</td>
<td>1975 El Camino Real W Mountain View, CA</td>
<td>(415) 965-5500</td>
<td>(415) 965-5647</td>
<td>1246</td>
</tr>
<tr>
<td>Integrated Computer</td>
<td>solutions, Inc.</td>
<td>(617) 621-0060</td>
<td>(617) 621-9555</td>
<td>1247</td>
</tr>
<tr>
<td>JPI</td>
<td>1101 San Antonio Rd., Suite 301</td>
<td>(415) 967-3200</td>
<td>(415) 967-3288</td>
<td>1250</td>
</tr>
<tr>
<td>Knowledge Garden</td>
<td>473A Malden Bridge Rd.</td>
<td>(518) 766-3000</td>
<td>(518) 766-3000</td>
<td>1251</td>
</tr>
<tr>
<td>Lexington Software Design</td>
<td>72A Lowell St.</td>
<td>(617) 863-9624</td>
<td>(617) 863-9624</td>
<td>1252</td>
</tr>
</tbody>
</table>
RESOURCE GUIDE

Logitech, Inc.
6505 Kaiser Dr.
Fremont, CA 94555
(415) 795-8500
fax: (415) 792-8901
Circle 1253 on Inquiry Card.

ProtoView Development
Co.
353 Georges Rd.
Dayton, NJ 08810
(908) 329-8588
fax: (908) 329-8624
Circle 1261 on Inquiry Card.

MDBS
2 Executive Dr.
P.O. Box 6089
Lafayette, IN 47903
(317) 447-1122
fax: (317) 448-6428
Circle 1254 on Inquiry Card.

Microformatic
26 Plains Rd.
Moodus, CT 06469
(203) 873-2173
fax: (203) 873-2171
Circle 1259 on Inquiry Card.

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(206) 882-8080
fax: (206) 883-8101
Circle 1256 on Inquiry Card.

Mozart Systems Corp.
1350 Bayshore Hwy., Suite 630
Burlingame, CA 94010
(415) 340-1588
fax: (415) 340-1648
Circle 1257 on Inquiry Card.

Next, Inc.
900 Chesapeake Dr.
Redwood City, CA 94063
(415) 366-0900
fax: (415) 780-3714
Circle 1258 on Inquiry Card.

Open Software Foundation
11 Cambridge Center
Cambridge, MA 02142
(617) 621-7300
fax: (617) 621-0631
Circle 1259 on Inquiry Card.

Precision, Inc.
8404 Sterling St., Suite A
Irving, TX 75063
(214) 929-4888
fax: (214) 929-1655
Circle 1260 on Inquiry Card.

ProtoView Development
Co.
353 Georges Rd.
Dayton, NJ 08810
(908) 329-8588
fax: (908) 329-8624
Circle 1261 on Inquiry Card.

Smathers Barnes
P.O. Box 639
Portland, OR 97207
(503) 274-2800
fax: (503) 274-0670
Circle 1268 on Inquiry Card.

The Softbridge Group
125 Cambridge Park Dr.
Cambridge, MA 02140
(800) 955-9190
(617) 576-2257
Circle 1269 on Inquiry Card.

SoftWorks International
P.O. Box 8628
Atlanta, GA 30306
(404) 876-6115
fax: (404) 876-0765
Circle 1270 on Inquiry Card.

Spinnaker Software
201 Broadway
Cambridge, MA 02139
(617) 494-1200
fax: (617) 494-1219
Circle 1211 on Inquiry Card.

Stony Brook Software
187 East Wilbur Rd., Suite 9
Thousand Oaks, CA 91360
(800) 624-7487
fax: (805) 496-7429
Circle 1212 on Inquiry Card.

Sun Microsystems
Mountain View, CA 94043
(415) 960-1300
fax: (415) 969-9131
Circle 1213 on Inquiry Card.

Symantec Corp.
10201 Torre Ave.
Cupertino, CA 95014
(408) 253-9600
fax: (408) 252-4694
Circle 1214 on Inquiry Card.

Unix System Laboratories
P.O. Box 25000
Greensboro, NC 27420
(800) 828-8649
fax: (919) 855-2753
Circle 1215 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 of the guide.
Embedded Systems in Control

Chips that once powered PCs are now in airplanes, automobiles, and appliances—and are changing the nature of embedded control

Rick Cook

From disk drives and laser printers to home appliances, embedded computer systems are part of our lives. In fact, the average computer nonuser probably uses a dozen or more computers regularly but does not recognize them as computers, because the devices are dedicated to running things like cordless telephones and automobiles (see the text box “Chips in the Old Block” on page 156).

The use of embedded systems is spreading rapidly for two main reasons. One is convenience. Putting a computer in an appliance, a car, or a turret lathe makes the equipment more flexible and better able to meet our needs. In a computer system, too, it makes more sense to have dedicated processors in keyboards and disk drives than to use the system processor to handle mundane repetitive chores.

The other reason for more widespread use of embedded systems is cost. Traditionally, control functions have been handled by mechanisms such as timers, cams, and relays. Today, an embedded computer-control system is not only more reliable than the older technologies but usually cheaper as well.

Another contributing factor to the proliferation of embedded processors is the tendency to use more of them to do a job. Hard disk drive controllers, keyboards, printers, and high-resolution video cards are all likely to have their own processors today. The processors are inexpensive enough that it makes sense to boost overall system performance by dedicating them to specialized jobs. Fifteen years ago, an industrial robot arm might have been controlled by a single computer; a modern arm might have five or six microprocessors, each controlling a specific function (e.g., the elbow or the gripper) and backed up by an embedded computer system to handle overall control and communications.

At bottom, embedded systems are like any other computer systems, but they have their own special characteristics and present their own peculiar problems. Broadly speaking, embedded systems fall into two major varieties: Event controllers are directly concerned with managing interaction with the real world, and embedded microprocessors do higher-level calculations and control functions.

Embedded microprocessors usually supervise groups of event controllers, or they handle more elaborate calculations, such as constructing bit maps in a laser printer. Because of the jobs they do, embedded microprocessors tend to be more like the computer systems you would normally work with, although with significant differences. The
68030 or Intel i960 in a laser printer is an example of an embedded microprocessor.

Although the real-time, real-world orientation of embedded systems applies most strongly to event controllers, embedded systems of all kinds are usually concerned with events happening in the outside world, whether it is the timing of a spin cycle on a washing machine or the handling of aircraft flight controls. In many cases, the system has to accept and respond to inputs within a predictable amount of time. A late answer is a wrong answer and may cause serious problems. As a result, operating systems, programming languages, and computer-aided software engineering (CASE) tools written for embedded systems are extremely time-conscious. For example, most embedded-system languages—whether assembly or high-level—specify the maximum and minimum number of clock cycles an instruction will take to execute.

For a programmer, an embedded system has some problems and some compensating advantages. It is expected to perform only over a range of known behaviors, unlike a personal computer, which is expected to handle any “compatible” hardware or software you throw at it. If the embedded system does what’s expected under the specified conditions and doesn’t do anything too seriously wrong with the undefined conditions, the implementation is a success. The problem with an embedded system is that the consequences of a failure can range from expensive to disastrous. A compact disc player that won’t access one of the tracks on a disc is going to cost the CD manufacturer a lot of money and good will. A faulty antilock braking system on an automobile will cost the owner a lot more than that. Because the consequences of buggy embedded-system software can be so heavy, systems developers tend to be very careful and to test their products thoroughly.

Testing is easier to do with event controllers than with the larger, more complicated systems that rely on embedded microprocessors. An event controller usually has a fairly small program (less than 64K bytes of code), and the system behaviors are simpler and can be more closely specified. An embedded microprocessor, on the other hand, is likely to run much larger programs and have to deal with the behavior of larger and more complex systems.

An aircraft autopilot for a commercial airliner, for instance, may use three completely different processors (say, a Zilog Z8000, a Motorola 68030, and a proprietary processor) running software written by three different teams using three different approaches. Even the libraries of standard functions will be different. In operation, the autopilot compares the results of the three systems, and if they disagree, it takes the majority decision.

The Hardware

The type of hardware used for embedded systems covers a broader range than that used for computer systems. A significant fraction of the embedded-system market is still served by 4-bit processors, for example; at the other end, the latest RISC chips and 32-bit processors are used in some applications.

The most common kind of event controller is a microcontroller, which is a microprocessor with auxiliary circuits such as A/D converters (ADCs), timers, and RAM and EPROM built right onto the chip. Microcontrollers are intended to be self-contained as possible, because that reduces the cost of the system.

One of the most striking features of the microcontroller market is the number of controllers that are using the same basic architecture. For instance, a company may offer two dozen or more versions of the same chip but all differing in speed, bus width, and auxiliary features such as the amount of ROM and the number of timers or ADCs on the part. The reason for this kind of flexibility is that cost is all-important for high-volume applications such as consumer electronics and automobiles. Choosing a microcontroller with only 256 bytes of RAM and two timers may save 50 cents a part over a controller with 1K byte of RAM and four timers. In a million-unit application, that is a significant difference.

The importance of cost also explains why, until very recently, 4-bit controllers outsold the 8-bit models. Often, microcontroller applications are very simple—perhaps as simple as replacing a mechanical timer. Four-bit controllers were adequate and less expensive, so they were preferred. The decline of the 4-bit controller isn’t because manufacturers want more power in these systems (although that is a trend, too) but because the cost difference between 4- and 8-bit controllers has essentially disappeared.

From the 4-bit and simple 8-bit controllers, applications shade upward in complexity and required power. Nearly every successful microprocessor has spawned a microcontroller variation. You can still find 1802s, 6502s, 6809s, Z80s, and other popular chips of 15 years ago powering everything from dishwashers to industrial robots. A number of chips that never achieved commercial success in computers are popular in control applications. For example, National Semiconductor’s 16- and 32-bit processors are widely used. Today, there is also a new microcontroller called the Echelon Neuron (see the text box “Echelon: A $10 Device Controller” on page 158).

Generally, the decision to use a microprocessor rather than a microcontroller depends on the task at hand. Microcontrollers are better suited to doing “dirty work”—interfacing and direct control, for example. Microprocessors are typically used to control groups of microcontrollers in applications where the microcontrollers’ more generalized architectures and flexibility pay off.

There are other reasons for using microprocessors, however. One of them is the need for sheer power. Although microcontrollers can be powerful, they are usually not at the cutting edge of CPU design. The need to add memory and auxiliary functions means that a microcontroller takes more real estate than the equivalent microprocessor. Sometimes, embedded systems need all the power they can get, even at the expense and complication of using a microprocessor.

The high end of jobs in industrial automation, real-time video control, and other such applications stretches even the latest chips to the limit. For example, high-power 32-bit RISC chips like the Motorola 88000 and Sparc International’s SPARC are used in some control applications.

Unlike microcontrollers, which concentrate on auxiliary circuits and low cost, microprocessors specifically designed for embedded-system applications tend to be state of the art. Intel’s i960 is a superscalar 32-bit processor available in versions of up to 40 MHz and 30 VAX million instructions per second.

Laser printers are one place where powerful microproces-
We Added...to DesignCAD 3D version 3.1: A Basic-like programming language entitled BasicCAD. We added new commands. We added hardware support for dozens and dozens of new devices. We made hundreds of overall internal enhancements!

We improved the manuals, the packaging and the speed.

**How much extra did we charge?** Nada. Nothing. Zip. No extra charge at all. Oh, sure...our accountant said we could increase the price. Our lawyer said there was no legal reason not to charge more. A minister said we had no moral obligation to keep the same price!

So, why didn't we raise the price for DesignCAD 3D version 3.1?

Because...in the Great American Tradition we said

"Aw...What the Heck. Let's see the other guys beat this price!"

DesignCAD 3D version 3.1 sells for $399.

**Does this include everything?** Yes. We include everything! The programming language, the hardware device drivers (more than 450!), built-in shading capability, hidden line removal capability, solid-object modeling capability, translators to-and-from other file formats, are all included!

**How can you afford to sell a program like this at such a low price?**

This is our most often asked question. We have a simple answer. Volume. We sell thousands of these programs each month! If we were to charge thousands of dollars per copy (like our competitors) we would restrict our sales to the professional trades only.

By lowering our price we sell to professional architects and engineers as well as the ordinary individual! Many ordinary individuals purchase DesignCAD 3D for personal projects. Many people purchase DesignCAD 3D and perform CAD Drafting at nights and on weekends as a second job.

People design "dream homes" and "widgets".

The uses are limited only by YOUR imagination!

---

**If there ever was a CAD program out to prove that AutoCAD, CADKEY, VersaCAD, and other $3000 programs are overpriced, it's DesignCAD!**

*(MicroCAD News review)*

DesignCAD 3D

$399

---

Remember - American Small Business Computers also sells a 2D version of DesignCAD. It costs only $99.

Write or call for FREE brochures that will help you determine which program best suits your need.

Circle 23 on Inquiry Card.
Chips in the Old Block
Vinny Minchillo

In 1966, the Oldsmobile Toronado was the first American car to have front-wheel drive. In 1977, it was the first car to be outfitted with a computer. The system was called MISAR—Microprocessed Sensing and Automatic Regulation. Its job was to compare input describing engine vacuum, engine speed, coolant temperature, and crankshaft position with values stored in ROM and then calculate the optimal moment for the distributor to fire a spark.

The MISAR’s brain was a two-chip set from Rockwell International: a 10-bit microprocessor with I/O and A/D-conversion circuits, and a ROM chip with a little over 10K bytes of data. This simple system boosted the Toronado’s fuel mileage from 13.8 to 15 miles per gallon. Still stinging from the OPEC nightmare, Detroit deemed the project a success. The computerized car was born.

Today’s engine-control unit is much more complex. In as little as 2.5 milliseconds, the ECU must take in information about the amount of air coming into the engine, engine temperature, fuel pressure, throttle position, manifold vacuum, engine speed, and more. From this data, it determines optimal levels for spark firing, ignition timing, and fuel-injection time (i.e., how long the fuel injector nozzle should spray gasoline into the cylinder).

In most cases, the ECU microprocessor is a specially designed 8- or 16-bit chip based on an existing processor. At one time or another, just about every major chip manufacturer has had its product in a car on the road.

Although Rockwell International made the first engine-control microprocessor, Motorola has become the biggest player. You’ll find derivatives of its 68000 (the original Macintosh CPU) in Chrysler and General Motors cars. Ford has used chips from Toshiba, Motorola, and Intel. Chrysler originally used an RCA processor for engine management, as well as some Texas Instruments chips in its technologically advanced—but universally hated—voice synthesis systems (the ones that reminded you over and over again, “Your door is ajar.”).

Not long after the introduction of the MISAR, Ford introduced its first ECU, based on a Toshiba microprocessor. In 1980, the company switched to a customized version of the Motorola 6800 (a predecessor of the 68000). Then in 1984, Ford made a major advance in automotive computers with the introduction of the electronic engine-control module—the EEC-IV.

The EEC-IV featured a custom-designed Intel 16-bit chip. With capabilities beyond those of traditional 8-bit systems, the EEC-IV was able to deliver fuel to each cylinder independently and accurately. The unit brought new efficiencies to Ford’s aging 302-cubic-inch engine, which became the heart of one of today’s most potent and popular sports cars, the 5.0-liter-engine Mustang GT.

For 1994, Ford’s EEC-IV will be getting a new lease on life. The original Intel 16-bit 8065 controller chip will be joined by a second 8065 chip. The two will operate in a coprocessor arrangement, with the second chip controlling the transmission.

Although it was the first to bring computers to cars, GM was not able to maintain its lead—but that could change. GM currently uses an 8-bit Motorola 68HC11 processor. But a joint development agreement between GM’s Delco division and Motorola has created the 68332, the first 32-bit processor designed for automotive use. Planned for introduction in GM cars around 1995, this chip is based on the 68020, found in the Mac II. While some claim a 32-bit processor is overkill, GM maintains that the next generation of cars will have to pack at least that much computing power. In fact, one experimental GM system is so complex that it needs two 32-bit 68332 processors.

The Japanese have also embraced automotive computer technology. Nippon Denso, the Japanese electronics giant, manufactures the Toyota Computer Controlled Systems. Toyota’s flagship luxury car, the Lexus LS400, uses TCCS computers in innovative ways to control the drive train, including shifting the automatic transmission electronically.

Not to be outdone, Nissan’s flagship, the Infiniti Q45 sedan, carries 14 separate computer modules that control the engine, transmission, speed-sensitive power steering (e.g., the slower you drive, the more power assist you get), security system, adjustable suspension, and more. Every module on the Infiniti Q45 is connected to an on-board communications system called the Diagnostic Data Link; technicians can download information about all modules through a single communications connection.

Like many luxury cars, the Infiniti and the Lexus come with antilock braking systems. While ABS is one of the most noticeable and beneficial features that computers have brought to cars, monitoring and controlling the brake system is actually one of an on-board computer’s easiest jobs.

Another feature, electronic traction control, relies on the same sensors and technology as does ABS. Electronic traction control minimizes wheel-spin by automatically reducing engine power—particularly on low-traction surfaces, such as ice or gravel.

LANs on Wheels
The basic automobile wiring system has not changed fundamentally over the years. Every switch is more or less directly wired to the device it operates. Open the door of almost any luxury car, and look at the cable running from the door to the body; it looks more like a phone company trunk line than car wiring. It’s not uncommon for that cable to carry up to 50 pairs of wire.

Now, imagine that same trunk replaced by a single LAN-style twisted-pair cable. The concept is called multiplexing, a technology that’s crucial if cars are to take full advantage of computers. Rather than having a traditional wiring harness, the car would have its own digital bus, with electric windows, electronic fuel-injection system, antilock brakes, and transmission hooked to it—just as a computer has disk drives, monitor, keyboard, and other devices connected to its bus.

Consider a light switch. Instead of sending electric current directly to the lights, the switching action would trigger an input signal module activating a body control module that would send a signal down the bus. The appropriate output signal module would pick up the instruction and activate the proper relay to send current to the lights. That’s how it hap-
EMBEDDED SYSTEMS

Running a true digital bus through the car will allow computers to share sensors and trade information. The bus will provide a foundation for future centralized computing systems and make it easier to add more and more high-tech options. In short, multiplexing will do for the automobile what the hard disk drive did for the PC.

Coming Attractions

For the last few years, Buick has been displaying a concept vehicle (an engineering dream car) with all its accessories completely controlled by voice command. There’s also electronically controlled four-wheel drive, a satellite navigation system, and drive-by-wire.

A drive-by-wire system is similar to the fly-by-wire systems used in fighter jets. Instead of mechanical links running from the steering wheel, pedals, and shift controls, these devices merely send electronic signals along the data bus to the controllers for the front wheels, accelerator, or transmission. Thus, unencumbered by the need to have the controls physically connected to the vehicle, designers will have the flexibility to locate the positions of the driver, passengers, and their respective controls anywhere in the car.

Another development with far-reaching possibilities is the electronic clutch, which will provide all the advantages, efficiencies, and fun of a standard-shift car along with the ease of driving a car. The current Ferrari Formula 1 car features automatic steering. For example, the steering wheel, pedals, and shift controls, these devices merely send electronic signals along the data bus to the controllers for the front wheels, accelerator, or transmission. Thus, unencumbered by the need to have the controls physically connected to the vehicle, designers will have the flexibility to locate the positions of the driver, passengers, and their respective controls anywhere in the car.

Not Quite State of the Art

For all the technical innovations built into today’s automobiles, the current state of computers in cars is something less than state of the art. It’s true that the chips and computers are excellent examples of high technology, but they are still only stand-alone devices that have been taken to their extreme technical limits. Making them all work together is the key. And for the average $14,000 car, that kind of integration is still a long way off.

Less than 15 years ago, the automotive computer was regarded as a nuisance—an invasion—a mysterious device to be tolerated or, if possible, removed. But the addition of computers has made today’s cars much more efficient. By using computers, we’re achieving the fuel mileage and emissions control demanded of us by the economical and environmental condition of the 1990s, while enjoying the performance of 1960s muscle cars. Automotive computers have been taken to their extreme technical limits. Making them all work together is the key. And for the average $14,000 car, that kind of integration is still a long way off.

Programming Embedded Systems

Embedded-system programmers have a variety of specialized tools at their disposal. A number of operating systems are designed for real-time control applications. They also have emulators that allow programmers to develop applications on common systems like the PC and the Mac. Other specialized tools include cross compilers and CASE tools.

Vinny Minchillo is a copywriter for the firm of Larkin, Meeder & Schweidel in Dallas, Texas. He has been writing about technical automotive subjects for four years and has worked with on-board automotive computers and aftermarket fuel-injection systems. He can be reached on BIX c/o “editors.”
Echelon: A $10 Device Controller

Rich Malloy

It's a small, low-cost device, but it may have a big impact on the computer industry, as well as on our personal lives. Introduced by Echelon (a new company started by A. C. "Mike" Markkula, a cofounder of Apple Computer), this networkable device—the Echelon Neuron—should be able to control a number of devices, not only in homes, but also in offices and factories.

The technology is based on a new chip called the Neuron. Like biological neurons, Echelon Neurons have built-in abilities to communicate with one another. They will be able to control many functions, including office lighting systems, alarms, factory machines, automobile components, and home appliances.

For example, a network of Neurons in your office connected to a motion detector and an ambient-light sensor can ensure that the lights in your office are on only when you are there and it's dark outside. In another example, Neurons connected to an array of smoke detectors, temperature sensors, and exit lights might determine where in an office building a fire has occurred, signal an alarm, and light only those exit signs that would direct people safely away from the fire.

Controllers based on the Neuron chip are expected to sell in volume quantities by late this year. They may eventually cost as little as $10 each, including network connection costs.

The Neuron is a single chip that contains a number of different components (see the figure). These include three 8-bit processors connected in pipeline fashion, 10K bytes of ROM, 1K byte of RAM, and 512 bytes of EEPROM. The 10K-byte ROM area contains the code for a complete seven-layer communications network protocol. Echelon has licensed the technology for the Neuron chip to Motorola and Toshiba; both say they will ship the chip around the middle of this year.

The Neuron is designed to be used in a network that Echelon calls a Local Operating Network. For physically connecting the Neuron chips, Echelon has proposed three “communications transceivers”—one for twisted-pair cable (1.25 megabits per second), one for communicating via AC power lines (9600 bps), and one for wireless radio communications (5000 bps). Any one of these transceivers can be connected to a Neuron, and LONs can be made up of any or all of these media.

Developers can use LONs with a LON Starter Kit. The kit consists of software for an IBM AT-class system plus an external box that allows developers to simulate a LON. Developers can program the individual Neurons using an enhanced version of C called Neuron C. Echelon officials say that the 512-byte EEPROM area of the Neuron can accommodate a three-page C program. For larger programs, another version of the Neuron chip will be available that can access up to 42K bytes of external memory. The Starter Kit costs approximately $15,000.

Echelon officials say that the most important component of the LON technology is its peer-to-peer LONTalk network protocol. According to the company, the design constraints for this network were much stricter than those of typical LANs designed for connecting microcomputers. Not only must the network be able to handle three or more different types of physical connections, but it also must be 100 percent reliable even at peak loads, easy to install, secure, and able to fit into just 10K bytes of ROM. The only deficiency of the network protocol is that it is optimized for use with only very small amounts of data.

Although Neurons and LONs have immediate applications in mundane tasks (such as turning on lights), they could also be used for a wide number of other, more challenging duties. For example, they could be used to control an airplane, eliminating miles of conventional cable and possibly lessening the need for a large central computer.

Rich Malloy is the New York-based managing editor of the BYTE news department and editor in chief of BYTEWEEK, a newsletter covering the personal computer industry. He can be reached on BIX as "rmalloy."
TI microLaser™ printers open new windows.

By now you've heard how fast and easy Microsoft® Windows™ makes it to tap all that PC power you've got on your desk.

Well now there's an affordable, easy way to put that power on paper — microLaser from Texas Instruments.

Right out of the box, microLaser comes with what you need to print the dazzle-dazzle pages of text and graphics you've dreamed of creating.

Just plug it in and go.

That's because microLaser PS models come with the Adobe® PostScript® language and the memory it takes to use it. Plus you get your choice of either 17 or 35 scalable fonts, starting at just $1,999.*

When it comes to print speed, microLaser zips along at 6 ppm. If you need a shared printer solution, turn to its cousin, microLaser XL. This workhorse gallops at a formidable 16 ppm.

If all that isn't enough, just look at what else you get with microLaser. It's the smallest printer in its class. It handles more paper and envelopes in more ways. And it supports more than 4,000 software packages, including your Windows applications.

So when you add it all up, you'll understand why MacUser gives the power of your ideas needs the power, convenience and economy of microLaser. Let microLaser open new windows for you.

For the name of the nearest dealer, call 1-800-527-3500.

The microLaser PS17 has earned the 1990 PC World Best Buy award; microLaser PS13 has earned the 1990 InfoWorld Excellent Value award and 4½ mice from MacUser.

*TI suggested retail price. (Dealers' prices may vary.) microLaser is a trademark of Texas Instruments Incorporated. Adobe, PostScript and the PostScript Logo are registered trademarks of Adobe Systems, Inc. Microsoft is a registered trademark and Windows is a trademark of Microsoft Corporation. ©1991 TI 71816

Circle 314 on Inquiry Card.
EMBEDDED SYSTEMS

Tightly coded; readability, maintainability, and everything else is sacrificed to get the program as compact as possible. These practices went out of general programming practice decades ago. Now, using such methods in embedded-system programming is fading, too, because microcontrollers with more memory are readily available; companies can now cut overall costs by facilitating software development and maintenance. The tendency is to program in higher-level languages and to use operating systems or, at least, libraries of reusable code to handle the runtime parts.

Because of the critical nature of embedded systems, a lot of attention is paid to testing and debugging. The software should be exercised against all possible I/O combinations—a huge task even on applications with a definable set of possibilities. In the early stages, testing may be complicated by the fact that testing can’t be done on the target system but must be tested on simulators. As a compensation to testing on simulators, the test can be set up to monitor the internal workings of the program closely, including the register contents and hardware details. In some embedded systems, physical environment testing is important, as well.

Trends in Embedded Systems

The trend today is toward more powerful systems. Four-bit controllers are beginning to fade, being replaced by fast 8-bit and even 32-bit controllers. The cost difference between the limited 4-bit controllers and the more powerful 8- or 16-bit controllers is steadily narrowing. With the headroom of these new processors, it is less expensive and easier to add new features to an embedded system.

With more space, it follows that the trend is away from replacement designs and toward feature enhancements to existing products, usually through software. There is also a growing focus on software productivity. This is an especially important issue, because embedded-system designs are essentially one of a kind, and the new processors require more programming.

One way to make programmers more productive is to give them a familiar environment to work in. Modern operating systems that combine a microkernel with message passing can do just that. Chorus, an operating system from Chorus International, can exist in as little as 24K bytes of memory, making it suitable for embedded-system applications. The larger version of Chorus is function-call-compatible with Unix System V release 4, meaning that programmers can develop software for embedded-system applications running Chorus under Chorus. Other, modularized operating systems are also becoming desirable software bases for embedded systems.

There is a tendency to give products better user interfaces to get around the dreaded “VCR Syndrome,” but the bottleneck is the cost of the I/O devices. A cryptic user interface with many states can use a very simple display and keyboard. A better user interface usually means a better, and hence more expensive, display and keyboard, but even these costs are dropping.

Historically, we have tended to think of embedded systems as being the smaller, weaker relatives of the hardware and software we use for general-purpose computing. That isn’t true anymore, and it is likely to become less and less true in the future. Some manufacturers are exploring advanced methods, such as parallel processing, AI, and neural networks. In another 10 years, the most powerful, capable applications we have may be in embedded systems.

Rick Cook is a freelance writer who specializes in high technology and writes science fiction and fantasy for fun. He lives in Phoenix, Arizona, and can be reached on BIX as “rcook.”
InfoWorld readers vote Northgate "Desktop Computer of the Year!"

Northgate Shatters Ten Years Of IBM, Compaq And Apple Dominance!

InfoWorld readers are the "Who's Who" of Corporate America's most knowledgeable computer buyers. For the past decade, InfoWorld has sent ballots asking readers to vote for their choice of "Desktop Computer of the Year." Only one wins. Apple, IBM and Compaq have dominated this voting.

But for 1990, a real shocker! When the tens of thousands of votes were tallied neither Apple, IBM nor Compaq had won. Nor had Dell, AST or Hewlett-Packard. Instead, InfoWorld's readers voted a Northgate system "Desktop Computer of the Year."

With this landmark vote, one era ended and a new one began. Northgate, a four-year-old computer designer and manufacturer from the Midwest toppled tradition and corporate computer buyers do business. Because Northgate doesn't sell just ordinary computers and we don't sell them in a traditional way. Northgate builds and builds the industry's highest performing systems. And we sell them direct to you. No dealers. Does this method work? You bet it does...

The top experts in thousands of America's largest businesses voted on it. And in one sweep, corporate computer buyers have declared:

It's safe to buy from other than IBM and Compaq... And now it's safe to buy high performance computers from a company that sells directly to the customer!

How did all this happen? Well, we could say it's a result of our years-ahead design. Performance that has won just about every other award in the industry. And legendary technical support and customer service policies that demand we deliver total satisfaction. A winning combination, indeed. But what matters most is...

Northgate goes the extra mile to assure your computer dollars are investments, not costs! It's the Northgate differences that create customer confidence! When sophisticated buyers, like the readers of InfoWorld, put pen to purchase order, Northgate gets the vote. They know they can trust Northgate. At Northgate, components are researched and evaluated under the most stringent methods to ensure highest performance, compatibility and reliability. Every system we sell has gone through at least 547 individual compatibility checks (315 software programs alone) before our quality control engineers say it's Northgate.

That's one of the reasons Northgate systems work so well. From our economical SlimLine systems, right up through our spectacular 486/33, winner of the InfoWorld 'Desktop Computer of the Year' voting, you can be sure when you buy Northgate you're putting a winner to work.

Northgate gives you the edge in today's tough marketplace. But that's not enough...

Half a million minutes a year Northgate technical support is ready for your call! When you buy IBM or most other computer brands from a dealer, you live with their support policies. At best they're open 9-5, and maybe a few hours on the weekend. Need to talk to someone "off hours?" When you deal with those guys, you're out of luck. No support. No help.

At Northgate, there's a friendly, understanding and superbly capable tech specialist ready to help you 24 hours a day, seven days a week.

Let's see IBM and Compaq match this offer...

We invite your company to enjoy the Northgate experience. Put our systems to the test for 30 days. If they don't deliver everything you expect — and more — well buy them back. No strings attached. Simply call our 800 number for a free Pre-Purchase Consultation with one of our account representatives.

For Your Free Consultation Call
800-345-8709

©Copyright Northgate Computer Systems, Inc. 1991. All rights reserved. Northgate, Elegance, Stand-up, and the Northgate 386 logo are registered trademarks of Northgate Computer Systems. IBM is a registered trademark of International Business Machines Corporation. All other products and brand names are trademarks and registered trademarks of their respective companies. We support the 'right to read' of software. ' copied software may not be used, and the Software Publishers Association Anti-Piracy Section at 1-800-223-2424.

JUNE 1991 • BYTE 161
PC Magazine said it best...
"Northgate stops at nothing to please its customers!"**

Call Northgate® Now.

Northgate Exclusive!
Edsun CEG Chip available with
SlimLine
386/331
Award-winning performance, unequaled service and incredible support for a price IBM®, Compaq® and Dell® can't hope to match.

The power of 386™ computing is the lifeblood of business today. And more and more, Northgate is the vendor of choice. Why? Northgate is the only company who consistently earns top ratings for performance, service, support and bottom-line value. Industry experts and users worldwide agree.

Northgate 386 ... computing’s most decorated line. Northgate’s rise to the pinnacle of 386 technology started in 1988 when Computer Shopper readers voted Northgate’s 386 Power System both a "Best Buy" and Overall Best Buy. A few months later, PC Magazine named Northgate 386/20 and 386/25 "Editors’ Choice." Later that year, our 386/33 received the same honor. Along the way, our 386 systems won several InfoWorld recognitions as well.

Northgate Elegance™: Full-size 386 power and expandability.

The business systems of choice. Elegance’s award-winning reputation has made them the choice of Fortune 1000 corporations, government agencies and universities around the world. And with good reason.

Elegance full-size systems are designed to allow you to easily expand your system as your business needs increase. You only pay for the components you need now.

Power for every application. From “simple” tasks like word processing and desktop publishing to advanced CAD/CAE and database management applications, Elegance delivers. To find out what systems are right for you, see next page for system configurations and upgrade options.

Revolutionary systems of the 90’s: Northgate SlimLine.”

Often copied, never duplicated! It seems like everyone has jumped on the SlimLine bandwagon these days. Truth is, Northgate pioneered this incredible technology. We were the first to introduce full power 386 systems in a case measuring only 4.25” high.

Architecture that stunned the industry! SlimLine’s fully-integrated motherboard features built-in IDE hard drive and floppy drive controllers, one parallel and two serial ports plus a 16-bit VGA controller. And we didn’t scrim on expansion capabilities. Our unique expansion tree has three full-length 16-bit and two half-length 8-bit slots for all your add-ons and peripherals.

Perfect single-user workstation or network terminal. SlimLine is ideal for use where you need full-size 386 power, but space is a premium.

For comprehensive system features and popular configurations, see next page.

CALL
TOLL-FREE 800-345-8709

In USA and Canada

Fortune 1000 corporations, government agencies and education institutions, call National Business Accounts: 800-548-3510

Notice to the hearing impaired: Northgate has TDD capability. Dial 800-535-6002.

NJ Northgate Computer Systems, Inc.

"Smart Tools For Business”

7075 Flying Cloud Drive
Eden Prairie, Minnesota 55344

Notice to the hearing impaired: Northgate has TDD capability. Dial 800-535-6002.

JUNE 1991 • BYTE 163
Northgate® 486™/25 & 33 MHz

486 ISA...486 EISA.
Only Northgate gives you a choice!
Number One! Elegance™ 486/25 & 33 MHz ISA

InfoWorld's Product of the Year! After outscoring the competition in InfoWorld's 1990 reviews, and being praised as "tops in support and value," Elegance 486/25i was awarded the publication's highest honor: Product of the Year. This was the fourth award given to an Elegance 486 system ... no other company comes close!

PC Magazine says "Editors' Choice!" When reviewing 486/25 systems, they said "Only one machine stands out ... you could pay less for a 486 system, but not get the bonuses that are offered with the Elegance."††

In the February 12, 1990 issue, PC Magazine declared Elegance 486/33 Editors' Choice, saying the system was "a sure winner in its class."

Computer Shopper readers agree! Elegance 486/25i breezed past the competition and captured a 1990 "Best Buy" award. This makes three years in a row, a Northgate Elegance system was voted tops by Computer Shopper readers.

ISA 486 System Features:
• Intel 486/25 or 33 MHz processor
• 4Mb RAM; expandable to 32Mb on motherboard
• 200Mb IDE hard drive
• 1.2Mb and 1.44Mb floppy drives
• 64K SRAM read/write-back cache
• ISA bus
• One 32-bit, six 16-bit and one 8-bit slots
• One parallel and two serial ports
• Vertical "Power" case (desktop available)
• 16-bit VGA graphics adapter with 512K video RAM (expandable to 1Mb)
• 14" SVGA color monitor
• OmniKey/Ultra keyboard
• MS-DOS 4.0l or 3.3 and GW-BASIC software installed
• Microsoft Windows® 3.0 and mouse
• FCC Class B Certified

486/25 and 33 MHz EISA give you full 32-bit performance!

Performance that rivals RISC-based minicomputers costing thousands more! New 32-bit EISA bus maximizes the performance of Intel's 486 chip ... gives you the power to control large networks at near processor speed!

Complete compatibility! Elegance 486 is 100% compatible with UNIX, Novell® and DOS. Plus, Elegance is compatible with existing 8-bit and 16-bit ISA adapters, so you benefit from downward compatibility.

Compare Elegance 486 performance and Northgate service and support with any other vendor's in the industry. You'll find you can't buy better than Northgate! Call now ... let Northgate build your system today!

True EISA 486 System Features:
• Intel 486/25 or 33 MHz processor
• 4Mb RAM; expandable to 32Mb on motherboard
• 1Mb EISA caching SCSI controller
• 200Mb SCSI hard disk
• 1.2Mb and 1.44Mb floppy drives
• 128K SRAM read/write-back cache
• EISA bus
• Eight 32-bit EISA slots; six bus master and two slave
• One parallel and one serial port
• 16-bit VGA graphics adaptor with 512K video RAM (expandable to 1Mb)
• 14" SVGA monochrome monitor
• Vertical "Power" case
• 300 watt power supply
• OmniKey/Ultra keyboard
• MS-DOS 4.0l or 3.3 and GW-BASIC software installed
• Microsoft mouse
• FCC Class B Certified

$5399.00 25Mb $6299.00 33Mb
8199.00 25Mb $9199.00 33Mb

Free Pre-purchase Consultation
Nobody spends thousands of dollars on systems during the first phone call. You know it, we know it. Instead, we offer a no-obligation pre-purchase consultation with one of our highly-trained Technical Consultants. You'll receive friendly assistance in matching your business needs with the appropriate Northgate solution.

Northgate wins 1990 Microcomputer Marketing Council's Service and Support Award!

• 30 Day No-Risk Trial. To assure your complete satisfaction, Northgate gives you a 30-day No-Risk Trial.
• Full parts and labor warranties: 1 year on systems; 5 years on OmniKey keyboards.
• Overnight shipment of replacement parts when needed — at our expense.
• Northgate's unique 24-hour toll-free technical support leads the industry — most needs are met with just one call!
• Free on-site service to most locations if we can't meet your technical needs over the phone.
• Easy financing: Use your Northgate Big 'N, VISA, MasterCard or Discover Card. Leasing terms up to five years also available.

CALL TOLL-FREE

800-345-8709

In USA and Canada

Fortune 1000 corporations, government agencies and education institutions call National Business Accounts:
800-548-3510
Notice to the hearing impaired: Northgate has TDD capability. Dial 800-535-0602.

Circle 219 on Inquiry Card.
PC Magazine said it best...
“Northgate stops at nothing to please its customers!”*
Award-winning performance, unequaled service and incredible support for a price IBM®, Compaq® and Dell® can't hope to match.

The power of 386" computing is the lifeblood of business today. And more and more, Northgate is the vendor of choice. Why? Northgate is the only company who consistently earns top ratings for performance, service, support and bottom-line value. Industry experts and users worldwide agree.

Northgate 386... computing's most decorated line. Northgate's rise to the pinnacle of 386 technology started in 1988 when Computer Shopper readers voted Northgate's 386 Power System both a "Best Buy" and Overall Best Buy. A few months later, PC Magazine named Northgate 386/20 and 386/25 "Editors' Choice." Later that year, our 386/33 received the same honor. Along the way, our 386 systems won several InfoWorld recognitions as well.

Revolutionary systems of the 90's: Northgate SlimLine.

Often copied, never duplicated! It seems like everyone has jumped on the SlimLine bandwagon these days. Truth is, Northgate pioneered this incredible technology. We were the first to introduce full power 386 systems in a case measuring only 4.25" high.

Architecture that stunned the industry! SlimLine's fully-integrated motherboard features built-in IDE hard drive and floppy drive controllers, one parallel and two serial ports plus a 16-bit VGA controller. And we didn't scrimp on expansion capabilities. Our unique expansion tree has three full-length 16-bit and two half-length 8-bit slots for all your add-ons and peripherals.

Perfect single-user workstation or network terminal. SlimLine is ideal for use where you need full-size 386 power, but space is a premium.

For comprehensive system features and popular configurations, see next page.

Northgate Elegance*: Full-size 386 power and expandability.

The business systems of choice. Elegance's award-winning reputation has made them the choice of Fortune 1000 corporations, government agencies and universities around the world. And with good reason.

Elegance full-size systems are designed to allow you to easily expand your system as your business needs increase. You only pay for the components you need now.

Power for every application. From "simple" tasks like word processing and desktop publishing to advanced CAD/CAE and database management applications, Elegance delivers. To find out what systems are right for you, see next page for system configurations and upgrade options.

Northgate wins 1990 Microcomputer Marketing Council's Service and Support Award!

- 30-day no-risk trial period
- Full one year warranty on systems, 5 years on OmniKey keyboards.
- Northgate responds to your needs with overnight shipment of parts—at our expense!
- Free on-site service to most locations for one year if we can't solve your needs over the phone.
- Unique 24-hour toll-free technical support—the industry's best!
- We accept VISA, MasterCard, Discover and Northgate's Big 'N' card. We offer leasing and financing options, too!

Free pre-purchase consultation. Nobody spends thousands of dollars on systems during the first phone call. You know it, we know it. Instead, we offer a no-obligation pre-purchase consultation with one of our highly-trained Technical Consultants. You won't get high-pressure tactics or commission-hungry salespeople. Just friendly assistance in matching your business needs with the appropriate Northgate solution.

Call toll-free 800-345-8709

In USA and Canada

Fortune 1000 corporations, government agencies and education institutions, call National Business Accounts:

Notice to the hearing impaired: Northgate has TDD capability. Dial 800-535-0602.

*PC Magazine, September 25, 1990

Circle 220 on Inquiry Card.

JUNE 1991 • BYTE 167
Only Northgate® offers a full range of 386 systems in SlimLine™, Desktop and Vertical Power Cases!

**SlimLine... a Northgate original!**

**SlimLine Features:**
- Small footprint (16.5" square x 4.25" high) SlimLine case with room for two exposed and one internal half-height devices
- 64K SRAM read/write-back cache
- 1.2Mb and 1.4Mb floppy disk drives
- Integrated 16-bit VGA with 1024 x 768 resolution; 512K memory
- Intel® and Weitek math co-processor support

**SlimLine 386SX/16 and 20 MHz with 64K Cache**
- Intel 80386SX/16 or 20 MHz processor
- 2Mb of RAM on motherboard
- $2399.00/$2599.00 Or as low as $759.00/$899.00 per month*

**SlimLine 386/25 MHz with 64K Cache**
- Intel 80386/25 MHz processor
- 4Mb of RAM on motherboard
- $3399.00 Or as low as $1059.00 per month*

**SlimLine 386/33 MHz with 64K Cache**
- Exclusive! The Edison CEG chip is now available with SlimLine 386/33. This device emulates up to 2048 x 2048 resolution and lets your standard VGA monitor display an incredible 760000 colors. Plus, it smooths out the jagged edges around images, giving you clarity and brilliance you must see to believe! Other features:
  - Intel 80386/33 MHz processor
  - 4Mb of RAM on motherboard
- $3899.00 Or as low as $1209.00 per month*

“Editors’ Choice” — all Elegance® systems

**Elegance Features:**
- 5-bay desktop case with room for 3 exposed and 2 internal half-height devices; 200W power supply
- Optional 7-bay vertical power case has 220W power supply
- RAM expansion up to 8Mb on motherboard (16Mb total RAM with 32-bit memory card)
- One parallel and two serial ports
- Intel and Weitek co-processor support
- MS-DOS 4.01 and GW-BASIC installed
- On-line user's guide to MS-DOS 4.01
- QA Plus Diagnostic and utility software
- FCC Class B certified

**Northgate Elegance 386/25**
- Intel 80386/25 Mhz processor
- 4Mb of RAM
- 100Mb hard drive
- 64K SRAM read/write-back cache
- 1.44Mb and 1.2Mb floppy drives
- $3699.00 Or as low as $1159.00 per month*

**Northgate Elegance 386/33**
- Intel 80386/33 Mhz processor
- 4Mb of RAM
- 200Mb hard drive
- 64K SRAM read/write-back cache
- 1.44Mb and 1.2Mb floppy drives
- $4449.00 Or as low as $1409.00 per month*

If one of these popular SlimLine or Elegance models doesn't meet your needs, CALL! We'll custom build one just for you!

CALL TOLL-FREE
800-345-8709

In U.S.A. and Canada

168 BYTE • JUNE 1991

Circle 221 on Inquiry Card.
National Software Testing Laboratories Supplement:

Advanced Spreadsheets
WeCycle Waste Corporation
The Materials Research Group Recommendation:
FOCUS: ALUMINUM

This study conducted by the Materials Research Group provides the basis for our most recent recommendation that WeCycle continue to expand its aluminum recycling capacity by another 70% over the next 6 years. The graph in the right shows the increasing proportion of our business provided by the aluminum division during the past three years, now approximately half of all revenues. It is our opinion that, at this rate of growth, aluminum recycling will continue to offer our company its greatest opportunity for expansion over the next decade, and certainly into the 21st century.

Glass and Plastics
As can be inferred from the graph to the left, glass and plastics recycling has been holding steady throughout this same period, and has consequently become a smaller proportion of our overall sources of revenue.

Although this group would strongly recommend that WeCycle Waste Corporation do all that is necessary to increase its activities in these areas, our studies show that aluminum will become increasingly the material of choice in the shipping, heavy manufacturing and container industries.

Aluminum
It is our opinion that sources of aluminum products will be pressed close to their limits over the next decade.

Therefore, we propose that WeCycle Waste Corporation invest in more aluminum capacity during the next five years in order to take the best advantage of this increasing market demand.
There's a lot to like about the new Lotus 1-2-3 Release 2.3.

For starters, it's not just a graphical spreadsheet. It's a fast, graphical spreadsheet for DOS. It's easy to use. And it works as well on an older XT with just 512K of memory as it does on the newest 486 machine.

It also shares many features in common with our powerful 3D spreadsheet, Release 3.1. Including its superb spreadsheet formatting and publishing capabilities and full mouse support. Along with its popular Auto Compress feature that gives you a trouble-free way of making larger worksheets print on a single page.

We've also added new features you won't find in other spreadsheets. Like the Lotus 1-2-3 with its WYSIWYG graphical environment, you can do all your formatting "live" on screen.

With its WYSIWYG graphical environment, you can do all your formatting "live" on screen.

View (based on Lotus Magellan technology) which helps you find the file you want before retrieving it. And a very helpful Auditor that simplifies the job of documenting and analyzing complex worksheet logic.

Of course, you won't just like what Release 2.3 does. You'll like how it feels.

What's New In Lotus 1-2-3 Release 2.3.

- A WYSIWYG graphical environment with live on-screen formatting
- Lotus Magellan viewer technology for fast file previewing, retrieving and linking... all without leaving your active worksheet
- More graph types, including 3D-effect graphs and graph annotation capabilities
- Auto Compress, for a trouble-free way of making larger worksheets print on single page
- Dialog Boxes for an easier, more interactive way of working
- Text-editing for easy on-screen word processing, including automatic word wrap, even around graphs
- The Auditor for documenting or highlighting your spreadsheet logic
- Improved memory management for building larger worksheets up to 12 MB in size
- New printer drivers that support all leading laser and dot-matrix printers
- Context-sensitive Help and an interactive tutorial

It's quick and smooth. With a WYSIWYG (what-you-see-is-what-you-get) graphical environment that lets you format text, data, and graphics "live" on screen. Plus, what you see on screen is what you'll get when you print. With the mouse, you can execute commands, highlight cells or ranges, open dialog boxes, place and size graphs, change type styles, fonts and point sizes. All with unparalleled speed and ease.

What's more, Release 2.3 gives you a wide range of printing and reporting capabilities. Including the capacity to place as many live graphs on a worksheet as you'd like.

Along with 96 type style combinations, new 3D-effect graphs, drawing and annotation tools, and the most font support, choices of colors and shading available.

Compatibility? As with any 1-2-3 product, it's no problem. Because Release 2.3 will read all of the files you've created on previous versions of 1-2-3, including files you've formatted using Allways and Impress. So you'll preserve all your work, as well as your training.

For more information about the new Release 2.3 or for upgrade details, call us today at 1-800-TRADE-UP, ext. 1116.

© Copyright 1991 Lotus Development Corporation. All rights reserved. Lotus, 1-2-3, and Magellan are registered trademarks and Impress and Allways are trademarks of Lotus.
Before You Blow $500
On Lotus 1-2-3, Excel Or
Quattro Pro, Read This.

CA Shocks Spreadsheet
World With 70% Price Cut:
Highly-Rated SuperCalc5
Now Only $149.00

CAMBRIDGE, Mass — Early
today Computer Associates
announced a dramatic price
reduction on one of the indus-
yry's most popular and best-sell-
ing spreadsheet programs,
SuperCalc5. Effective immediately, the
suggested retail list price for
SuperCalc5 has been slashed
from $495.00 to $149.00. This
means that the new street price
for SuperCalc5 — which is
Lotus 1-2-3 compatible — will
very likely be under $100.00.
This bold, new pricing strategy
is great news for spreadsheet
users. It means now everyone
can afford to trade up to the
most advanced spreadsheet
technology in the industry. And
unlike Lotus 1-2-3 3.0 or Excel
workshops, which may be
priced out of reach for some
users.

"We've always listened closely
to what users want and
they've been concerned with
high spreadsheet prices and the
expensive hardware upgrades
which are often required," said
a CA spokesperson. "Users told
us that they wanted the latest
spreadsheet technology, but
they needed it at a price they
could afford and in one applica-
tion that would run on all of
their PCs. That is exactly what
we're giving them. SuperCalc5
at this new low price is by far
the best value in the spreadsheet
industry."

Initial reaction amongst
spreadsheet users and software
dealing has been overwhelm-
ingly positive. "This is terrific,"
said one user, "it's about

It's the beginning of a revolution.
The affordable spreadsheet revolution. Now every
user in America can afford the
most advanced spreadsheet
technology. The latest break-
throughs. Newest features.
Hottest 3-D graphics.
It's all there inside
SuperCalc5. With Lotus 1-2-3
compatibility, presentation
quality graphics and spread-
sheet linking. SuperCalc5 has become one
of the most popular, best-selling spread-
sheets in the industry.

More than 3,000,000 copies have been sold and unlike
some others, SuperCalc5 runs on virtually every type of PC
that exists.

If you've been thinking about moving up to a
more powerful, full-featured spreadsheet, now's
the time. Move up to SuperCalc5 and get every-
thing you've always wanted for hundreds of
dollars less than Lotus 1-2-3, Excel or Quattro
Pro. For the name of your nearest SuperCalc5
dealer call 1-800-

Do it right now.
After all, at this
price, why wait?

© 1991 Computer Associates International, Inc., 711 Stewart Avenue, Garden City, NY 11530-4787. Lotus and 1-2-3 are registered trademarks of Lotus Development Corporation. Excel is a registered trademark and Windows is a trademark of Microsoft Corporation. Quattro Pro is a registered trademark of Borland International, Inc.

Circle 73 on Inquiry Card.
Each month, BYTE evaluates dozens of products in a broad range of categories. We cover a lot of ground, but we are always trying to do more. To that end, BYTE is proud to bring you the NSTL Review Supplement series. As reports become available, BYTE will present the results of product comparisons from the National Software Testing Laboratories, a division of Datapro Research Group and a BYTE sister company. NSTL is one of the world’s premier independent hardware and software testing facilities. Its services and advice are sought by many businesses from the Fortune 500 on down.

These pages are supplemental; nothing has been cut from the regular issue of BYTE to make room for them. And the BYTE Lab will continue its long-standing tradition of producing comprehensive, hard-hitting product comparisons.

NSTL publishes ratings reports on Macintosh and PC hardware and software, as well as on networking products. BYTE will select topics based on timeliness and appropriateness to our readership. We will also avoid duplicating product coverage found elsewhere in BYTE.

Many of the tests devised by NSTL are similar to BYTE’s—the basic performance benchmarks, for example. Unlike BYTE, NSTL provides a scoring system based on numerical weightings assigned to key attributes such as performance, ease of use, versatility, and overall quality. While some of these ratings are by nature arbitrary, the criteria within the evaluation are consistent for each package and do provide a legitimate means of comparison. Though we’ve examined NSTL’s methodology and found it satisfactory, BYTE has not tried to duplicate NSTL’s tests. NSTL retains full ownership of the results published here.

Due to space limitations, we could not publish all the data that NSTL provided in its 75-page report. Instead, we boiled down the information to its essential core. The full report is available for sale from NSTL (see the text box “About NSTL”).

We bring you these supplements as a service. The additional pages allow us to provide you with more products comparisons in a wider range of categories. NSTL’s format and methodology might differ from what BYTE provides, but they offer a reasonable, alternative means of comparison that complements BYTE’s own extensive product reviews. We welcome NSTL to BYTE, and we welcome your comments on the NSTL supplements.

About NSTL

National Software Testing Laboratories (NSTL) is an independent organization that tests personal computer and LAN hardware and software. It provides unbiased performance, compatibility, comparison, and usability testing for personal computer users and vendors. Founded in 1983, NSTL pioneered this use of objective, real-world-based, and comparative methodologies to gain its position as the leading independent testing and evaluation facility in the microcomputer industry.


NSTL’s Commercial Testing Division offers test services on a confidential, contract basis to vendors.

Additional information on NSTL’s Commercial Test Division is available from NSTL, Plymouth Corporate Center, Plymouth Meeting, PA 19462, (215) 941-9600.

Advanced Spreadsheet Programs

In the MS-DOS world, spreadsheets cover a lot of territory—from simple computerized balance sheets to computational wizards with sophisticated viewing and printing options. For this comparative review, NSTL focuses on the high-end of the features and performance spectrum.

Although the capabilities of advanced spreadsheets are constantly expanding, the most important components of this software category continue to be worksheet characteristics and data manipulation functions. The past year has brought a number of significant improvements, however. The availability of moderately priced high-performance computer systems has encouraged the development of highly graphical programs, and widespread use of laser printers and color printers means that many advanced packages now include full-featured charting modules. In addition, these programs’ list of file handling powers has grown to include networking capabilities, spreadsheet linking, and three-dimensional worksheets. Some offer freeform modules, as well. (For advice on what to look for in an advanced spreadsheet, see the text box “Advanced Spreadsheets: Adding Up Your Options.”)

In this roundup, NSTL evaluates seven programs that qualify as advanced spreadsheets: Lotus Development’s 1-2-3, Microsoft Excel for Windows, WordPerfect Corp.’s PlanPerfect, FormalSoft’s ProQube 3D, Borland International’s Quattro Pro, Computer Associates International’s SuperCalc5, and Informix Software’s Wingz for Windows. With the exception of a prerelease version of Microsoft Excel for Windows (the final version was not available at the time of testing), all were production copies of the companies’ latest releases. (Borland has since released version 3.0 of Quattro Pro.) In the case of 1-2-3, for which two versions were available, NSTL evaluated the more powerful release 3.1 instead of the more widely distributed release 2.2. (Lotus’s high-end 1-2-3/G was omitted because it does not run under MS-DOS. See the table on page 191 for a list of additional spreadsheet vendors.)
# Advanced Spreadsheet Programs

<table>
<thead>
<tr>
<th>Product &amp; Supplier</th>
<th>NSTL Rating</th>
<th>Overall Evaluation</th>
<th>Overall Power</th>
<th>Overall Usability</th>
<th>Performance</th>
<th>Quality</th>
<th>Versatility</th>
<th>Ease of Use</th>
<th>Price</th>
<th>Memory Requirement</th>
<th>Hard Disk Space Needed</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft Excel for Windows Prerelease 3.0</td>
<td>****</td>
<td>8.9</td>
<td>8.1</td>
<td>9.6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>$495</td>
<td>1 MB; 2 MB recommended</td>
<td>5.2 MB</td>
<td>MS-DOS 3.0 or higher; Windows 3.0</td>
</tr>
<tr>
<td>Quattro Pro 2.0</td>
<td>****</td>
<td>8.4</td>
<td>7.7</td>
<td>9.1</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>$495</td>
<td>512K; 640K recommended</td>
<td>4 MB</td>
<td>MS-DOS 2.0</td>
</tr>
<tr>
<td>1-2-3 Release 3.1</td>
<td>***</td>
<td>7.2</td>
<td>6.8</td>
<td>7.7</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>$499</td>
<td>1 MB</td>
<td>5 MB</td>
<td>MS-DOS 3.0; compatible with Windows 3.0</td>
</tr>
<tr>
<td>Wingz for Windows 1.1</td>
<td>**</td>
<td>6.2</td>
<td>7.7</td>
<td>4.7</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>$495</td>
<td>2 MB; 3 MB recommended</td>
<td>2 MB</td>
<td>MS-DOS 3.1 or higher; Windows 3.0</td>
</tr>
<tr>
<td>SuperCalc5 5D</td>
<td>*</td>
<td>5.5</td>
<td>5.4</td>
<td>5.6</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>$495</td>
<td>512K; 640K recommended</td>
<td>5 MB</td>
<td>MS-DOS 2.0 or higher</td>
</tr>
<tr>
<td>PlanPerfect 5.1</td>
<td>Less than 5.0</td>
<td>4.8</td>
<td>4.7</td>
<td>4.8</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>$495</td>
<td>384K; 512K recommended</td>
<td>3 MB</td>
<td>MS-DOS 2.0 or higher</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>Less than 5.0</td>
<td>3.8</td>
<td>4.3</td>
<td>3.4</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>$99</td>
<td>512K; 640K recommended</td>
<td>1 MB</td>
<td>MS-DOS 2.0 or higher</td>
</tr>
</tbody>
</table>

### RATINGS KEY (On a scale of 0 to 10)

- **Standard Edition**
- **Network Server**
- **Network Mode**

<table>
<thead>
<tr>
<th>OVERALL EVALUATION</th>
<th>ALL OTHER RATINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>***** 9.0 or higher</td>
<td>7.0 - 10.0</td>
</tr>
<tr>
<td>**** 8.0 - 8.9</td>
<td>5.0 - 6.9</td>
</tr>
<tr>
<td>*** 7.0 - 7.9</td>
<td>Under 5.0</td>
</tr>
<tr>
<td>** 6.0 - 6.9</td>
<td></td>
</tr>
<tr>
<td>* 5.0 - 5.9</td>
<td></td>
</tr>
</tbody>
</table>
## Advanced Spreadsheet Programs

<table>
<thead>
<tr>
<th>Computer Systems</th>
<th>Mouse</th>
<th>Supplier Support</th>
<th>Volume-Purchase Agreements</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>286, 386</td>
<td>Supported; not required</td>
<td>Telephone support; bulletin board; newsletter; support plans available; discounted or free upgrades</td>
<td>No</td>
<td>Background recalculation; outlining; fast calculation speed; font preview; 3-D graphing; linear and nonlinear problem solving; backsolver; ability to place graphs on spreadsheets; linking to database tables; charting and free-form graphics; graphical page preview; array of data functions; background printing capability; quality of worksheets and charts</td>
<td>Inability to disable undo feature; lack of free-form lines in free-form graphics module</td>
</tr>
<tr>
<td>8086, 8088, 286, 386</td>
<td>Supported; not required</td>
<td>Telephone support; bulletin board; newsletter; forum on CompuServe; discounted upgrades</td>
<td>Yes</td>
<td>Background recalculation; fast calculation speed; fast overall performance; 3-D graphing; linear problem solving; backsolver; ability to place graphs on spreadsheets; graphical page preview; mapping feature; quality of worksheets; free-form drawing; linking to database tables</td>
<td>Slow speed when printing enhanced spreadsheets; lack of user-defined functions; lack of autosave feature; lack of background printing feature</td>
</tr>
<tr>
<td>286, 386</td>
<td>Supported; not required</td>
<td>Telephone support; newsletter; CompuServe forum; Lotus Prompt and Prompt CD; training centers; courseware</td>
<td>Yes</td>
<td>Seamless background calculation; 3-D spreadsheets; ability to place graphs on spreadsheets; linking to database tables; free-form graphics capabilities; graphical page preview; background printing; quality of worksheets; mapping feature</td>
<td>Lack of 3-D graphing; lack of user-defined functions; lack of autosave feature; inability to justify numbers</td>
</tr>
<tr>
<td>286, 386</td>
<td>Required</td>
<td>Telephone support; upgrade information</td>
<td>Yes</td>
<td>Interruptible recalculation; 3-D graphing; ability to place graphs on spreadsheets; charting capabilities; graphical page preview; background printing capability; quality of charts; free-form drawing</td>
<td>Inability to disable undo feature; poor manuals; difficult to learn; poor page preview; lack of free-form lines in free-form graphics module</td>
</tr>
<tr>
<td>8086, 8088, 286, 386</td>
<td>Supported; not required</td>
<td>Telephone support; newsletter; forum on CompuServe; CA-Insight magazine; support packages available; discounted upgrades</td>
<td>Yes</td>
<td>Interruptible recalculation; 3-D graphing; 3-D spreadsheets; good auditing features; strong financial functions; mapping feature</td>
<td>Lack of free-form drawing; lack of graphical page preview; lack of user-defined functions; lack of background printing; lack of support for virtual memory</td>
</tr>
<tr>
<td>8088, 286, 386</td>
<td>Supported; not required</td>
<td>Telephone support; bulletin board; WordPerfect magazine</td>
<td>Yes</td>
<td>3-D graphing; factorial overview; graphical page preview; background printing capability</td>
<td>Lack of background or interruptible calculation; poor enhancement features; lack of free-form drawing; lack of undo feature; slow calculation; slow execution speed</td>
</tr>
<tr>
<td>8086, 8088, 286, 386</td>
<td>Supported; not required</td>
<td>Telephone support; bulletin board</td>
<td>Yes</td>
<td>3-D graphing; 3-D spreadsheets; backsolver; mapping feature</td>
<td>Lack of background or interruptible calculation; lack of free-form drawing module; 512-row limitation; lack of undo feature; lack of graphical page preview; inability to support PostScript devices; lack of user-defined functions; poor manuals; lack of autosave feature; lack of background printing feature; inability to justify numbers; lack of support for virtual memory; poor enhancement features</td>
</tr>
</tbody>
</table>
Testing Procedures

To ensure the accuracy of its results, NSTL used the same equipment throughout its testing: a Hewlett-Packard Vectra QS/16s equipped with 5 megabytes of RAM, a 40-MB hard disk drive, a VGA monitor, and a Microsoft serial mouse. The hard disk was partitioned into two drives, designated as C and D; before each program was tested, it was installed on a newly reformatted drive D. Tests were conducted using Compaq DOS 3.31D and Microsoft Windows 3.0 (HIMEM.SYS and SMARTDRV.SYS were included when operating in Windows). BUFFERS and FILES statements in the system's CONFIG.SYS file were set to 30, and extended memory was accessed through Quarterdeck's QEMM.

In evaluating the print quality of each program's enhanced worksheet features, NSTL relied on three printers: a QMS-PS 810 turbo PostScript printer, an HP LaserJet III, and an HP PaintJet (for evaluating color printing).

Most performance tests used a complex business worksheet that included a three-year cashflow model, balance statement, inventory, one-year amortization schedule, data table, and personnel file consisting of sales, commissions, and projections. All parts of the model were linked with interdependent formulas. Formulas consisted primarily of arithmetic operations such as addition, subtraction, averaging, and combinations of these functions; others included minimum and maximum functions, vertical lookups, IF...THEN...ELSE statements, financial functions, and a table comparing double-declining, straight-line, and sum-of-the-years' digits depreciation. Raw recalculation tests used a 50-by-200-cell matrix. Unless otherwise specified, tests were timed from the moment the command was entered until program control was restored and the cursor could be moved to another cell.

The default program settings of the spreadsheets were modified only to optimize performance, and features that might slow the programs (automatic backup and save, for instance) were disabled. Tutorial files and sample worksheets were not installed unless required by a program's setup procedure, and each package's program window and worksheet were designed so that they encompassed the entire screen. 1-2-3 was tested using extended rather than expanded memory, and tests were run using its standard and its WYSIWYG interface. Quattro Pro also was tested under both its default character-based interface and its WYSIWYG interface.

Because it has a 512-row limitation, ProQube 3D could not load the entire model as one worksheet. To ensure ProQube was tested using memory requirements equivalent to those used for testing other programs, the inventory portion of the benchmark spreadsheet was loaded as the second sheet of a 3-D spreadsheet.

Ratings Analysis

To rank the effectiveness of the seven spreadsheets, the NSTL staff conducted an exhaustive array of evaluations on each product in turn. Spread sheet capabilities were first broken down into five categories: performance, quality of printed spreadsheets and charts, versatility of a program's features, ease of learning, and ease of use. The various component ratings of each category were weighted according to their importance within the category. The component parts of the ease-of-use category, for instance, are the program interface (assigned a weight of 1), worksheet creation and editing capabilities (3), formatting tools (2), graphing capabilities (2), linking/3-D capability (1), database functions (1), file management (1), quality of manuals (1), and overall ease of learning (4).

Performance

Methodology

NSTL's benchmark tests for performance measure the speed of common spreadsheet operations and calculations. Tests are devised to rate raw calculation speed, the minimal recalculation speed, and the length of time required to return control to the user from a background or interruptible calculation. Performance is a weighted average of scores for the rated benchmarks. Individual test scores are computed using the following formula: (Program Time - Average Time) / (Best Time - Average Time). The result is then rescaled so that the results for all seven spreadsheets fall within a 1-to-10 scale.

<table>
<thead>
<tr>
<th>Weight</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Import .WK1 file</td>
</tr>
<tr>
<td>2</td>
<td>Save a File</td>
</tr>
<tr>
<td>2</td>
<td>Load a File</td>
</tr>
<tr>
<td>2</td>
<td>Insert a Row, Manual Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Insert a Row, Auto Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Delete a Row, Manual Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Delete a Row, Auto Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Insert a Column, Manual Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Insert a Column, Auto Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Move a Block, Manual Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Move a Block, Auto Recalc</td>
</tr>
<tr>
<td>2</td>
<td>One-Key Sort, Manual Recalc</td>
</tr>
<tr>
<td>2</td>
<td>One-Key Sort, Auto Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Multikey Sort, Manual Recalc</td>
</tr>
<tr>
<td>2</td>
<td>Multikey Sort, Auto Recalc</td>
</tr>
<tr>
<td>3</td>
<td>Background Recalculation</td>
</tr>
<tr>
<td>3</td>
<td>Data Table Manipulation</td>
</tr>
<tr>
<td>3</td>
<td>Data Table Manipulation, Inputs Switched</td>
</tr>
<tr>
<td>2</td>
<td>Print Quality, LaserJet III</td>
</tr>
<tr>
<td>2</td>
<td>Print Quality, PostScript</td>
</tr>
<tr>
<td>4</td>
<td>Calculation</td>
</tr>
</tbody>
</table>
The New Generation
MATH COPROCESSOR

High-Performance Sub-Micron CMOS Technology
Speeds Up To 40 MHz • Guaranteed Compatibility • Lifetime Warranty
30-Day, No-Questions-Asked, Money-Back Guarantee

Increases System Performance
The US83C87 Math•Co™ from SDC is a high performance sub-micron CMOS math coprocessor that is software compatible with applications designed to operate with all 386 computers. The Math•Co™ is available for DX systems in speeds up to 40 MHz and for SX systems in speeds up to 25 MHz.

Completely Compatible with all Chip Sets and Mother Board Manufacturers
The Math•Co™ is guaranteed to be completely compatible with industry standards, used worldwide by not only scientists and programmers, but by the general business community – individuals who want to speed up applications like spreadsheets, graphics, font generation, desktop publishing, databases and statistics.

Power Support
We are so confident in the design and performance of this product that we offer a 30-Day, No-Questions-Asked, Money-Back Guarantee. If, for any reason, you are not completely satisfied, SDC will give you a full refund of your purchase price. Of course, the Math•Co™ also offers a Lifetime Warranty.

Experience the New Generation of Math Coprocessors
Plug in the Math•Co™ from SDC and sit back for a fast ride through the most cumbersome applications. No more long waits while data is processing. With the 30-Day, Money-Back Guarantee and Lifetime Warranty, now is the time to plug in the Math•Co™.
Call 1-800-284-7732 for your nearest Math•Co™ dealer.

SPECIALTY DEVELOPMENT CORPORATION
1001 Capital of Texas Hwy. South, Bldg. 1 • Austin, Texas 78746 • 512/327-8608 • FAX 512/327-5233
Circle 290 on Inquiry Card.
Print Quality

A program's print-quality score is the average of its scores for charting quality and spreadsheet quality. Procedures involve creating the available reports and charts, then enhancing them using shading, outlining, and so on. Quality scores for a program's charts average its evaluations for bar, pie, and line charts. Programs are scored on the basis of available options and on their overall effectiveness at producing the required output.

Quality of Printed Spreadsheets

<table>
<thead>
<tr>
<th>Weight</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Options</td>
</tr>
<tr>
<td>1</td>
<td>Print Quality with the HP LaserJet III</td>
</tr>
<tr>
<td>1</td>
<td>Print Quality with the QMS-PS 810 turbo</td>
</tr>
</tbody>
</table>

Quality of Printed Charts

<table>
<thead>
<tr>
<th>Weight</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>When Long X-Axis Labels Used</td>
</tr>
<tr>
<td>2</td>
<td>Print Quality with the HP LaserJet III</td>
</tr>
<tr>
<td>2</td>
<td>Print Quality with the QMS-PS 810 turbo</td>
</tr>
<tr>
<td>2</td>
<td>Print Quality with the HP PaintJet</td>
</tr>
</tbody>
</table>

Ease of Learning

To evaluate ease of learning, NSTL employed groups of novice spreadsheet users and testers with varying levels of experience with Microsoft Windows, 1-2-3, and WordPerfect. Testers were provided with a test model and were given free reign to create a workable spreadsheet solution using a package's manuals, help screens, and program logic. A proctor reviewed each tester's solution and suggested changes to ensure that specific features were included in all the models. A program's ease-of-learning rating is a weighted average of individual scores within the category.

Ease of Use

After learning a program, testers evaluated its usability, including the number of keystrokes required for particular procedures, intuitiveness of the menu structure, time needed to perform operations, and quality of reference manuals.
The New Generation
CACHING DISK CONTROLLER

SERIES™


Lightning-Quick Disk Access
In today's high performance PCs, disk access is the number one system bottleneck. The SERIES 400™ from SDC is a new class of hard drive controller with its own powerful on-board parallel processor and memory to independently manage disk drive data. The SERIES 400™ actually anticipates what information the PC is going to need and stores the data in its own high-speed cache RAM. Disk accesses are 100 times faster and large file transfers are up to 10 times faster. This means applications load and execute fast! Even the slowest and most cumbersome applications become lightning quick. All applications – Windows, CAD, databases, desktop publishing – become supercharged with near instant file access. SDC has broken the price barrier to hardware disk caching. No longer is powerful disk performance limited to mainframe systems.

Call 1-800-284-7732 for your nearest SERIES 400™ dealer.

Power Support
We are so confident in the design and performance of this product that we offer a 30-Day, No-Questions-Asked, Money-Back Guarantee. If, for any reason, you are not completely satisfied, we'll give you a full refund of your purchase price.

Cash In Today
Cash in on the time you'll save with the SERIES 400™. Enjoy startling increases in system performance at an affordable price. Installation is easy - The SERIES 400™ is fully compatible with all 486, 386 and 286 systems and is available in ESDI, SCSI, and IDE drive interfaces.

SPECIALTY DEVELOPMENT CORPORATION
1001 Capital of Texas Hwy. South, Bldg. 1 • Austin, Texas 78746 • 512/327-8608 • FAX 512/327-5233

Circle 291 on Inquiry Card.
That's Intel's. And our new family of Math CoProcessors is faster—up to 50% for the 287XL. In fact, working side by side with the Intel microprocessor already inside your computer, an Intel Math CoProcessor can increase the speed of your spreadsheet, graphics, CAD and database programs by as much as 500%. That's good to know.

And the fact that it's made by Intel is also good to know.

Because Intel developed the first Math CoProcessor in 1982, and we've shipped millions since then. Each one is manufactured by Intel in the world's most advanced logic
facility, and then tested and retested against an exacting set of criteria.

And we can guarantee that every Intel Math CoProcessor lives up to the industry hardware standards we helped develop, delivering the same results regardless of what type of computer you're doing calculations on. So call Intel at (800) 538-3373. Ask for Literature Packet #F6 on Intel's new and improved Math CoProcessors. And put an Intel Math CoProcessor inside your computer. It's the only one with the Intel name to live up to.

©1990 Intel Corporation. 386 and 387 are trademarks of Intel Corporation.

Circle 152 on Inquiry Card (RESELLERS: 153).
Versatility

Versatility ratings are based on a checklist of program features that are assigned weighted scores and grouped by category.

### The Overall Ratings

After evaluating each spreadsheet in the five categories, NSTL computed two overall ratings. The first establishes a power-versus-usability index by weighting the characteristics relating to power (performance, quality of printed spreadsheets and charts, and versatility) and those relating to usability (ease of learning and ease of use) and plotting the scores for each program on a grid. (See "Power vs. Usability" on page 192.) The second overall rating establishes the top spreadsheet among the seven advanced programs tested. NSTL recommends as good buys the programs designated with a checkmark (√).

The overall evaluation is a weighted average of scores in six categories: the five main evaluation categories plus the testers' general evaluation.

<table>
<thead>
<tr>
<th>Weight</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Worksheets</td>
</tr>
<tr>
<td>5</td>
<td>Data Manipulation</td>
</tr>
<tr>
<td>2</td>
<td>Presentations</td>
</tr>
<tr>
<td>1</td>
<td>File Manipulation</td>
</tr>
<tr>
<td>2</td>
<td>Macro/Programming</td>
</tr>
<tr>
<td>1</td>
<td>Charting</td>
</tr>
<tr>
<td>1</td>
<td>Free-Form Graphics</td>
</tr>
</tbody>
</table>

---

**MICROSOFT EXCEL FOR WINDOWS**

**PRERELEASE 3.0 √**

With Microsoft Excel for Windows, Microsoft adds many features to an already powerful program. New features—such as an improved page preview, font preview, and double-clicking with a mouse to invoke dialog boxes—enhance the program's usability. Double-clicking column guides make it simple to adjust column width to accommodate the longest entry.

Excellent flexibility in charting and spreadsheet quality are the consequence of a wide array of enhancements and charting features, including the addition of extensive 3-D
Crunch!

Nothing crunches numbers like the Advanced Math Co-processors from Integrated Information Technology. They really speed up graphics, CAD/CAE, spreadsheets, and other calculation-intensive applications.

Three models provide a perfect match to your 286, 386, or SX PC, delivering up to twice the performance of other CoProcessors. No wonder hundreds of thousands have been sold. Five-year limited warranty. BYTE-rated. So plug in, and crunch!

Count on iii.

Available at most local dealers.
charting options. Excel now places graphs on spreadsheets and includes free-form graphics capability, 3-D graphics, a tool bar, outlining, a goal seeker, a solver, a font preview, style guides, automatic summing, and a format for fractions. Font preview, page preview, WYSIWYG display, shortcut icons, mouse control, and keyboard shortcuts combine with an intuitive interface and excellent on-line tutorial to make Excel easy to learn and use. Microsoft also has improved the program's already speedy recalculation scheme.

QUATTRO PRO 2.0

While Quattro Pro does not provide the range of features that Excel offers, it outperforms Excel in all but the calculation benchmarks. The program features an intuitive menu structure that you can customize: Existing menus can be changed and rearranged, new commands added and renamed, and new descriptions applied to commands. The program's blazing execution speed enhances productively, enabling the user to experiment with options rather than wait for the program to finish executing an operation. Although the program runs in less than 640K bytes of RAM, it takes advantage of expanded memory and offers 3-D graphics, a backsolver, linear optimization (in its solver feature), 3-D linking, a graphics mode, free-form capability, a wealth of data functions, and an annotator. On-screen enhancements include outlines and shading. Although the program does not have a graphical interface, it does have programmable buttons that you can use to automate tasks and thus speed operations. Using these buttons to conduct a slide show is a specialty of the program.

Quattro Pro's excellent usability, quality, above-average versatility, fast execution speed, and low memory requirement make it a good choice for any 286 or 386 system—and the only choice for an 8086 or 8088 computer.

1-2-3 RELEASE 3.1

1-2-3 Release 3.1 comes with the standard 1-2-3 interface (filled out with a few more menu choices) and a WYSIWYG interface that keeps the program competitive with Excel and Quattro Pro. But this dual menu structure can be cumbersome when you're hunting for a certain option. Further, 1-2-3's execution is slow compared with that of the top two spreadsheets, and its charting module lacks the same wealth of features and level of flexibility.

On the other hand, 1-2-3 Release 3.1's WYSIWYG environment provides the most free-form features of the advanced spreadsheets tested here. Background calculation is seamless, and network capability goes beyond simple file locking and read-only access. The capability of its 3-D worksheet is excellent, but 3-D graphics, a solver, and a backsolver are available only in Lotus's very high-end spreadsheet, 1-2-3/G.

WINGZ FOR WINDOWS 1.1

Wingz for Windows is fast and versatile but crashes unpredictably, displaying messages regarding unrecoverable termination errors. And while the program's charting capability is second to none, mastering charting techniques is difficult and the program's overreliance on a mouse is frustrating. Wingz does let you create charts and free-form objects directly on the spreadsheet, but its page preview is not truly WYSIWYG.

SUPERCALC5 5D

SuperCalc5 lacks a page preview of any sort, which adversely affects its usability rating, and its main menu presents an overwhelming number of options. Still, the program offers the best auditing features and financial functions, making it one of the best spreadsheets for heavy-duty financial use. SuperCalc manipulates 3-D spreadsheets in the same manner as 1-2-3, but provides no free-form graphics capability.

PLANPERFECT 5.1

Slow and cumbersome, PlanPerfect requires many steps to complete even simple operations. The program also suffers from a lack of free-form graphics, spreadsheet enhancements, 3-D spreadsheets, and a background calculation feature. Charting and auditing features are limited. On the positive side, however, PlanPerfect offers a factorial operator, and its page preview and background printing control are among the best.

PROQUBE 3D 2.00

ProQube 3D—at $99, priced far below the cost of the other products evaluated here—not provides an equivalent range of advanced spreadsheet features. Missing are spreadsheet enhancements, background calculation, page preview, database functions, font control, an Undo command, matrix inversion, free-form graphics capabilities, and support for PostScript printers.

ProQube does offer 3-D spreadsheets and 3-D bar charts. Although no database functions are available, the program includes a backsolving feature, hyperbolic trigonometric functions, and a wealth of mathematical and statistical functions.

---

Performance Results

To measure spreadsheet performance, NSTL ran each of the seven programs through a battery of tests, weighting benchmark results to obtain an overall performance rating.

Load Lotus .WK1 File

Each program retrieves a 237K-byte file created in 1-2-3 release 2.01.

<table>
<thead>
<tr>
<th>Program</th>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quattro Pro</td>
<td>13.8</td>
</tr>
<tr>
<td>Lotus 1-2-3 Release 3.1</td>
<td>18.9</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>21.5</td>
</tr>
<tr>
<td>Microsoft Excel for Windows</td>
<td>26.8</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>33.3</td>
</tr>
<tr>
<td>Wingz for Windows</td>
<td>38.5</td>
</tr>
<tr>
<td>SuperCalc5</td>
<td>49.1</td>
</tr>
</tbody>
</table>

This page contains proprietary test results. Reproduction or quotations, in whole or in part, is prohibited without written permission of NSTL, Inc.
Here's a chance to buy our $99 Math Coprocessor at no risk whatsoever! It's fully guaranteed to at least double the math performance of your software.

If you want to unlock the full power of your PC, pick up the phone and order an AMD 80C287 math coprocessor. Without it, your PC just isn't really complete. You see, our math coprocessor can dramatically increase the performance of 1-2-3®, dBASE®, Excel, and hundreds of your other favorite business applications! It actually runs calculations two to ten times faster than your PC can without a math coprocessor. Which means your graphs will draw incredibly fast and your spreadsheets will recalculate at truly blazing speeds. (And that's just for starters!)

High speed at a low price.
Don't think you have to pay over $200 for a math coprocessor. Now you can get ours for just $99 when you order direct from AMD! The AMD 80C287 is fully compatible with your 80286-based PC and the hundreds of commercially available software packages written for it. Our coprocessor is also compatible with the Intel NMOS 80287.

Installation is a snap.
The AMD 80C287 plugs easily into a socket that's already inside your 80286-based PC. In fact, you can be up and running in just five minutes. Simply plug the chip into the socket and watch the dazzling improvement in performance! The AMD 80C287 comes with easy-to-follow installation instructions, a free utilities disk (which includes diagnostics and test software), and free color computer games.

Advanced Micro Devices, Inc.
9020-11 Capital of Texas Hwy N., Suite 400
Austin, TX 78759-9797

Volume or dealer inquiries welcome. 1-2-3 is a registered trademark of Lotus Development Corporation. dBASE is a trademark of Ashton-Tate Corporation. Intel is a registered trademark of Intel Corporation.

---

Our Triple Guarantee

Guarantee #1: If the AMD 80C287 doesn't do everything we promise, or if you are unsatisfied for any reason, return the product within 30 days of purchase and AMD will happily refund your money.

Guarantee #2: If your AMD 80C287 Math Coprocessor ever fails to perform for any reason, AMD will replace it free of charge, no questions asked. Limited to two lifetime replacements per person.

Guarantee #3: AMD guarantees that the AMD 80C287 is fully compatible with your 80286-based hardware and software. If you have any compatibility problems with the AMD 80C287 during the first year, return the product and we will gladly refund the purchase price.

---

To Order Call Now
1-800-888-5590 ext. 2600
Outside of USA call (512) 345-1728

Yes. I want to double or triple the calculation speed of software running on my 286-based PC. Send me an AMD 80C287 Math Coprocessor, risk free, for only $99 plus tax, shipping and handling. I understand that I can return the AMD 80C287 for a full refund within the first 30 days if I am not completely satisfied.
Save a File

Each program saves a file in its proprietary format. The worksheet is completely recalculated to ensure accurate times, and changes are made to the file to provide a means of checking that the file actually is saved. File backup features are disabled.

<table>
<thead>
<tr>
<th>Program</th>
<th>Time (Manual)</th>
<th>Time (Automatic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wingz for Windows 2.7</td>
<td>2.6</td>
<td>11.1</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>3.2</td>
<td>27.8</td>
</tr>
<tr>
<td>Quattro Pro</td>
<td>4.1</td>
<td>6.4</td>
</tr>
<tr>
<td>Microsoft Excel for Windows 8.9</td>
<td>7.7</td>
<td>7.8</td>
</tr>
<tr>
<td>SuperCalc5</td>
<td>7.7</td>
<td>7.8</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>13.7</td>
<td>15.6</td>
</tr>
<tr>
<td>Lotus 1-2-3 Release 3.1</td>
<td>12.8</td>
<td>15.6</td>
</tr>
</tbody>
</table>

Load a File

Each program loads a file saved in its proprietary format. The test is timed from a clear screen; all worksheets, including blank ones, are closed.

<table>
<thead>
<tr>
<th>Program</th>
<th>Time (Manual)</th>
<th>Time (Automatic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wingz for Windows 4.5</td>
<td>3.2</td>
<td>5.2</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>7.3</td>
<td>7.8</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>10.1</td>
<td>11.2</td>
</tr>
<tr>
<td>Quattro Pro</td>
<td>11.3</td>
<td>13.0</td>
</tr>
<tr>
<td>Microsoft Excel for Windows</td>
<td>12.2</td>
<td>12.8</td>
</tr>
<tr>
<td>Lotus 1-2-3 Release 3.1</td>
<td>12.8</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Insert a Row

Each program inserts a blank row at row 33, a procedure that simulates the addition of a cash disbursement. Using manual recalculation, the programs are timed to obtain the actual spreadsheet manipulation time. The test is repeated with automatic recalculation to assess the effects of the background and minimal recalculation.

<table>
<thead>
<tr>
<th>Program</th>
<th>Time (Manual)</th>
<th>Time (Automatic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quattro Pro</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Wingz for Windows</td>
<td>2.6</td>
<td>11.1</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>3.2</td>
<td>27.8</td>
</tr>
<tr>
<td>Lotus 1-2-3 Release 3.1</td>
<td>3.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Microsoft Excel for Windows</td>
<td>4.1</td>
<td>6.4</td>
</tr>
<tr>
<td>SuperCalc5</td>
<td>7.7</td>
<td>7.8</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>13.7</td>
<td>15.6</td>
</tr>
</tbody>
</table>

Delete a Row

Each program deletes the row inserted in the previous test. Using manual recalculation to assess actual spreadsheet manipulation and automatic recalculation to assess the effects of the background and/or minimal recalculation, the programs are timed.

<table>
<thead>
<tr>
<th>Program</th>
<th>Time (Manual)</th>
<th>Time (Automatic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quattro Pro</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Wingz for Windows</td>
<td>2.6</td>
<td>11.2</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>3.7</td>
<td>29.0</td>
</tr>
<tr>
<td>Lotus 1-2-3 Release 3.1</td>
<td>3.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Microsoft Excel for Windows</td>
<td>4.1</td>
<td>6.4</td>
</tr>
<tr>
<td>SuperCalc5</td>
<td>8.2</td>
<td>8.4</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>28.3</td>
<td>44.0</td>
</tr>
</tbody>
</table>
System Architect has the power to handle your most complex applications. And it's so easy to use, even beginners will be productive in no time.

"The software’s incredible ease of use belies the power hidden within."  
Computer Language

System Architect works with such methodologies as DeMarco/Yourdon, Gane & Sarson, Ward & Mellor (real-time), entity relation diagrams, decomposition diagrams, object oriented design (optional), state transition diagrams, and flow charts.

"System Architect stood out from many other prospects because it had the best core technology."
Toshiba Corporation

With System Architect, you get support for an integrated data dictionary/encyclopedia, and multi-user support both with and without a network. And System Architect’s open architecture lets you easily import and export data to other products.

"We’re surprised with its flexibility and much taken with the idea of being able to link different kinds of diagrams..."  
Cutter Information’s CASE Strategies

System Architect is a pleasure to work with. It’s Windows-based, has context-sensitive help, and a novice mode.

"SA is an excellent value."  
CASE Trends

At $1,395, System Architect is quite affordable. And it runs on almost any PC.

"...truly a price performance leader."  
System Builder

For a powerful CASE product that’s easy to use and affordable, look to System Architect. It’s the right concept for CASE.

FOR MORE INFORMATION, CALL (212) 571-3434

POPKIN Software & Systems Inc.  
11 Park Place, NY, NY 10007  
(212) 571-3434  
Fax: (212) 571-3436

Supporting IBM’s AD/Cycle

IBM is a registered trademark of IBM Corp. Microsoft is a registered trademark of Microsoft Corp.

Circle 253 on Inquiry Card.
Our exclusive Outlining feature lets you expand and collapse your worksheet. So you're able to display and print only the data you need to view or share with others.

Eliminating the need to create separate documents for your boss and your boss's boss. Furthermore, if you don't select specific parameters, the program will automatically outline your worksheet. You can also combine virtually hundreds of worksheets through the consolidation feature. Regardless of format or structure.

Select a range of cells and transform them into a chart on a worksheet. With one simple click. Or why not create a 3-D chart? Then rotate it 360°. How's that for a view? With new Microsoft Excel, you can choose from 68 different chart types, 24 of which are 3-D. Or even create your own.

And because this is a graphical program, it's easy to combine text, data and graphics on a single page. Of course, it's WYSIWYG too. Which means you can actually see what you're working on.

For more information in the 50 United States, call (800) 541-1281, Dept. Q13. In Canada, call (416) 568-3552. Outside the U.S. and Canada, call (206) 936-8661. ©1991 Microsoft Corporation. All rights reserved.
to make this spreadsheet do
tely it'll only take you one.

Introducing Microsoft Excel version 3.0.

Out of all the steps it took us to create the new Microsoft® Excel for Windows®, there were two in particular that had the most impact. The first was to listen to our users and to listen carefully. The second was to take that knowledge and implement it intelligently.

The result is outrageous power coupled with ease-of-use. It is this idea that drives all of our efforts. And has since we introduced the first graphical spreadsheet back in 1985.

A recent example of this is the Toolbar: This addition lets you do everything from formatting, to formulas, to outlining with one click of a button.

Best of all, it's really easy to make the move. Microsoft Excel comes with online help for 1-2-3® users. So you can learn by simply applying your existing knowledge.

Take the next step, call (800) 541-1261, Dept. Q13, for the name of a dealer near you.

Microsoft® Making it all make sense

Microsoft and the Microsoft logo are registered trademarks and Making it all make sense, Autosum, Toolbar and Windows are trademarks of Microsoft Corporation. 1-2-3® is a registered trademark of Lotus Development Corporation.
**Insert a Column**

Each program inserts a column at the second column position. The programs are timed, first using manual recalculation to obtain the actual spreadsheet manipulation times and then using automatic recalculation to assess the effects of the background and minimal recalculation.

<table>
<thead>
<tr>
<th>Software</th>
<th>Manual</th>
<th>Automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quattro Pro</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Lotus 1-2-3</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Wingz for Windows</td>
<td>4.7</td>
<td>4.7</td>
</tr>
<tr>
<td>Microsoft Excel</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>SuperCalc5</td>
<td>7.6</td>
<td>7.6</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>30.5</td>
<td>45.0</td>
</tr>
</tbody>
</table>

**Move a Block**

Each program moves one column to the left a block of cells that encompasses C1 through AR93. The programs are timed in two ways: while executing a Block Move command and while deleting the range B1 to B93, which accomplishes the same task. Scoring is based on the faster time.

<table>
<thead>
<tr>
<th>Software</th>
<th>Manual</th>
<th>Automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lotus 1-2-3</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Quattro Pro</td>
<td>1.8</td>
<td>2.1</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>3.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Microsoft Excel</td>
<td>4.4</td>
<td>6.8</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>4.7</td>
<td>4.7</td>
</tr>
<tr>
<td>Wingz for Windows</td>
<td>5.2</td>
<td>5.2</td>
</tr>
<tr>
<td>SuperCalc5</td>
<td>10.4</td>
<td>10.4</td>
</tr>
</tbody>
</table>

**Calculation**

Each program calculates a 50- by 200-cell block; the test ends when the last cell is recalculated. Each cell contains an identical formula that is dependent on the preceding cell so that 10,000 formulas are calculated. The test is first performed with each formula executing a simple addition operation; the test is repeated with formulas for subtraction, multiplication, division, and exponentiation.

### Calculation Table

<table>
<thead>
<tr>
<th>Operation</th>
<th>Lotus 1-2-3</th>
<th>Excel</th>
<th>PlanPerfect</th>
<th>ProQube</th>
<th>Quattro Pro</th>
<th>SuperCalc5</th>
<th>Wingz for Windows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition</td>
<td>6.7</td>
<td>3.0</td>
<td>22.3</td>
<td>16.8</td>
<td>5.7</td>
<td>9.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Subtraction</td>
<td>6.6</td>
<td>3.0</td>
<td>22.6</td>
<td>17.7</td>
<td>6.4</td>
<td>10.1</td>
<td>4.0</td>
</tr>
<tr>
<td>Multiplication</td>
<td>7.5</td>
<td>3.0</td>
<td>25.6</td>
<td>18.2</td>
<td>6.4</td>
<td>10.6</td>
<td>5.8</td>
</tr>
<tr>
<td>Division</td>
<td>7.7</td>
<td>3.2</td>
<td>26.6</td>
<td>18.2</td>
<td>6.4</td>
<td>10.6</td>
<td>5.8</td>
</tr>
<tr>
<td>Exponentiation</td>
<td>62.0</td>
<td>29.6</td>
<td>51.8</td>
<td>38.0</td>
<td>36.1</td>
<td>58.7</td>
<td>32.7</td>
</tr>
</tbody>
</table>

**Background Recalculation**

This test measures the time required to return program control to the user when background recalculation is in effect and a value is entered into the worksheet. The test does not measure the recalculation time. Return of control times will vary considerably depending on the cell in which the value is entered and the number of formulas that reference the cell either directly or indirectly.

<table>
<thead>
<tr>
<th>Software</th>
<th>Manual</th>
<th>Automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft Excel</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Quattro Pro</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SuperCalc5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lotus 1-2-3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wingz for Windows</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>14.6</td>
<td>14.6</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>17.9</td>
<td>17.9</td>
</tr>
</tbody>
</table>
For most people, the best reason to buy a math coprocessor is to make your software run faster. And the coprocessors that run it fastest are from Cyrix. Because our FasMath coprocessors outperform all others in running Lotus 1-2-3® and other leading software by every available measure.

FasMath processors perform floating point operations from five to ten times faster than other coprocessors, thanks to an entire new, innovative architecture. Which means that everyone's favorite spreadsheet will run up to three times faster with a Cyrix coprocessor.

You'll also find FasMath products are more accurate. Because they compute results to 20 decimal digits of accuracy, instead of the usual seven.

What's more, the FasMath family consumes less power. Which preserves battery life for laptop users. And, across all clock speeds, from our 16, 20, 25 and 33 MHz parts to our newly-announced 40 MHz processors, Cyrix coprocessors are unmatched in compatibility. They're even backed by a five year limited warranty and a toll-free support hotline.

So call us at 1-800-FASMATH (that's 1-800-327-6284) and we'll send you the unvarnished truth straight from the experts who measure PC performance, including the experts at Lotus Development who test products and certify compatibility. Which should make choosing the math coprocessor that's right for you as simple as 1-2-3.
Sorting

Each program sorts a 19- by 86-cell block, using one key in ascending order (sorting by name in alphabetical order). The test is initiated with the top of the key column positioned at the upper-left corner of the screen.

Each program also sorts the block using the third and first column as keys, thus creating a list of names and associated data sorted in two ways: in descending order by commission rate (expressed as a percentage with one decimal place) and in alphabetical order by name for each rate.

SINGLE-KEY SORT

<table>
<thead>
<tr>
<th>Software</th>
<th>Single-Key Sort</th>
<th>Multi-Key Sort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quattro Pro</td>
<td>0.7</td>
<td>12.8</td>
</tr>
<tr>
<td>PlanPerfect</td>
<td>0.8</td>
<td>15.1</td>
</tr>
<tr>
<td>ProQube 3D</td>
<td>1.1</td>
<td>27.9</td>
</tr>
<tr>
<td>Wingz for Windows</td>
<td>1.4</td>
<td>10.1</td>
</tr>
<tr>
<td>Microsoft Excel for Windows</td>
<td>3.2</td>
<td>5.3</td>
</tr>
<tr>
<td>SuperCalc5</td>
<td>6.3</td>
<td>6.4</td>
</tr>
<tr>
<td>Lotus 1-2-3 Release 3.1</td>
<td>6.5</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Data Table

Each program uses a complex two-input data table to perform a what-if analysis on the working capital available for the spreadsheet model. A 12-month cashflow model determines the amount of working capital available after one year of operation and uses formulas that hinge on percentages based on actual and projected sales. Values for sales increases vary from 1 percent to 13 percent in 0.4-percent increments, and values for operating expenses vary from 16.0 percent to 18.2 percent in increments of 0.2 percent. The data table provides a maximized peak based on the two inputs. All times are measured in minutes. The benchmark is repeated with the two input cells switched.

Print Speed

Each program prints a four-page, cashflow report in quality-print mode on a QMS-PS 810 turbo PostScript printer and an HP LaserJet III. The first row of the worksheet functions as a border on all subsequent pages. The range is printed in landscape orientation with half-inch margins. Headers and footers include the date and page number. Output includes borders, shading, and different fonts and type sizes. The programs use the same enhancement options in each location wherever possible.
Power vs. Usability

One way to judge the effectiveness of advanced spreadsheets is to analyze how well they balance power and usability. NSTL first rated the programs in each category and then plotted the programs' scores to produce an index of power versus usability.

Overall Power

Overall power is a weighted average of scores for the various criteria.

<table>
<thead>
<tr>
<th>Weight</th>
<th>Criteria</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Performance</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Quality</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Versatility</td>
<td></td>
</tr>
</tbody>
</table>

Overall Usability

Overall usability is a weighted average of scores for the various criteria.

<table>
<thead>
<tr>
<th>Weight</th>
<th>Criteria</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Ease of Learning</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Ease of Use</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Testers' General</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evaluation</td>
<td></td>
</tr>
</tbody>
</table>
Index of Power vs. Usability

Programs plotted in or near the shaded portion of the chart come closest to having the ideal combination of power and usability. Programs plotted in the center of the chart are equally powerful and useful. Those that fall near the diagonal in the upper-right corner exhibit a balance of power and usability that becomes less acceptable toward the lower-left corner. Difficult, yet powerful, programs gravitate to the upper left, and very accessible programs with little power gravitate to the lower right.

To compute the coordinates for each program, NSTL uses the following weighted formulas:

Overall Power = \((2 \times \text{Performance Score}) + (2 \times \text{Versatility Score}) + \text{Quality Score}\) / 5

Overall Usability = \((3 \times \text{Ease of Learning Score}) + (6 \times \text{Ease of Use Score}) + \text{Testers' General Evaluation}\) / 10
No Assembly Required.

With Template Development by Software Spectrum, your Lotus 1-2-3 application is ready to use right out of the box.

Let our Spectrum Integrated Services division develop a Lotus® 1-2-3® analytical model that's right for you or your clients, right away. We offer template development for all three leading releases of Lotus 1-2-3, for applications that range from budgeting to sales analysis to resource allocation to cash-flow projections.

In just seven years, Software Spectrum has grown to be the nation's second-largest software reseller. And during that time, we've helped 2,000 organizations select and implement the right accounting solutions. Understanding your business needs is our specialty.

Whatever you need, however simple or complex, we can deliver a model just waiting to crunch your numbers and give you the results you need.

To learn more, call 1-800-624-0503 and ask for template services for a free consultation. There's no obligation. And no tools are required.

For more information, call 1-800-624-0503 from 7:30 a.m. to 6:30 p.m. (Central).

Lotus and 1-2-3 are registered trademarks of Lotus Development Corporation. ©1991 Software Spectrum

Circle 286 on Inquiry Card.
Advanced Spreadsheets: Adding Up Your Options

Today's high-end spreadsheets reach far beyond the bounds of simple number-crunching. Printing and presentation features approach desktop-published quality. Impressive charting and graphing modules rival dedicated graphics packages. And sophisticated modeling features make designing complicated what-if scenarios a breeze. The best packages blend these capabilities with an intuitive interface.

Spreadsheets come in a wide variety of prices and capabilities. Before you buy, first carefully consider the kind of work you need your spreadsheet program to accomplish. That's the key to determining which features are most important.

You should first look for an efficient means of linking data sheets together. You can expect any high-end spreadsheet to support some type of linking facility. The most powerful mechanism for linking sheets together is a true three-dimensional design. Three-dimensional spreadsheets form a "cube" of data. While a conventional spreadsheet mimics a single ledger sheet, a 3-D sheet resembles a stack of sheets. You can specify ranges of data vertically and horizontally, as with a conventional spreadsheet, but you can also specify ranges across pages. You could, for instance, put a day's worth of sales totals on the first page of your spreadsheet and the next day's total on the second page until you have a full month's worth of data within a single structure. If each page has a daily sales total at cell D11, you can add all the D11 cells on each page by summing a range that spans from D11 of page 1 to D11 of page 30.

Linked spreadsheets do the same thing, but it takes a little more effort. In the daily sales model, you would have 30 separate spreadsheet files, one for each day's sales totals. Another spreadsheet would contain the totals. Instead of simply summing a range, you would have to include a file reference for each sheet (e.g., PAGEONE:D11+PAGETWO:D11... and so forth, where PAGEONE is the name of a single spreadsheet file and D11 is the cell containing the daily total).

If your spreadsheets contain fewer complex links, you won't need a true 3-D structure. However, if you have many related spreadsheets that follow a similar structure and require extensive summary data (such as the example given), a 3-D spreadsheet will be a big win. It not only saves time, it also keeps your data organized by putting related sheets in a single file. If you decide that linking by external reference is sufficient, check to see if you can link to a file on disk. Some linking spreadsheets insist that all file references be open. This can eat up a lot of memory if you have numerous external references in a single sheet. You must have all your referenced sheets loaded in memory to do any recalculations.

Flexible recalculation schemes can boost performance considerably. If your spreadsheet work can take advantage of minimal recalculation, definitely look for a product that supports this feature. With minimal recalculation enabled, a recalculation operation will affect only the cells directly changed. Without this feature, a recalculation command will recalculate every formula in your spreadsheet, even those that will remain unchanged. If you work with large spreadsheets and perform operations on small sections of them, you'll appreciate the efficiency of minimal recalculation.

With background calculation, you can continue working on your spreadsheets while recalculation proceeds in the background. This will usually degrade responsiveness, but it is still faster than waiting for a long recalculation to complete before resuming your work.

The latest spreadsheet programs include sophisticated solver capabilities. With a conventional spreadsheet, you plug in different data values to perform what-if scenarios. A solver feature takes this a step further. You can specify adjustable cells (such as the price you charge for an item) as well as cells that you cannot change (such as the number of items in your inventory). You can then designate a cell to maximize (such as profits), and the solver utility will deliver all the available solutions for the defined problem. A solver utility can save lots of time and effort if your applications require revenue projection, budget management, or extensive what-if modeling.—Stanford Diehl
Make Your Spreadsheets Fly!

Lightning 5.5 by DacEasy
"the best $29.95 you'll ever spend."
Computer Shopper - April 1991

Lightning is the disk caching program that reduces disk accesses to speed up your PC or double your money back!

Today's powerful spreadsheet programs are very disk intensive. They slow down even the most powerful PCs. Lightning is the perfect, yet inexpensive solution for speeding up your computer since it works with virtually all your hardware and software including large DOS hard drives and Windows, too. Plus if you use a laptop, Lightning will extend the life of your batteries by reducing energy-wasting disk activity!

Try it RISK-FREE and get a working demo of Lucid* 3-D
The easy spreadsheet that reads and writes Lotus files!

$29.95

DacEasy, Inc.
1-800-877-8088

Order Today Risk-Free!

When ordering, specify disk use. 30 day money-back guarantee with double refund if Lightning does not significantly reduce disk accesses. Lightning and Lucid 3-D are registered trademarks of PCGO. Windows is a trademark of Microsoft Corp. Copyright © 1991. DacEasy Inc. 17039 Preston Rd, Ste. 800 Dallas, TX 75252

Circle 39 on Inquiry Card (RESELLERS: 303).
A lot of things in this world are relative—beauty, comfort, ease, productivity—but speed is not one of them. Speed can be measured with terms like miles per hour, megabytes per second, nanoseconds per instruction, and so on—faster and faster until, eventually, physical limitations come into play.

For example, a microprocessor can operate at what seems to be an ever-increasing speed, from 12 MHz to 25 MHz to 33 MHz—onward and upward. But the fact is, the single electronic microprocessor has a limit in terms of speed and performance, and we are fast approaching it.

As users, we have insatiable appetites for speed and performance from our computers. Where will further speed improvements come from? Optics is one answer, bound only by the speed of light. But completely optical systems are expensive, and they are still largely on the drawing board.

A more affordable and more available solution lies in multiprocessing. If one processor isn’t fast enough, then use more than one. It sounds too simple, but using multiple processors can significantly increase throughput speed and, thus, performance. In “Multiprocessor Surf’s Up,” Bob Ryan discusses a variety of multiprocessing options.

However, multiprocessing isn’t as simple as it sounds. As you multiply the number of processors, you don’t just equally expand the number of potential problems—you also add new ones. Among them are connecting the processors, coordinating the processes, and maintaining consistency among the caches. In “Catch as Cache Can,” Steven J. Vaughan-Nichols looks at different methods of dealing with this critical issue in shared-memory multiprocessors.

Shared-memory multiprocessors are more popular than message-passing multiprocessors because they can use current sequential programming. However, the shared-memory aspect of their architecture also creates a performance bottleneck. In “Popular and Parallel,” Mike Robinson examines some of the research under way at various universities to create alternative shared-memory architectures.

Message-passing multiprocessors have no such bottleneck. They can achieve linear speed increases that are directly proportional to the number of processors used. So, why aren’t they more popular? Because you must program for parallel processing to realize such linear improvements.

In “Scaling Up: Get the Message?” Richard Marlon Stein explores both the good news and the bad news of the message-passing alternative. Alternatives seems to be the name of the game in operating systems as well. In fact, until recently, there were almost as many varieties of multiprocessing operating systems as there were multiprocessors. To combat the myriad problems caused by the proliferation of nonstandard operating systems, the Intel Multiprocessor Consortium has come out with a standard Unix for symmetric multiprocessing systems. In “Symmetry, Thy Name Is Unix,” Mark Nudelman describes Unix SVR4/MP and how it fits into the open-systems picture.

The trend toward speed and performance in computing mirrors the trend in our lives: Do it faster and faster, and do more of it—whatever it happens to be. We’re reaching the limit of the single microprocessor’s capability, but what about the human’s? Do similar limits apply?

The quantity-versus-quality dilemma has been largely ignored—or temporarily forgotten—in today’s competitive atmosphere. Balance and reason need a louder voice in corporate decisions. The bottom line isn’t always the most important consideration.

How fast is fast enough? Have you smelled any flowers lately?

—Jane Morrill Tazelaar
Senior Editor,
State of the Art
The Right Choice
Could Save You $25,000.

HTBasic from TransEra turns your PC into a computer automated test station at a fraction of the cost of hardware alternatives. A PC with HTBasic gives you the capabilities you require for complex test applications, while retaining compatibility to run and share data with standard PC software.

The savings don't end with the test station itself. With HTBasic, you can use industry-standard computers, printers, graphic output devices, and networking systems. You get the flexibility you need to lay out the test system you want.

HTBasic is a state-of-the-art language which gives you advanced test features not found in other BASIC packages.

Features such as data acquisition and IEEE-488/RS-232 instrument control syntax, COMPLEX arithmetic, matrix mathematics, complete HP-style graphics, a comprehensive on-line help facility, and many more, add up to increased productivity for all levels of users.

The right choice for your next engineering workstation is a PC with HTBasic. Call or write us today for more information.

TransEra
Engineering Excellence for 15 Years

3707 N. Canyon Road  Provo, UT 84604
(801) 224-6550  Fax (801) 224-0355

Circle 326 on Inquiry Card (RESELLERS: 327).
If Ben Franklin were alive today, he might sing a different tune, especially if he were producing Poor Richard's Almanac on a desktop machine. “Everything in moderation—except MIPS” would be more in keeping with the never-ending mania for more computing power.

In theory, there is nothing your current personal computer or workstation can do that couldn't be done on a 1981-era IBM PC or a circa-1977 Apple II. People wrote graphical user interfaces for the 8088, and I'm sure someone, somewhere, tried to do ray tracing with a 6502. The sticking point is practicality.

As applications become more complex, you need more horsepower to make them practical. As you gain more horsepower, you discover more applications for your computer. The driving force behind the quest for ever-faster personal computers is, thus, twofold: making practical applications faster and making complex applications practical.

For the past two decades, making faster personal computers has meant using faster and more powerful microprocessors. As the millennium approaches, however, limitations on how far you can push semiconductor technology will require us to rely more on architectural advances than on material advances to create more powerful computer systems.

From a commercial standpoint, multiprocessing architectures hold the most promise for delivering the most power at a reasonable price. They provide increased computing power by tying together current-generation microprocessors into systems that can harness their combined capabilities.

continued
**Computer Taxonomies**

Ask a dozen people to define multiprocessing, and you'll probably get a dozen different answers. Part of the confusion comes from the fact that while the term parallel architecture is commonly used to refer to any machine that employs multiple identical processing units connected in some fashion, parallel processing is often used quite specifically to describe situations where a process is split among multiple processors. Thus, multiprocessing can be a subset of parallel architectures and a superset of parallel processing!

To convey more precisely what the terms used to describe computer architectures mean, many researchers have come up with classification systems for computers. The most widespread classification scheme is Michael J. Flynn's stream classification, developed in the mid-1960s (see reference 1). Flynn classifies computer architectures on the basis of how many instruction streams and how many data streams they can handle at the same time. His scheme divides computers into four classes:

- **Single-instruction, single-data (SISD)** architectures handle one instruction stream and one data stream at a time. This describes the classic von Neumann architecture.
- **Single-instruction, multiple-data (SIMD) computers**, such as array processors, can have a single instruction stream act upon many data streams at the same time. Because many processes don't lend themselves to having many pieces of data that require simultaneous, identical processing, array processors are useful for specialized processing only.
- **Multiple-instruction, single-data (MISD) architectures** theoretically have many instruction streams operating on one data stream at the same time. No one has yet implemented such an architecture, mainly because no one can see a practical use for it.
- **Multiple-instruction, multiple-data (MIMD) computers** have multiple instruction streams acting upon multiple data streams. There can be various types of interaction between the different instruction and data streams.

Although Flynn's classification remains in use, it has proven ineffective in differentiating among many of the new architectures developed in the past 25 years. Numerous alternatives have been proposed.

In 1988, David B. Skillicorn, of Queen's University at Kingston, Ontario, came up with a classification system based on the number of instruction and data processors in a system, the relationships among them, the memory model for both instructions and data, and the way multiple data processors interacted (see reference 2). He derived 28 computer architectures that can handle everything from computers without instruction processors (data-flow architectures) to those with multiple instruction and data processors. Skillicorn based his classifications on abstract architectures, making them more useful to researchers than to laypersons.

In 1990, Ralph Duncan, of Control Data, introduced a hierarchical taxonomy for parallel architectures to help show the relationships among them (see reference 3). He kept some of Flynn's system while also addressing those architectures that didn't fit into it.

Duncan also shed some light on the intrinsic characteristics of parallel computers. He excluded low-level parallel mechanisms (e.g., instruction pipelining, multiple functional units in CPUs, and separate CPU and I/O processors)
because these items have become so commonplace that they negate the usefulness of the term *parallel architecture*.

Duncan's taxonomy (see figure 1) employs three primary classifications: synchronous, MIMD, and MIMD-based paradigms. Synchronous parallel architectures, as the name implies, perform parallel functions in lockstep. MIMD computers employ multiple asynchronous processors. That's not to say that the processors don't work together, but that any cooperation among them is the result of software. MIMD-based paradigms share the multiple, asynchronous aspects of MIMD architectures, but each adds a unique organizing principle.

Most commercial parallel machines come from the MIMD group. This is the group commonly referred to as multiprocessors.

**Characteristics of Multiprocessors**

Multiprocessors are computers with multiple processors that can each operate on its own data. The processors operate independently of one another, normally on autonomous tasks or significant portions of large tasks. Therefore, they are usually described as providing coarse-grained or medium-grained parallelism.

Unlike the exotic processors used in some parallel machines (e.g., 1-bit processors in the Connection Machine), the processors in multiprocessors are usually off-the-shelf components, such as 386s, 68030s, i860s, or Inmos transputers.

Multiprocessing systems come in two flavors: shared-memory systems and distributed-memory systems. The mechanisms used to synchronize the functions of their component processors distinguish one system from the other.

**Shared-Memory Systems**

The processors in a shared-memory system communicate by reading from and writing to memory locations in a common-address space. Shared memory also usually implies a shared bus. This isn't necessarily the case, however. You can also connect processors to shared memory using crossbar interconnections and multistage interconnection networks (see figure 2). Some other options are being explored in research labs (see "Popular and Parallel" on page 219). But a shared bus is the simplest and, therefore, the most widespread solution.

The problems of having many processors share a single bus are twofold. The first is the problem of bus saturation. With many processors using the same bus, there is always the chance that one

---

**Figure 2:** The simplest way to connect shared-memory processors is with a bus (a). These systems usually require a complex caching scheme to reduce bus contention. A crossbar arrangement uses switches to let multiple processors access multiple memory segments (b), thus allowing more than one processor to access memory in different segments without contention. Having two processors accessing memory in the same segment still causes contention. A multistage interconnection network (MIN) connects multiple processors to multiple memory segments using different levels of switches. In (c), processor P2 accesses memory segment M3 using address 11. The first stage switches using the most significant bit of the address; the second stage uses the least significant bit. MINS scale more easily than crossbars; connecting N processors (where N is a power of 2) to N memory segments requires log2N stages, each of which contains N/2 switches.
MULTIPROCESSOR SURF'S UP

processor will have control of the bus when another one needs to access memory. This problem is usually addressed by giving each processor a sizable local memory cache that it can access in place of the shared memory. Caches do not eliminate contention for the bus, but they do make it possible for two or three dozen processors to share memory.

The second major problem with shared-memory systems is data consistency. With many processors having access to the same data, you can wind up with different values for the same variable in every cache in the system (see “Catch as Cache Can” on page 209). There are many schemes available to ensure the consistency of data—bus snooping, different caching systems, and so on—but all of these add to the cost and complexity of the system.

Because issues like bus contention and cache coherency are normally invisible to programmers, shared-memory multiprocessors are the easiest parallel computers to program. In fact, with coarse-grained systems, where the simplest executing unit is a complete process, you can often run programs written for a uniprocessor system on a multiprocessor. (The granularity of a system describes the relative time that a processor spends communicating as opposed to computing. Processors in fine-grained systems spend much more time communicating than do those in coarse-grained systems, which spend more time computing.)

For example, the MPX extensions for SCO Unix let you run unaltered Unix processes on a multiprocessor system (see “A Fearful Symmetry,” May 1990 BYTE). The additional structures needed to schedule the multiple processors and handle external devices are contained in the MPX-modified kernel. Instead of running multiple processes on a single processor, MPX lets you run multiple processes on multiple processors.

Other Unix variants also support coarse-grained multiprocessing. For example, the Mach operating system and Open Software Foundation’s OSF/1 have built-in support for multiprocessing, and many vendors are offering multiprocessing extensions to Unix System V release 4, called SVR4. (See “Symmetry, Thy Name Is Unix” on page 243.)

Distributed-Memory Systems

Distributed-memory multiprocessors have many advantages over shared-memory systems. Because they don't share a common-address space, they don't have consistency or contention problems. They are also far more easily scalable than shared-memory machines.

Scalability describes how additional processors affect overall system performance. A linear scalable system is the ideal: Add 25 percent more processors, and you get 25 percent more performance.

Shared-memory systems are scalable when you add small numbers of processors. Go much beyond 10 or 20 processors, however, and you begin to see the performance/processor ratio drop off as the bus becomes saturated.

With no bus to worry about, distributed-memory systems can theoretically be scaled to include hundreds, and even thousands, of processors. Software that can take advantage of the extra processors will also see a linear increase in performance (see “Scaling Up: Get the Message?” on page 231).

Because they don't access the same address space, the processors in a distributed-memory system use messages to coordinate their activities. Each processor has its own memory space and interconnected with one or more of the other processors in the system.

A processor, its memory, and its interconnects are normally referred to as a node on the system. Because of the use of messages to synchronize the activity of the processors, distributed-memory systems are sometimes referred to as message-passing multiprocessors. And because each node is a complete computer in its own right (that is, it has a processor and memory), these systems are also called multicomputers.

Distributed-Memory Interconnects

How you connect processors in a distributed-memory system has an enormous effect on its performance. The interconnection strategy is paramount because it determines the average latency of any message transmitted on the system.

The ideal interconnection strategy would be to connect every processor in the system to every other processor. No message would ever have to pass through an intermediate node before reaching its destination. Although optical interconnects may one day make this practical, the difficulty of engineering and scaling such a system precludes universal interconnections for all but the smallest distributed-memory systems.

Many interconnection strategies exist for the processors in distributed-memory systems. These include rings; binary trees; and two-dimensional arrays of processors, where every processor is connected to all its neighbors. The problem with many of these strategies is that the
Take Our Course In C And The First Lesson You'll Learn Is In Economics.

C's power and portability make it the language of choice for software developers. Unfortunately, learning C can be a very costly proposition. Classroom instruction is, in a word, expensive. And many C video courses carry hefty price tags.

The top C video course at the lowest possible price
But now, there's The Complete C Video Course from Zortech. It's the ultimate C training tool for home or work. And all it costs is $295.

Learn C in as little as two weeks
Speaking of speedy, with The Complete C Video Course you can learn C in only two weeks. Compare that with the up to four months it can take to learn C in class. Each lesson averages 17 minutes of clear, concise instructions. Used in conjunction with our workbook you'll find they provide everything you need to know to become proficient in programming in C.

Save your company thousands
If you think The Complete C Video Course is a great way for you to save money learning C, think about how much it could save your company. Use it instead of sending programmers to school and you'll save thousands. What's more, The Complete C Video Course is even tax deductible.

Free C compiler included
Yes, that's right. The Complete C Video Course includes our famous C compiler (it runs on any MS-DOS machine) with linker, library manager, full graphics library and on-line help. It's the choice of professional programmers everywhere for fast code, fast development and fast debugging.

Look at all these C video pluses
- Only $295 complete.
- Ten videos with 36 lessons.
- Comprehensive 365-page workbook.
- Free C compiler with linker, library manager, full graphics library and on-line help.
- Compiler and hardware independent.
- Designed to help you learn C in as little as two weeks.
- Tax deductible.

Zortech Inc.
4-C Gill Street
Woburn, MA 01801
Voice: 617-937-0696
Fax: 617-937-0793

★ Yes, rush me The Complete C Video Course including free C compiler for $295.00 (VHS only)
★ Please include (No.) extra workbooks at $29.95 each.
★ I'd like to order (No.) extra C compilers with this course at the special price of $49.95.

Name/Company
Address
City
State
Zip
Phone

Here's my check for

VISA/MC#

Exp. Date

Prices do not include shipping.

The Complete C Video Course $295
Order Hotline (800)848-8408
Circle 385 on Inquiry Card.
MULTIPROCESSOR SURF'S UP

**THREE-DIMENSIONAL HYPERCUBE**

![Three-dimensional hypercube diagram](image)

**Figure 3:** A three-dimensional hypercube has the logical structure of a cube, with each node containing a processor, local memory, and connections to three other nodes (see inset). The edges of the cube represent the interconnections. The longest transmission path between any two processors—the communications diameter—need involve only three processors (excluding the sender but including the receiver).

The number of nodes a message must travel through on average before reaching its destination increases dramatically as you add processors.

The hypercube is currently the best answer to the problem of scaling up the number of processors in a distributed-memory system without unduly increasing the average message latency. Hypercube topology was first demonstrated in the California Institute of Technology's Cosmic Cube. A 2-D hypercube consists of four processors, two 3-D hypercubes have 8 processors, and a 4-D hypercube consists of eight processors. Known as the C-bus, this architecture forms the basis of multiprocessors, Unix machines, DEC and ALR.

For example, Corollary (Irvine, CA), the developer of MPX for SCO Unix, has also developed a bus and cache architecture for linking multiple 386 and 486 processors. Known as the C-bus, this architecture forms the basis of multiprocessors, Unix machines for companies such as DEC and ALR.

**Commercial Multiprocessors**

Developing software for multiprocessing systems is the main obstacle to their general acceptance. Today, with more and more businesses demanding open systems, the only new architectures that can succeed are those that can run portable software, and only certain shared-memory machines using one of the Unix multiprocessor extensions fit this bill.

For example, Corollary (Irvine, CA), the developer of MPX for SCO Unix, has also developed a bus and cache architecture for linking multiple 386 and 486 processors. Known as the C-bus, this architecture forms the basis of multiprocessors, Unix machines for companies such as DEC and ALR.

Such systems provide the coarsest granularity. The unit of parallelism in such systems is the process. With each process being essentially autonomous, the only significant shared data in a coarse-grained system is in the operating-system kernel, particularly in the process-scheduling mechanism. Thus, only the kernel must be modified to have the system run multiple processes.

System-speed increases come not from decreasing the time it takes to execute individual processes but from decreasing the time it takes to execute all the processes. This is a significant improvement, but not as significant as the speed increases you can achieve if you split a process into multiple, independently executable parts.

The reason current commercial multiprocessors don't go this extra step is that there is not a significant commercial software market to support such systems. So, while shared-memory systems are viable today, distributed-memory systems, which are best-suited to medium- and fine-grained parallelism, remain confined primarily to research labs and college campuses.

**Where's the Software?**

Why is developing parallel programs so hard? John Allen and Ken Kennedy of Rice University may have put their collective finger on the problem when they wrote in 1985 (see reference 4): "Because humans tend to think sequentially rather than concurrently, program development is most naturally done in a sequential language such as FORTRAN. While the resulting programs are usually very efficient on a scalar machine, they are often incapable of directly making effective use of parallel processors."

Developing commercial-quality software for nonparallel computers is a difficult intellectual enterprise. Developing parallel software engenders all the problems of traditional programming and adds quite a few more, all without the benefit of the variety of aids and tools available to traditional programmers. Parallel programmers must handle synchronization among parts of a program, map processing units to processors, and do other architectural details that are transparent to traditional programmers.

The most efficient way to do this is with parallel programming languages...
There's more to comparing LaserJet printer sharing options than just the name

<table>
<thead>
<tr>
<th>Pacific Data Products Pacific Connect™</th>
<th>Hewlett-Packard HP ShareSpool®</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price</strong></td>
<td>$399</td>
</tr>
<tr>
<td>Upgradeable memory buffer</td>
<td>Yes</td>
</tr>
<tr>
<td>Cables and adapters included*</td>
<td>Yes</td>
</tr>
<tr>
<td>Centronics interface</td>
<td>Yes</td>
</tr>
<tr>
<td>Warranty</td>
<td>Lifetime</td>
</tr>
</tbody>
</table>

Don't settle for less just to buy the HP name. For LaserJet printer sharing devices that offer you more features for less cost, choose Pacific Connect from Pacific Data Products. It's the low cost way to give up to five PC or four Macintosh users access to a LaserJet Series II, IID, III or IID printer. Completely transparent to users, Pacific Connect is easy to install and use. It even comes with four cables and five adapters. And to handle large print files or to spool documents sent simultaneously to the printer, its memory buffer is upgradeable from 256k to 1.25 MB.

To learn how you can get more for less, call your nearest dealer or contact Pacific Data Products, 9125 Rehco Road, San Diego, CA 92121, (619) 597-4609, Fax (619) 552-0889.
that resemble assembly languages in their degree of architecture dependence (e.g., Occam). Architecture-independent solutions, such as Strand88 and Linda, are far easier to program, but you pay a price—sometimes a significant one—in performance because of the control you give up.

Unlike von Neumann architectures, parallel architectures differ so radically that it is difficult to come up with one programming paradigm that works well with all of them. So, while Strand88 and Linda make parallel programming far more accessible to traditional programmers, it is not yet clear whether either can provide the basis for a commercial market in portable, parallel software.

Parallel Markets
What is the future of multiprocessing systems for business users? Ted Lewis is director of the Oregon Advanced Computing Institute, a consortium of schools and companies dedicated to advancing parallel-processing technologies. Lewis sees the commercial market for parallel computers developing in three stages.

In the first stage, from the present to 1995, Lewis believes shared-memory multiprocessing systems will be the first parallel architecture to gain general acceptance in the commercial arena. Such systems excel at transaction processing, and Lewis expects to see them used in applications like automated-teller machines and database servers. He also notes that successful systems will use multiprocessor versions of Unix and run standard Unix applications.

According to Lewis, successful designs won’t necessarily be the most powerful. “Interoperability, not MIPS, is the issue,” he says. Systems that can’t run standard software and provide a platform where DOS, OS/2, and Macintosh computers can work together won’t make the grade.

By about 1998, Lewis expects another parallel technology to have a significant commercial impact. Compilers for data-parallel technologies will enable a commercial software market for machines like those being offered by MASPAR and Thinking Machines.

In about 10 years, Lewis thinks that a viable commercial software market will ultimately exist for what he calls “true parallel processing.”; that is, running a single application across multiple processors in a multiprocessing system.

Parallel technologies have long been touted as the future of computing. With Unix-based, shared-memory multiprocessors, the technology will finally start to deliver solutions outside of universities and research labs. And if Ted Lewis is right, it is only the first wave in the flood tide of parallel processing.

REFERENCES

Bob Ryan is technical editor of BYTE’s State of the Art section. You can contact him on BIX as “b.ryan.”
Introducing software testing the easy way!

Why every developer needs Ghost — the exciting new tool for testing DOS software automatically!

If you want to get the bugs out of your software and keep them out, Ghost is just what you’re looking for! It’s a breakthrough product that finally makes it practical for developers and testers like you to do extensive, repetitive regression testing throughout the entire development cycle — all automatically!

That’s right. At last there’s an easy way to end the testing nightmare that’s been driving you crazy. No matter what language you program in, Ghost can help you deliver high-quality, reliable software without the hassle. We guarantee it!

Ghost makes exact recordings of your software test sequences and screen displays, so you can rerun them and compare the results automatically whenever needed. Ghost will:
- Document program errors automatically.
- Make testing grow more complete over time.
- Shorten the critical integration and testing phase of development.
- Lessen the chance of that “last-minute fatal bug.”
- Make regression testing for new releases a practical reality.

Meet Ghost Jr.
Ghost Jr. is a limited-capability version of Ghost that provides full keyboard and screen recording, but has no playback capability. This low-priced version makes it practical to give copies to everyone who tests your product — even end users. All the problems they encounter will be documented by Ghost scripts. Think of how this will speed up your debugging and testing cycles!

The price is right and you don’t risk a thing!
Ghost costs just $195 and comes with a 90-day money-back guarantee. Ghost Jr. costs just $79 and steep quantity discounts are available. Don’t miss this chance to end the tedium of software testing. Pick up the phone and order right now!

Ghost at a glance.
Ghost provides you with a way of making exact recordings of your software test sequences and screen displays in a machine readable form.
- You can then re-execute any set of tests at high speed without the manual labor that’s normally required.
- You can interactively view all the differences found in the screen displays between the two runs, or have them printed out in a handy report.
- Requires no program changes or special hardware!
- Uses only 16K of memory!

MONEY-BACK GUARANTEE
If you’re dissatisfied with Ghost or Ghost Jr. for any reason, return them within 90 days of purchase for a prompt, friendly, no-questions-asked refund.

TO ORDER or for more information, call toll-free: (800) 848-1248
International: (802) 848-7731
Fax: (802) 848-3502
Vermont Creative Software, Pinnacle Meadows
Richford, VT 05476 U.S.A.
Please mention Offer 137.

Ghost. So good at getting rid of the bugs, it’s scary.

Circle 349 on Inquiry Card.
Developers:
Lock Up Your Profits

We have the key for protecting your software profits and your copyright.

Software piracy's a crime! What it can do to a developer's profit margin is shameful. The cost of development and marketing products demands you receive the revenue you are entitled to. We have the solution.

- Custom hardware and software for each developer
- Encrypted interrogation routines and debug disablers. Over 140 language interfaces available.
- Available active read/write memory and on-board microprocessor provide the ultimate protection
  - Keys for PC "compatibles," Macintosh, UNIX and RS-232C standard
  - Total compatibility, reliability and end user satisfaction

We have the key. Call us for more information or a demonstration package.

1-800-843-0413


For Distributors In:
- BELGIUM, E2S (091 21 11 17)
- GERMANY, AUSTRIA: MicroPhar GmbH (06223 - 73730)
- HUNGARY, Polyware Kft, (76-22-307)
- ITALY, Stolsternl (030 24 21 074)
- PORTUGAL, ECR (1 56 18 65)
- SPAIN, Hal 2000 (032 37 31 09)
- SWITZERLAND, SAFE (024 21 53 85)
- THE NETHERLANDS, E2S (015 15 88 37)
- UNITED KINGDOM, Clearsoft (091 378 91 91)

See us at Booth #3757
Single-CPU microcomputers are approaching their limits. So far, they have grown from circuit-board toys to desktop workhorses to network nodes. In doing so, microcomputers have retraced the steps of minicomputers and mainframes.

The next step in this evolution is to move to multiple-CPU microcomputers, or multiprocessor systems. The makers of such new systems as the Compaq Systempro and the NetFrame NF-400 must contend with difficulties unlike any encountered before in microcomputers.

Chief among these problems is cache coherency in multiprocessor systems. In particular, the bottleneck created by using shared-memory caches in multiprocessor architectures has yet to be cleared to everyone's satisfaction on any platform.

Why Use Caching?
If all parts of a computer system operated at the same speed, caching wouldn't be necessary. However, processors, as they zoom past 25 MHz, demand data faster than even the speediest disk I/O, bus, or memory can provide. The slowest parts of a system shackle its performance.

Caches grant freedom from the shackles of slow I/O. In the simplest terms, a cache is memory that is dedicated to storing the data and instructions that the CPU may require at a moment's notice.

You can place caches at several different locations within a system's architecture. Software implementations such as Microsoft's Smartdrive typically reserve a section of main memory. While this memory normally isn't fast enough for optimal CPU use, it is much quicker than
directly accessing mass-storage devices like floppy and hard disk drives. Even the least efficient caching software can improve effective disk-access rates by an order of magnitude.

Hardware schemes typically call for dedicated high-speed cache memory banks. This type of cache is normally made up of expensive static RAM chips. The memory banks can be located on the motherboard, the disk drive controller (hence, caching controllers like Western Digital’s WD1007A), or the CPU itself. The i486 and 68040 microprocessors, for instance, both have tiny on-board caches.

No matter where the cache is located, the principles behind it are the same. The nature of most programs and data manipulation is that the same information or code will be needed again and again. Once you load this information into a cache from a slower storage or transmission medium, you can access it far more efficiently. In addition, it’s often a good idea to load related information into the cache, called read-ahead caching, to anticipate process requirements.

Uniprocessor Caching
In a uniprocessor system, the cache is relatively easy to implement. Years of mainframe and minicomputer experience have blazed the trails that microcomputers now tread. However, due to certain problems, building the perfect cache becomes a Herculean task.

The first of these problems is that every cache eventually fills with data. When this occurs, you must kick some data out of the cache. It’s not easy to decide what information to throw out. The most common solution is to use a least recently used algorithm to decide which data to exile. However, this is far from a perfect method.

More polished caching software and firmware use a least frequently used algorithm. At the price of memory and processing overhead, these schemes ensure that frequently accessed data will stay in the cache even if it hasn’t been called on recently.

Another issue that every cache must contend with is how to handle data writing. Cache designers do not agree on the best way to perform this task. Most caches will check, using a variety of algorithms, to see if the write request will force the cache to overwrite identical data that has already been written to disk. Other caching plans try to optimize the data-writing process. This minimizes the mechanical—and therefore most time-consuming—element of writing data to disk.

Write-through designs have the advantage of ensuring that the cache writes data to disk as soon as possible. This reduces the probability of data corruption in the event of a power outage. Unfortunately, write-through caches are not the most processor-efficient means of handling data writes. By preempting clock cycles and occupying bus bandwidth at times when they’re needed for ongoing processes, write-through caches slow down the system.

The alternative deferred writes delay disk writes until the system is free from other activities. While a favorite method in mainframe and minicomputer environments, where uninterruptible power supplies are de rigueur, data-integrity concerns limit the appeal of this approach in microcomputer environments.

Another problem is how to determine the optimal cache size for a system. No master key or algorithm exists to solve this one. Contrary to popular belief, bigger is not always better. As cache size increases, at first cache misses decrease, but not in a linear fashion. And eventually, cache misses increase. The ratio of misses to hits shrinks until it reaches the data-pollution point. When this occurs—determined by the size of the cache and its component memory blocks—misses begin to increase.

Using smaller memory blocks delays the arrival of data pollution in larger memory caches. Memory costs become the limiting factor long before you reach the data-pollution point.

Multiprocessor Caching
Now, take all the caching problems for a uniprocessor system and transplant them into a multiprocessor environment. They multiply dramatically. Multiprocessor systems must cope with the woes of caching in general and with three other issues as well: memory, communications, and bandwidth contention.

Multiple processor requests to the shared-memory cache cause memory contention. These data requests create communications contention and can interfere with each other’s access to data even if the requests are not aimed at the same area of memory.

Bandwidth contention occurs whether the processors are located on a network or on a common bus. The larger a multiprocessor system becomes, the more time it requires to carry out data communications. Together, these three factors can interfere with effective multiprocessing.

This troublesome trio would exist even without caching, but with it, the problem becomes how to implement caching to maximize processor I/O efficiency and minimize contention. One popular method of attacking this problem is to furnish every system processor with its own cache. Private caches avoid most memory-contention problems. However, they increase communications and bandwidth contention.

Another way to use caching in a multiprocessor environment is to let the processors share common caches. The advantage of this approach is that applications that can make good use of shared data and code will need less memory and will execute more efficiently.

---

Cache coherency is critical in shared-memory multiprocessor systems. Without it, if two or more people are working in the same area at the same time, changes made by one person can be overwritten by others and lost. A variety of options is possible to handle this potential problem—none of them perfect. But finding a solution you can live with is essential to the success of such a system.
Are you playing board games?

Choosing a board is serious business. The quality of the motherboard will determine the performance and reliability of your machine, and the success of your company.

That is why more OEMs and Integrators are using American Megatrends, Inc. for their motherboard needs. Already the industry leader in 386 and 486 BIOS, AMI has now established the standard for EISA and ISA boards.

**EISA TECHNOLOGY**
AMI has the expertise to provide you with premium 486 EISA boards. These 33 MHz systems can support up to 96 meg of memory and up to 256K of CPU cache. Used along with the optional SCSI Host Adapter, it creates a terrific high performance network server or UNIX hub.

**ISA SOLUTIONS**
If EISA is not required, the AMI 486 ISA boards are the answer. Operating at 33 MHz and possessing the fastest video speeds in the industry, they provide the perfect platform for graphic intensive applications.

**THE AMI DIFFERENCE**
Unlike any other motherboard, AMI boards provide total BIOS compatibility; this ensures the highest levels of performance and reliability. Call today and see how the team at AMI will put you ahead of the game.

Circle 21 on Inquiry Card (RESELLERS: 22).

American Megatrends, Inc.
800-U-BUY-AMI or 800-928-9264, 404-263-8181, fax 404-263-9381
See us at Comdex, booth #1930, East Hall

---

AMI
Single Source Technology

---

American Megatrends, Inc.
800-U-BUY-AMI or 800-928-9264, 404-263-8181, fax 404-263-9381
See us at Comdex, booth #1930, East Hall
Cache Coherence

Unfortunately, even shared caches contain multiple local copies of memory locations and, possibly, of the data in those locations. Any time that the system modifies the local location of data—which it will do constantly with data flow—it must update the system view of the cache data.

If you don't have a consistent global view of cached data, data corruption and a system crash are not far away. The crux of the cache-coherence problem lies in trying to maintain a single, coherent version of cached information without imposing unnecessary system overhead.

The cache-coherence problem doesn't apply to some uses of cached information. For example, read-only data causes no problem. However, public read/write structures (e.g., the disk directory) must be maintained properly. Even private writable structures aren't safe from cache-coherence woes if the system allows applications to move from one processor to another.

Both private caches and shared-memory caches must contend with cache-coherence issues. The difference is that in shared-memory caches, process communications can address cache coherency within memory, while the private caches must ensure coherency over a network or bus. Thus, private caching actually incurs a greater overhead because of bandwidth and communications contention.

Cache-coherence problems have no easy answers. Despite a long history of dealing with these issues in parallel-processing and multiprocessor systems, no panacea has been discovered. The roads now taken by microcomputer vendors are rocky and ill-mapped.

Bus Cache Coherence

The most popular real-world solution to the problem is to use the bus as the basis for cache-coherence maintenance plans. Buses lend themselves to this use because all the system processors can be attached to a single bus. You can then instruct the processors or dedicated cache controllers to look at all memory-bus transactions.

When a change that affects an element in the local data image is recorded over the bus, the system can either invalidate or update the image. This is the general theory behind snoopy protocols, which constantly monitor bus transactions (hence the name).

More precisely, each cache looks for cache-consistency commands in the data stream. When it finds them, the cache controller must process the command to decide if it applies to its own cache.

The disadvantage to the bus approach is that any bus has a limited bandwidth. The more often cache programs "snoop" on the bus, the less room the bus has left for other transactions, which can cause a traffic jam on the bus. Bus caching actually eats up bandwidth. This shuttling process, which can cause a traffic jam on the bus or network, is called the ping-pong effect.

Fixing the Bus

Increasing the size of the cache or memory block won't tame the ping-pong effect. Simulations have demonstrated that neither measure works satisfactorily in a multiprocessor system.

One way of cutting down on the ping-pong effect is to expand the bus's bandwidth. By adding lanes, in effect, to the

When any copy of a data block changes, the system updates every cached copy. The memory copy may or may not be updated, depending on the implementation.

While this approach keeps the bus hopping as it shuttles data hither and yon, it cuts down on data misses. Another concern is that the cache processor can waste time updating copies of data blocks that it won't need again.

A write-invalidate system (when I change disk to tape) invalidates any other existing copies of the data block, including the one in main memory. As I'm the user who made the latest change to this block, my copy has now become the "real" document.

If I make another change (if I decide that I like holographic storage better, my copy of the document is still the real one as far as the system is concerned. If Frank, down the hall, opens the document and starts to edit it, the protocol validates and updates his copy from my cached version of the document.

While elementary to put into practice, this approach is fraught with problems. For instance, if Frank and I are both working on a document at the same time, my changes invalidate his copy, and his changes invalidate mine. Both caches start registering misses because neither copy can be updated until it has been revalidated from the other. These validation misses put a heavier load on the bus.

Whoever made the latest change to the document has the one true copy, but determining who this is puts a large load on bandwidth and communications. As acknowledgments of missed reads and validations begin to clog up the free flow of data communications, the shuttling back and forth of data blocks between caches eats up bandwidth. This shuttling process, which can cause a traffic jam on the bus or network, is called the ping-pong effect.

Figure 1: In a full-map directory, every cached block has a record and a pointer in the cache controller. The record includes status flags that indicate whether you can write to the block and whether it is a valid block. The costs for a centralized cache directory are primarily memory overhead, more controller processing demands, and communications bottlenecking.
data highway, traffic jams are less likely to take place. This amounts to the traditional solution of bulldozing a problem with more capacity. However, some bus designs inherently help cache coherency by providing dedicated bus lines to support cache-consistency commands.

The most noteworthy of the dedicated-bus designs is the venerable Futurebus, the IEEE-proposed standard-896-32-bit bus. This bus has built-in cache-coherency support for multiprocessor write-back caches. Unfortunately, Futurebus and its successor, Futurebus Plus, are more theoretical models than working realities.

In Theory
Despite the growing numbers of multiprocessor systems, surprisingly little experimental work has been done on testing new answers to cache-coherence questions. For all the troubles that are attached to snoopy caching, considerable effort is still being devoted to improving these protocols.

There have been attempts to give the write-invalidation model new life with a protocol named read-broadcast. In this protocol, the system updates all appropriate copies of a record when the first read-miss occurs. This avoids multiple read-miss traffic while (mostly) avoiding the write-update bandwidth problem.

Beyond the Bus
Broader answers exist as well that can be used on a bus and in other architectures. Such solutions can handle situations that bus-based methods can't. For example, scalable multiprocessor systems, while possessing greater potential bandwidth than bus-based systems, can't easily support snooping methods.

One area that has been studied a lot lately is the use of cache directories. While only useful in bus-based systems, directories are essential to maintaining cache coherency in other architectures.

A cache directory, which may be either centralized or distributed, maps every cached data block's location. Each directory record holds a flag bit and pointers to the location of every copy of a data block.

The flag bit, usually called the dirty bit, indicates whether a particular cache can write to the data block that the directory entry points to. Other informational flags may also be set, depending on the directory design.

Many different directory plans exist. From a structural point of view, you can divide them into three types: full map, limited, and linked list. These three types have one element in common. Usually, control structures are in place to ensure that only a single cache can write to a data block at one time. In this case, the writing cache is said to have ownership of the data block. Each directory type provides a way of transmitting a data-change notification through main memory and the caches. Other than this, the different directory plans go their own separate ways.

Full-Map Directory
Full-map directories have the singular advantage of being able to store information on every block in memory. This style of directory has pointers equal in number to the number of processors on the system (see figure 1) plus two status bits and the dirty bit.

The bits that correspond to a processor indicate whether a particular block is present in that processor's cache. The status bits, which are duplicated in the cache, show whether the block can be written to and whether it is a valid block.

The dirty bit indicates whether a particular cache can write to the block.

Full-map directories have several problems. Because the directory is centralized, it is prone to conflict between competing processors and could become a performance bottleneck. Another concern is that searching and updating the directory could put an undue burden on caching performance. Although optimizing mechanisms could address both problems, they would also add complexity. In addition, full-map directories impose considerable memory overhead.

Limited Directory
Limited directories avoid the memory troubles of full-map protocols. By requiring that only a limited number of pointers be maintained, they keep memory overhead within bounds. Otherwise, the structure resembles that of a full-map directory. When the number of copies of a particular memory block exceeds the number of pointers assigned to track them, the newest pointer replaces an earlier one in a process called eviction (see figure 2).

How can a limited directory preserve cache coherency? Its defenders have a twofold answer that is not completely satisfactory.

The first part of the answer says that, statistically, a limited directory is sufficient because rarely will more processors need a particular data block at once than it can handle. This part of the answer ignores data blocks containing primary storage-directory information. They may very well be simultaneously in use on multiple caches.

You wonder what would happen, for example, on a multiprocessor Unix system using a limited directory if, on the approach of a thunderstorm, all the users ran sync at once. The sync command flushes all previously unwritten buffers to disk, including the latest copy of the data block containing the system's master directory. Hopefully, the multiprocessor extensions to the operating system would handle the resulting mess.

In addition to this worst-case scenario, there are other concerns. Thrashing seems to be a distinct possibility if the number of pointers is smaller than the number of processors referencing a
limited set of data blocks.

The second part of the answer says that limited directories can fall back to a write-invalidate broadcast protocol. That is fine as far as bus-based systems are concerned, but what about systems that are built around scalable point-to-point interconnection networks? In these systems, it is almost impossible to ensure that the broadcast will reach every applicable cache.

In short, while limited directories may serve a role in certain special-purpose architectures, it seems unlikely that they will gain widespread use. Their only real advantage is that the rate of memory overhead grows linearly with the number of system processors. This reason is insufficient to outweigh either the disadvantages of a centralized system or the directory’s limited usefulness in non-bus-based systems.

**Linked-List Directory**

The promise of linked lists shines more brightly than that of any other method. Thus, several research groups are pursuing this route. Among them are DEC, in conjunction with Stanford University, and the IEEE Scalable Coherent Interface (SCI) standard project.

There are two approaches to implementing linked-list, or chained, directories: single-linked and doubly-linked. In these methods, the directory comprises linked lists of pointers to shared-memory blocks.

In a single-linked chain, whenever the system places a copy of a data block in a cache, it sets a pointer to the new block in a directory in main memory or the cache controller. The system also sets a flag, called the chain-termination pointer (CT), in the first data-block copy.

When the system needs another copy of the block, it makes the copy from main memory with a pointer to the prior copy made. For instance, with three cached copies of one memory location, the first copy would include the CT, the second copy would have a pointer to copy 1, the third copy would have a pointer to copy 2, and the directory would have a pointer to copy 3 (see figure 3).

There are variations on this theme. In the SCI coherence protocol (a double-linked system), when a processor calls for a data block, it doesn’t receive a copy from main memory. Instead, it receives a pointer to the most recently changed or most recently added cache copy. The requesting cache then asks for the data block from the cache owning the freshest version of the data. This cache replies by setting a pointer to the requesting cache and transmitting the data block. When multiple data-block requests are received, they are handled in first-in/first-out order.

In the single-linked model, when a change is to be made to a data block, the system sends a data-invalidation message down the list until the CT is reset. This indicator informs the system that a particular memory block has been changed and invalidates all previously cached versions of the block. During this process, the system locks every block in the chain to prevent competing changes.

The double-linked version adds another pointer to the directory and each cached-memory location. The additional pointer lets the system send invalidation messages up and down the chain. The result is faster, more flexible adjustments to changes in the caches.

Nothing is free, of course. In the linked-list directory, the block size is larger, and maintaining cache coherency is more complicated. Preliminary theoretical studies show that a double-linked system is only marginally better than a single-linked system.

The efficiency of the linked-list method comes close to that of a well-implemented full-map directory without the headaches. At this early stage in its development, no firm disadvantages to this method have surfaced. However, this scheme is more complex to put into place than other methods. Further work is needed before linked-list implementations live up to their potential.

**Return of the Bus**

It’s true that methods using a bus as the foundation for a shared-memory cache-coherency scheme eventually run into difficulties with bandwidth and communications contention. There is, after all, only so much room on a bus. However, this doesn’t mean that you have to abandon the simplicity of bus designs.

Perhaps the most interesting exploration of this area is the proposed Wisconsin Multicube multiprocessor. In this computer, every processor would sit at the intersection of a two-dimensional array of vertical and horizontal buses. Every vertical bus would have a memory module attached to it. Each processor would come equipped with a snoopy cache controller and a large cache. Fully ramped up, this computer would have 1024 processors. (For more information on the Wisconsin Multicube, see “Popular and Parallel” on page 219.)

**Software Solutions?**

Up until now, every answer to multiprocessor cache coherency has appeared in hardware. However, that does not mean that you cannot deal with the issues in software. It’s just a great deal more difficult.

Some researchers have suggested designing compilers or preprocessors that can mark variables or data structures as cacheable or noncacheable. Other designs would attach counters to data structures to determine when they should be updated from main memory.
**CSS:STATISTICA**

**CSS/3™** Complete Statistical System with over 1,000 presentation-quality graphs fully integrated with all procedures and on-screen graph customization. The largest selection of statistics in a single system: in-depth, comprehensive implementations of: Exploratory techniques; multi-way tables with banners; nonparametrics; distribution fitting; multiple regression; general nonlinear estimation; logit/probit analysis; general ANOVA/MANOVA; stepwise discriminant analysis; log-linear analysis; factor analysis; cluster analysis; multidimensional scaling; canonical correlation; item analysis/reliability; survival analysis; time series modeling, forecasting; lag analysis; quality control, process analysis; experimental design (with Taguchi); and much more. Manuals with comprehensive introductions to each procedure and examples. Integrated Stats Advisor expert system. Extensive data management facilities (powerful spreadsheet with formulas; relational merge; data verification; flexible programming language). Optimized (plain English menus/mouse) user interface: even complex analyses require just a few self-explanatory selections (CSS can be run without manual; Quick Start booklet explains all basic conventions). Macros, batch/commands also supported. All output displayed in Crossheets™ (dynamic tables with pop-up windows and instant graphs). Extremely large analysis designs (e.g., correlation matrices: up to 2,000x2,000). Unlimited size of files; extended precision; unmatched speed (Assembler). Exchanges data (and graphics) with many applications (incl. Excel®, Lotus 1-2-3®, DBASEIV®, SPSS®). Highest resolution output on practically all printers (incl. HP, Postscript), plotters, recorders, typewriters. IBM compatibles, 640k or more. **Price: $595.**

**Quick CSS™** Subset of CSS/3: all basic statistical modules (incl. data management) and the full, presentation-quality graphics capabilities of CSS/3. **Price: $295.**

**CSS:GRAPHICS™** A comprehensive graphics/charting system with data management. All graphics capabilities of CSS/3 and, in addition, extended on-screen drawing, 19 scalable fonts, special effects, icons, maps, multi-graphics management. Hundreds of types of graphs. Interactive rotation and interactive cross-sections of 3D graphs. Extensive selection of tools for graphical exploration of data; fitting, smoothing, spectral planes; overlaying, layered compressions; marked subsets. Unique multivariate (e.g., 3D) graphs. Facilities to custom-design new graphs and add them permanently to menu. Import/export of graphs and data, 15 formats. Optimized (menues/mouse) user interface: even complex graphs require few keystrokes: all graphs on this page can be produced from raw data in less than 20 minutes. Macros, batch/commands also supported. Unlimited size of files. Highest resolution output on all hardware (CSS/3) IBM compatibles, 640k or more. **CSS:GRAPHICS is included in CSS:STATISTICA (available separately for $495).**

**Megafile Manager™** Comprehensive analytic data base management system. Unlimited size of files (up to 32,000 fields or 8 MB per record). Megafile Manager is included in CSS/3 and CSS:STATISTICA (separately: $295).

**CSS:STATISTICA™** A fully integrated system that combines all the capabilities of CSS/3 and CSS:GRAPHICS into a single extremely comprehensive data analysis system. **Price: $795.**

Domestic ship $7 per product. 14-day money back guarantee.

Circle 296 on Inquiry Card.

---

**CSS:STATISTICA/Mac™** A CSS-compatible, comprehensive data analysis and graphics system designed for the Macintosh. Large selection of statistical methods fully integrated with presentation-quality graphics (incl. EDA, multiple, a wide selection of interactively rotatable 3D graphs; Macdraw-style tools). Unlimited size of files. Exchanges data with Excel and other applications. **Price: $395.**

**Quick CSS/Mac™** A subset of STATISTICA/Mac: all basic statistical modules and the full, presentation-quality graphics capabilities of STATISTICA/Mac. **Price: $245.**
While they may be very promising, software solutions to cache-coherency problems are still in their infancy. The most exciting research in this area is actually being conducted on the Cedar system at the University of Illinois at Urbana-Champaign, where researchers are exploring a variety of possible software answers.

**Software solutions to cache coherency are still in their infancy.**

**A Critical Element**

People outside the computer field—when they do not think computers are black magic—presume that computer design is a hard-and-fast science. Nowhere is that assumption more absurd than in shared-memory multiprocessor cache coherency.

The puzzling question of cache coherency is a critical element in designing multiprocessor systems, but no one has even come close to a satisfactory solution. Additional research and a great deal more hands-on experimental work are required to solve the problem. The arrival of microprocessor-based multiprocessors on the scene only increases the need for cache coherency.

**BIBLIOGRAPHY**


Steven J. Vaughan-Nichols is a freelance writer from Lanham, Maryland. You can reach him on BIX as “sjvn.”
### Books for only $1 Each

as your introduction to the Small Computer Book Club

You simply agree to buy three more books—at significant savings—within the next 12 months

**Values to $89.85**

(Publisher's prices shown.)

MEMBERSHIP BENEFITS

In addition to getting 3 books for only $1.00 each when you join, you'll also receive discounts on books you choose to purchase. Discounts generally range from 15% to 30% off the publishers' prices, and occasionally even more. Also, you will immediately become eligible to participate in our Bonus Book Plan, with savings of 60% off the publishers' prices.

- At 3-4 week intervals (15 times per year), you will receive the Small Computer Book Club News, describing the coming Main Selection and Alternate Selections, together with a dated reply card. In addition, up to two times a year, you may receive offers of Special Selections which will be made available to a group of select members.
- If you want the Main Selection, do nothing, and it will be sent to you automatically. If you prefer another selection, or no book at all, simply indicate your choice on the card and return it by the date specified. You will have at least 10 days to decide. If, because of late mail delivery of the News, you should receive a book you do not want, we guarantee return postage.

© Newbridge Communications, Inc.

If reply card is missing, please write to Small Computer Book Club, Dept. Y-DBB, 3000 Cindel Drive, Delran, NJ 08075, for membership information and an application.

.Byte (691)
See the picture of quality for yourself. Discover the unsurpassed picture crispness, brilliance, and infinite range of color of the CTX monitors. Compare the superlative quality with the rest. Then check the affordable prices. 1,000 words won't do it justice.

Available from CTX is a full range of powerful 14" color monitors: from the top-of-the-line Multiscan to a Super VGA and Deluxe and Standard VGAs as well as EGAs and CGAs.

---

CTX INTERNATIONAL, INC.
161 Commerce Way, Walnut, CA 91789
714/595-6146, FAX 714/595-6293

CTX SOUTH, INC.
6990 F Northbelt Parkway, Norcross, GA 30071
404/729-8909, Fax 404/729-8805

Factory:
CHUNTEX ELECTRONIC CO., LTD.
6F, No. 2, Alley 6, Lane 265, Pao Chiao Rd.
Hsin Tien, 23115 Taipei Hsien, Taiwan, R.O.C.
886-2-9175055, Fax 886-2-9172795

Watch for CTX's new 17" and 21" Large Screen Displays coming soon.

---

Add to all these features complete IBM and Macintosh compatibility, handy up-front controls, non-glare direct etch screens, detachable tilt/swivel bases, and reliable nationwide servicing, and you will agree that the CTX monitors are the best deal available on the market.
In the world of multiprocessing, shared-memory systems have proven extremely popular. They are easy to program, because you don’t have to confront the issue of data partitioning. They are also compatible with standard programming languages and can run sequential programs without any changes.

Shared-bus, or bus-based, shared-memory systems are particularly attractive for several reasons. For one, their implementation is relatively straightforward, because they are extensions of bus-based uniprocessor systems. For another, they offer a simple way to give the processors access to the shared memory. And since each processor (or cache) needs only to observe the memory transactions on the bus, a shared bus also provides a simple mechanism to maintain the consistency, or coherence, of multiple caches. In addition, the globally shared memory and consistency mechanisms yield a programming model that is very similar to systems of cooperating processes on a uniprocessor.

For these reasons, shared-memory machines are more popular for parallel programming than are distributed-memory, or message-passing, multiprocessors (also known as multicomputers). However, distributed-memory multiprocessors are highly scalable, whereas current shared-bus, shared-memory architectures generally allow scaling only to a few tens of processors.

Shared-memory systems are limited by memory-access issues: access times, communications contention (i.e., several processors contend for the same link in the interconnection network), and memory contention (i.e., several processors
Shared-memory multipro­
cessing systems are ex­
tremely popular because 
they are easy to program and 
compatible with standard 
programming languages. 
Various research facilities 
are working on ways to solve 
the shared-bus bottleneck 
that limits these systems.

Figure 1: The Wisconsin multicube is a special case of a multicube architecture in which a grid of buses interconnects a highly scalable number of processors. A node (see inset) consists of a high-performance microprocessor (which would probably have its own cache); a separate, conventional cache; and a snooping cache connected to the node’s row and column buses.
chical shared-memory multiprocessors, however, are intended to yield general-purpose machines capable of handling a wide range of applications and parallel-processing granularity.

The Wisconsin Multicube

Perhaps the simplest experimental architecture is the Wisconsin multicube, being developed by researchers at the University of Wisconsin-Madison. The multicube consists of a symmetric grid of buses with a processing node located at each intersection. In addition, a memory module is connected to each column bus. A snooping (frequently called snoopy) scheme is used to ensure cache consistency (see figure 1).

A processing node comprises a processor, a conventional cache memory (called the processor cache) to reduce memory latency, and a snooping cache that is connected to both its row and column buses. The processor would probably have an on-chip cache as well. The large snooping cache (built with DRAM chips) is designed to reduce bus traffic as well as to implement the snooping protocol.

This architecture is a member of a new class of symmetric-interconnection topology that the researchers have proposed. Called simply the multicube, it consists of \( n^2 \) processors, where each bus is connected to \( n \) processors and each processor is connected to \( k \) buses (\( k \) also can be considered the number of system dimensions). The hypercube is a special case of the multicube in which \( n = 2 \).

The Wisconsin multicube is a two-dimensional version \((k = 2)\) in which \( n \) scales to 32, yielding a proposed system of 1024 processors.

The researchers were attracted to the hypercube topology because of its extreme scalability. However, they were reluctant to adopt the architecture's liabilities: the explicit mapping of processes and data onto the processors and memory that a distributed system requires and, for a large-scale machine, the large number of intermediate nodes a message must often traverse.

By adopting a grid of buses and shared memory, the Wisconsin multicube eliminates those drawbacks. Furthermore, because it uses a snooping cache-coherence protocol, the view of shared memory resembles that of existing single-bus, shared-memory multiprocessors.

The symmetry of the multicube's organization distributes bus traffic uniformly among the buses, reducing the chance of bottlenecks. Because of its grid organization and snooping scheme, a memory request that produces a cache miss requires, at most, twice the number of bus operations as that of a single-bus multiprocessor.

The researchers note that the architecture can be considered a collection of conventional bus-based multiprocessors connected by orthogonal sets of buses that transparently extend the snooping cache protocol to higher dimensions. Indeed, a conventional shared-bus multiprocessor can be viewed as a multicube with \( k = 1 \).

In a \( k \)-dimensional system, the total number of buses is \( kn^k \). Therefore, the bandwidth per processor equals \( kn^{k-1}n^k \), or \( kn^k \). Thus, the bandwidth available to each processor scales directly with the number of dimensions.

Although the architecture specifies that main memory must be spread across the column bus, it could be distributed among the processors. The snooping protocol requires only that each memory block have a home column, or home bus, on which it resides.

The Aquarius Multi-Multi

Researchers at the University of California at Berkeley investigated a variety of hierarchical architectures and were led to develop a design based on the multicube. Although the research effort is called the Aquarius project, the researchers call the architecture a "multi-multi." (Like the developers of the multicube, they use Gordon Bell's term multi for today's multiprocessors.)

Like the multicube, the multi-multi uses a grid of buses with a moderate number of processors per bus and accommodates several dimensions. However, the shared memory is divided among the nodes (from a suggestion made by the developers of the Wisconsin multicube that it could be), resulting in a "semiprivate" address space for each processor. Memory is shared using the high bits of the memory address.

This arrangement is efficient for private data and serves as a natural division of directory information. Thus, each node can run independently of the rest of the system as well as share memory to any extent. Sharing, of course, is most efficient for processors on the same bus.

The cache-coherence protocol combines aspects of snooping and directory schemes. The snooping component maintains the consistency of caches on individual buses, and the directory com-

---

**Figure 2:** The Aquarius project's "multi-multi" divides up the main memory among the processing nodes and adds a directory scheme to a snooping scheme to ensure cache consistency.
The Hector Architecture

In some ways, the simplest conceptually of these proposed hierarchical architectures is Hector, being developed at the University of Toronto. One of the project's aims is to produce a scalable design with a good cost/performance trade-off; another is to ensure that the cost of a system is directly proportional to its size.

To achieve those aims, the architecture uses two levels of bit-parallel rings to link small buses (see figure 3). Because the buses and rings can transfer data independently, the total bandwidth increases proportionally with the number of interconnection units.

More important, the interconnection scheme is simple, inexpensive, and scalable to higher speeds. It contributes to increased reliability and flexibility. In addition, the cost of accessing remote memory increases incrementally with distance; in contrast, most systems with nonuniform memory access have only two time costs: local and remote.

Hector's simplicity derives from the fact that it merely links processing nodes by a bus and bus interfaces and then uses two simple, higher-level links and associated controllers to configure the system. Part of that simplicity, however, is due to the lack of cache consistency across all the nodes.

At the lowest level, a bus connects a group of processing nodes. The researchers call the nodes modules and the groups stations. Although a processing module typically consists of a microprocessor, cache memory, local memory, and a station-bus interface, the researchers use the term processing module to indicate memory and I/O modules as well.

A local ring links several stations, and a global ring connects the local rings. Because they can be built with short point-to-point links, rings provide faster signaling than buses. More important, the total bandwidth increases proportionally with the number of segments. (The optimal number of segments, however, is a trade-off, since network latency likewise grows proportionally.)

Information is transferred in packets. The transfers are handled hierarchically by three types of interface circuits. At the lowest level, the station-bus interface manages a processing module's communications. Next, a station controller handles the traffic within a station plus the traffic to and from the local ring. At the highest level, an inter-ring interface links the local ring and the global ring.

The DASH Architecture

Stanford University's DASH multiprocessor is another conceptually simple architecture. It uses a simple hierarchical structure with a distributed-directory cache-coherence protocol. A scalable interconnection network and the directory protocol are the key elements in making the system scalable.

The general architecture consists of clusters of processors linked by a high-bandwidth, low-latency interconnection network (see figure 4). A cluster, which the developers call a node, contains a small number of high-performance processors, each with its own cache, local memory, common cache for remote accesses, and directory that connects the
cluster to the network. A bus links the elements within the cluster, and a snooping scheme maintains the consistency of the cluster's caches. Across nodes, the directory scheme ensures consistency.

The directory protocol is independent of the type of interconnection network. DASH can use any of the low-latency networks that were originally developed for message-passing parallel processors, such as a mesh or a hypercube.

The Paradigm Architecture

As with Hector, the developers of the Paradigm architecture sought to show that a shared-memory multiprocessor can scale from a few processors to hundreds and provide cost-effective performance across the entire range. Believing that a switching network is required for scalability but recognizing the high latency of such networks and the high cost of specialized types like shuffle-exchange networks, the developers turned to clusters of high-performance microprocessors that use an optimized hierarchy of shared buses and caches.

Unlike the other architectures, Paradigm—also being developed at Stanford University—is a software and hardware architecture. More specifically, it combines the operating system, hardware, and firmware-like components such as cache management software modules. (An earlier version of Paradigm had the name VMP-MC, for V multiprocessor multicomputer, and was an extension of the original VMP work.)

Paradigm's use of distributed-operating-system techniques for very large-scale, widely distributed operation and parallel application-structuring tech-
Figure 5: In Paradigm, high-level groups of processors, called nodes (see inset), are linked to a switching network. The links, however, are not central nodal links; instead, they connect multiprocessor module groups—the second level down in the hierarchy—to the network, eliminating some bus traffic.

Techniques that maximize locality and minimize contention help it to realize high-performance scalability. The general hardware architecture consists of processing "configurations" connected by the switching network (see figure 5). The configurations, confusingly called nodes, consist of clusters of processors linked hierarchically to memory modules.

Each processor is a microprocessor with an on-chip cache. Two to eight microprocessors, connected by a bus and sharing a higher-level cache, form a multiprocessor module. The MPM also contains an interface that connects it to a high-speed network. Similarly, a number of MPMs are linked by a higher-level bus to a higher-level cache, called an interbus cache module. This collection is called an MPM group. Finally, a number of MPM groups, linked by a memory bus to a memory module, form a node.

Each MPM is connected through the switching network to all the other MPMs and through the module bus (called a board bus, since the module is implemented as a single board) to the other MPMs in its node. The shared bus and cache interconnection of this setup provide low-latency communications among the clusters of processors within a node.

Although the described structure contains three levels of buses and caches, it can be extended recursively to additional levels. A key task in the Paradigm project...
ANNOUNCING

PASCAL+™

A High Performance Option
For Turbo Pascal Users

We agree that Borland Turbo Pascal® is a great street machine. But when your applications demand the ultimate in performance, the Stony Brook Pascal+ optimizing compiler has the extra power you need — and an unbeatable list of standard features.

DON'T CHANGE A LINE OF YOUR CODE

It couldn't be easier to trade up to Pascal+. We're 100% language-compatible with Turbo Pascal V6. You don't change your Turbo Pascal programs at all. Just compile with Pascal+ and get:

- Execution speeds up to 100% faster
- Code size up to 30% smaller

You get fully optimized code with NO difference in your program's operation!

ELIMINATE ROADBLOCKS

Pascal+ comes fully equipped to handle ANY programming problem you encounter. Unlike Turbo Pascal, we produce standard Microsoft® objects, support all memory models, and give you complete control over procedure-calling and parameter passing conventions.

INSTANTLY LINK TO OTHER LANGUAGES

With Pascal+ it's easy to interface with code written in any other language. This means, for instance, that you can have immediate access to millions of lines of commercial library code written by and for C programmers.

AND WE DO WINDOWS!

Stony Brook Pascal+ comes with full support for Microsoft Windows 3.0. We provide the interface units, and you use the windows API exactly as you would with Microsoft C.

In fact, anything you can do with Microsoft® C or TurboC®, you can do with Stony Brook Pascal+!

So get on the track with Stony Brook Pascal+. You'll qualify for races you never could enter before.

CALL NOW OR WRITE FOR INFORMATION

187 E. Wilbur Rd., Suite 9, Thousand Oaks, CA 91360
Makers of Stony Brook Professional Modula-2 and QuickMod

SAVE $100! WITH OUR SPECIAL INTRODUCTORY OFFER!

Buy directly from us by 7/31/91 and pay only:

$295 incl. shipping, U.S. & Canada
$375 incl. shipping, outside U.S. & Canada

$395 after offer expires
$475 after offer expires

Turbo Pascal and Turbo C are registered trademarks of Borland International, Inc. Microsoft and Windows are registered trademarks of the Microsoft Corporation. Stony Brook Software and Pascal+ are trademarks of Gogeschi Micro Systems, Inc.

Circle 297 on Inquiry Card (RESELLERS: 298).
GIGAMAX ARCHITECTURE

Figure 6: The only commercial R&D project to develop a bus-based shared-memory multiprocessor, Encore's GigaMax links a number of the company's shared-bus Multimaxes.

The GigaMax Architecture
The GigaMax project, carried out by Encore Computer (Fort Lauderdale, FL), was the one serious commercial effort to develop a scalable shared-memory multiprocessor that uses at least one bus. But whether it is truly scalable (by which computer architects mean "highly scalable") depends partly on how you define the term.

Simulations of GigaMax indicated that a 128-processor system is practical, and analytic modeling suggested that a 160-processor version might be possible. The initial discussion of the proposed architecture was one of the first to describe a hierarchical bus and cache arrangement; Paradigm resembles it in its board-level cache and its directory scheme, and another system, the Data Diffusion Machine, is similar to it in many ways.

GigaMax is an extension of Encore's Multimax system. In the last version of Multimax, a system can be configured with 2 to 20 processors (1 to 10 processor cards) and up to 160 MB of memory (10 memory cards), plus I/O cards (the bus has 19 slots). Each processor, which is built around a National Semiconductor 32532 microprocessor, has its own write-back cache, which snoops on the bus to maintain consistency.

The version of GigaMax most recently described consists of eight processing clusters connected by fiber-optic links and a high-speed bus serving as a global switch. A cluster comprises a Multimax, a system interface (called a uniform interconnection card), and a second-level cache card (called a uniform cluster cache). The cards occupy two slots in the Multimax, which uses a high-speed bus, called a nanobus because of its 80-nanosecond cycle time. (See figure 6.)

The cluster cache stores the location of remote memory blocks that the local (cluster) processors have recently accessed. The interconnection card handles the traffic with the rest of the system and snoops on the bus to maintain cache coherence at the cluster level.

Part of the GigaMax project involved the design of the processor board, contributing to the company's next-generation system, the 93 series. It uses a Motorola 88100 with 32K bytes of write-through cache, with four processors per card and up to eight cards per system. An important part of the system is a 1-MB write-deferred board-level cache.

The original goal of GigaMax was to develop a machine that was capable of 1000 million instructions per second (MIPS). By using the 88100, Encore can achieve this target by linking just two 93-
all you need in time is MICROBAG

The portable office in the attaché-case
The office solution for all frequent travellers – independence from time and place – an attribute for quality and reliability
LAPTOP: the centre-piece of the MICROBAG
PRINTER: prints texts, graphics, faxes, etc...
MOBIL CELLULAR PHONE: the most important communication device
TELCON ELECTRONIC: the heart of the MICROBAG
Do you want to have more informations about the MICROBAG?

Are you interested in being a TELCON Representative:
Please request informations from:
TELCON GMBH GERMANY (Headquarter)
Prinzregentenstr. 120, 8000 München 80
Tel.: 089/457912-0 Fax: 089/4708211
TELCON USA
Tel.: 305/6691981 Fax: 305/6677059
TELCON IBERICA
Tel.: 1/73373.67 Fax: 1/73373.67

Specifications are subject to change without notice. DBGM TELCON GmbH © Copyright 1991 TELCON GmbH – Munich
The Data Diffusion Machine

Although it is based on the GigaMax architecture, the Data Diffusion Machine (DDM) represents, in some ways, the greatest departure in conception for a scalable shared-memory multiprocessor. Part of the European ESPRIT project, it uses a tree structure (as did the original GigaMax proposal).

What most distinguishes the DDM from the other architectures is that the shared memory is a virtual one. In other words, the location of a piece of data in the machine is completely decoupled from its virtual address. Furthermore, there is no set location where a data item must reside; instead, it migrates to where it is needed. This arrangement reduces access times and traffic.

Thanks to its virtual memory scheme and the extensibility of the hierarchy, the machine is scalable to an arbitrary number of processors. The hardware organization comprises a hierarchy of buses and data (i.e., directory) controllers linking the processors. Each processor has a large set-associative memory, and each data controller has a set-associative directory containing status bits for the data under its control (see figure 7).

The design of the DDM is based on the following ideas: Software does not really need to know where a piece of data resides; all it needs is a way to identify each data item—the virtual address. The physical placement of the data should be done automatically by the hardware in a dynamic, totally flexible manner that enables most of a processor's memory accesses to be satisfied locally.

The machine's design was oriented to executing logic programs, but it is very general because it is independent of the choice of processor, language, or application. It will, therefore, run software written for conventional shared-memory machines without change.

At the bottom of its tree structure are the processors (each likely to have its own cache) and their local, set-associative memories. This memory, which is the sole form of main memory, is large and is organized like a very large cache, but it contains an image of part of the global virtual memory.

The memory is connected by a memory controller to a local bus; a group of processors and memory forms a cluster. The cluster (i.e., local bus) is connected to a higher-level bus through a directory controller, and so on up the tree.

The directory controller's set-associative directory has space for the status bits for all the data blocks in the memories below it. The controller also observes the activity on the buses on which it is attached to (i.e., the one immediately above it and the one below it), acting like a snooping cache.

**But Will They Fly?**

All but one of these projects are academic, and the one commercial project (GigaMax) has ended its efforts to build a highly scalable system. The other commercial makers of shared-memory multiprocessors—primarily Sequent Computer Systems and Alliant Computer Systems (which uses a crossbar switch rather than a bus)—see no value in pursuing such a goal. Sequent says it does not see a demand for more than 30 processors—its maximum in the current Balance series—and that the average customer uses only 8 to 10 processors.

As Bob Hessinger, manager of large-systems marketing at Encore, put it, the explosion of individual CPU capability calls into question the whole notion of a highly scalable shared-memory machine that uses one or more buses. For one thing, you no longer need to link hundreds of processors to achieve what was once considered supercomputer performance. More important, the need for bus bandwidth grows with the processor's performance, and a large-scale multiprocessor using today's microprocessors would need lightning-fast buses, which are not technologically feasible.

Furthermore, shared-memory systems, especially bus-based ones, are general-purpose machines, and other types of machines are more competitive. Vector processors are well suited to certain applications and are simple to program because of their optimizing compilers. And distributed-memory multiprocessors are more economical for the kind of applications they serve.

Still, economies of scale and the fact that they are binarily compatible over a wide range of configurations—2 to 32 processors—make shared-memory multiprocessors at the large end competitive with mainframe computers. Research aside, their future seems to be confined to that level of parallelism.

Mike Robinson is a freelance writer and editor in Lexington, Massachusetts, specializing in electronics technologies. You can reach him on BIX c/o "editors."
LIKE MAGIC, CREATE SIGNS, LABELS AND STICKERS INSTANTLY!

Introducing the magic of STIKA! STIKA is the revolutionary, compact and simple sign-making system from Roland Digital Group!

You can use STIKA with or without a computer. The built-in scanner allows you to easily scan and cut artwork (from any original, clip-art or printed piece) to create your own signs, labels, stickers and reverse iron-on transfers from either vinyl or flock material measuring up to 3" x 23"!

With a wide variety of colors you can apply your creations permanently to walls, windows, cars, RV’s, boats, cycles, shirts, hats and a lot more! The magic of STIKA!

Now the power to cut graphics and text from vinyl and flock rests directly in the palm of your hand.

Experience the Wizardry of STIKA!

1. Scan and Cut.
   With STIKA’s built-in scanner, simply scan the original art or text. Then with one push of a button, STIKA will cut your design in vinyl or flock.

2. Apply.
   Your design is easily applied to just about any surface with pressure-sensitive vinyl or iron-on flock material.

3. It’s finished!
   Signs, labels or stickers are now ready for permanent display!

INTERNATIONAL DISTRIBUTORS: U.S.A.: Roland DGA Corporation 1961 McGaw Avenue, Irvine, CA 92714 Phone: (714)975-0660 Fax: (714)975-0669 • CANADA: Roland DG Canada Inc. Phone: (450)275-0666 Fax: (450)275-0652 • AUSTRALIA: Roland DGA Australia Pty Ltd Phone: (03)9661 0483 • NEW ZEALAND: Roland Corporation NZ Ltd Phone: (09)309 1104 Fax: (09)309 1106 • UNITED KINGDOM: Roland (UK) Ltd Phone: 020 8181 1181 Fax: 020 8181 1182 • SCANDINAVIA: Roland Scandinavia AB Phone: (08) 20 30 30 Fax: (08) 20 30 30 • BEHLEULI, FRANCE, GERMANY, AUSTRIA, SWITZERLAND & PORTUGAL: Roland DG Europe N.V. Phone: 32 14 57 51 11 Fax: 32 14 57 51 11 • SPAIN: Roland Electronics de España, S.A. Phone: 34 93 20 20 55 Fax: 34 93 20 20 55 • HUNGARY: Intermac Ltd. Phone: (36) 14 9666 Fax: (36) 14 9666 • JAPAN: Roland DG Corporation Phone: 03 5483 7171 Fax: 03 5483 7171

Circle 274 on Inquiry Card (RESELLERS: 275).
**Discover Parallel Processing**

**Quadputer™**

The Microway Quadputer is the world's most popular PC Transputer development environment. It can be purchased with two to four Transputers and one to four megabytes of RAM per processor. The Quadputer runs all the popular Transputer development software, all of which is available from Microway. It is compatible with our Monoputer™ which provides 1M6 megabytes of RAM and a single T800, our Videoputer™ which comes in VGA and higher resolution versions and is powered by a memory mapped pair (T800 and 34010), and our Linkputer™ whose crossbar switching network can dynamically link up to 32 Transputers. Finally, all Microway Transputer products can be used with our Number Smasher-860 to provide out-of-this-world numeric performance.

For more information, please call 508-746-7341.

**NDP Fortran-860, C-860 and C++860**

Microway NDP 860 Compilers make it easy to recompile your favorite mainframe, 80386 or PC application for the 80860. The resulting code runs on our XTEND-860™ environment under DOS, UNIX or XENIX.

**Microway**

The World Leader in PC Numerics
SCALING UP: GET THE MESSAGE?

Message-passing multicomputers can produce linear improvements in performance; current shared-memory multiprocessor systems can’t

RICHARD MARLON STEIN

While currently each new generation of multiprocessor systems delivers faster and faster results, soon the computing bandwidth of shared-memory multiprocessors will reach its limit. The laws of physics weigh against substantial speed improvements that preserve the existing cost-effectiveness of multiprocessor systems. Message-passing parallel computers circumvent the architectural limits of current shared-memory multiprocessor systems. Also called multicomputers, these systems can achieve speeds that continue to increase linearly with the number of processors used.

Multicomputing vs. Multiprocessing
Multicomputers are scalable computation systems; they share no resources and, architecturally, exhibit no areas of contention—a giant killer. The shared-memory architectures found in current multiprocessor systems are limited in the number of CPUs that they can connect to a common memory pool. This limitation constrains the performance on real work to a less-than-linear improvement (see figure 1).

A generally accepted bound for multiprocessor systems is eight processors, but some workstations can only accommodate four. Each CPU must arbitrate with its bus partners to gain access to the common memory—a source of significant contention. Thus, bus bandwidth becomes more costly and less efficient.

Some manufacturers, such as Alliant Computer (Waltham, MA), permit over 20 CPUs to share a common memory. To achieve this architecture, multiple buses
combine several CPUs (four to eight) into a cluster. When one CPU requires data that resides in a different cluster’s address space, a message is passed through a high-speed channel.

To exploit this architecture, the software engineer must partition the problem across many clusters and organize message passing between them. Distributed-memory multicomputers require this mechanism.

Message passing in shared-memory systems is simpler than this. When a message is sent, the synchronization between process peers is conducted according to a common clock. Each peer “knows”—in a temporal sense—when a message was sent or requested.

A distributed-memory multicomputer has no such luxury. Many hundreds or thousands of processors execute asynchronously. The improper coordination and synchronization of these processors can lessen performance gains or even halt processing.

To build multicomputer software, you need to learn to think in a concurrent context to comprehend the complexity of this articulated multiprocess situation. If you understand the concurrency issues, you can apply standard structured software-engineering principles to the multicomputer domain.

You can also construct a system that exhibits linear increases in speed. Problems will be solved in times that are directly proportional to the number of nodes in your multicomputer.

Active, Dynamic—and Staggering

Multicomputers are not burdened by contention; they offer linear increases in speed and are typically \( \frac{1}{80} \) to \( \frac{1}{800} \) the cost of equivalent multiprocessor systems (in terms of million instructions per second and million floating-point operations per second). Why, then, are they substantially less prevalent? Because there is little or no software for them.

While multiprocessor systems enjoy a vast resource of “dusty decks” (i.e., old computer programs full of intrinsically sequential code), few multiprocessor programs have been written. A multicomputer’s distributed-memory architecture deters the wholesale port of existing sequential software; it is much harder to write effective multicomputer software than it is to write sequential shared-memory implementations.

Part of the difficulty is algorithmic.

Gaussian elimination (see reference 1), a familiar technique for solving simultaneous systems of linear equations, can be implemented in a multicomputer. However, the performance results, in a per-processor comparison, don’t match those obtained by a vectorized multiprocessor solution.

Some algorithms just don’t map well into multicomputer architectures. Since most of the existing programs are based on “tried and true” algorithms, it is hard to invent new techniques that are distributed and work with multicomputers.

The other stumbling block is conceptual. A multicomputer is constructed from many individual processors, each possessing a small portion of local memory, perhaps 4 megabytes each. These computation elements, or nodes, are connected to each other with high-speed links. Processes send and receive messages through these links to other processes resident on different multicomputer nodes.

The conceptual difficulty with this architecture is that you must now consider not one processor and one process, as in the sequential machines, but \( n \) processors and \( m \) processes, each exchanging messages with the others. This ensemble is an active, dynamic system with \( n \) times \( m \) degrees of articulation. The configuration can be quite staggering.

Thinking Concurrently

Good software depends on a solid, thoroughly organized design, and for multicomputers, this is the rule, rather than the exception. Software engineering depends on abstraction to transform a physical system or environment into a superposition of operators and data types that a computer can process. Therefore, you need to describe the system requirements and find a method to extract the parallel elements of the problem and abstract them into a software design.

A computer performs work by executing a process. A process is literally a superposition of inputs, outputs, and assignments. A multicomputer process accepts input from other processes by way of message passing, performs some computations (e.g., \( x = y \cdot \sin(2 \cdot z) \)), and outputs results to another process, also through message passing.

This abstraction leads to the process-structure graph, an illustration that details the granularity of the system (see figure 2). The process-structure graph quantifies the number of processes and their interfaces. With several simple processes, such as those that perform simple arithmetic operations (e.g., +, -, and
A LOGICALLY CONCURRENT MULTICOMPUTER

Host workstation
memory

Worker process
Message-passing
interface simulated
with sockets or
UDP datagrams

CPU

SCALING UP

A "fine-grained" process-structure is said to exist. It takes a good many simple arithmetic processes to perform a fast Fourier transform or matrix inversion that may be implemented without using a separate process to do all arithmetic operations.

You may decide to create a separate process, called proc_add(a, b), that performs all the additions for your system. Or you may decide to create a single process called proc_sstraj(position, attitude, velocity, mass, ..., etc.) that determines the space shuttle's re-entry trajectory. Clearly, proc_add is superfluous and quite expensive to use in a run-time environment. However, you only need to use proc_sstraj once, because it is a complex set of assignments and functions.

You can create the process-structure graph at any level of detail you wish. The graph becomes more fine-grained as additional process bubbles, or circles, are added. Similarly, the fewer the number of process bubbles, the more coarse-grained the graph is. Each process is entirely isolated with the interface arrows, which point out the direction of message passing flow between processes and enumerate the packet structure of the messages.

A single-interface arrow may carry more than one message type, or packet structure. The precise organization and process dependency (who gets what message from whom) of these interfaces must be known; otherwise, a nondeterministic system, one that does not produce the same results for a fixed set of initial conditions, may arise.

Bubbles and Nodes

Specifying the process structure of a multicomputer system sets the stage for evaluating the logical concurrency of the graph (see "T800 and Counting," November 1988 BYTE). Logical concurrency is a measure of the simultaneous actions, events, and processes that occur during the course of execution. The process structure expresses the logical concurrency of the system through the relationship of each process bubble to its companions.

Processes on equal footing (i.e., those appearing in the graph at the same level of granularity) are logically concurrent peers of the same rank. Processes of equal concurrency rank should exchange messages. This is a "rule of thumb" that aids multicomputer software specification and design development. Message passing between multiple concurrency ranks is permissible as long as you can clearly document and illustrate the message path.

By imposing this restriction on the process-structure graph, the logical concurrency within the process hierarchies, their interfaces, and their functions is easier to maintain and transform into a multicomputer system. It's a way to eliminate "spaghetti code" in multicomputer software.

To transform a process-structure graph into a multicomputer system, you must convert the logically concurrent specification into the physical concurrency of the multicomputer. That is, if you have a process-structure graph that describes a system of eight processes and each is organized as an element along a straight line where messages are passed point-to-point through "nearest neighbors" along the line, then somehow you must place each process onto a multicomputer node such that the interface arrows preserve this topological configuration (see figure 3).

The message-passing portion of a multicomputer system is critical. Each message that is sent must have a receiver, and vice versa, or the system will deadlock. The transaction between sender and receiver must complete, or the sender will block (cease execution). Deadlock is the scourge of multicomputer software. Fortunately, a design technique helps minimize the probability of deadlock.

The process-structure graph that is constructed from the software design should execute in a single address space. By spawning separate processes corresponding to the process-structure graph, the message passing occurs in the single address space of a workstation. You can create the message-passing primitives from sockets or User Datagram Protocol datagrams under Unix.

By exercising and validating the logically concurrent specification in a single address space, the system's message-passing communications requirements can work correctly without deadlock. If the message passing works, then the internals of each process in the process-structure graph will also cycle correctly. This design technique actually realizes physical concurrency. The physical concurrency's multiprocess emulation is enough to guarantee execution in the multicomputer, provided the topology is wired correctly.

One multicomputer operating system, Genesys from TransTech Parallel Systems (Ithaca, NY), incorporates a "stand-
SCALING UP

FROM LOGICAL TO PHYSICAL CONCURRENCY

Processor Local RAM Interprocessor message-passing links

Figure 3: After checking out its logical concurrency in a single address space, you can translate a process-structure graph to physical concurrency by porting the system to a multicomputer.

Achieving message passing in a single address space has another advantage: It is far easier to debug the process internals of a complicated computation in a single address space. Can you imagine poking around hundreds of multicomputer nodes, trying to find out which one has the erroneous information? While the system's temporal structure is not preserved in a single address space, the logical structure and message passing are.

Dividing the Data

To achieve proportional increases in speed in multicomputers, you have to map the logical concurrency, which the process-structure graph describes, onto the physical concurrency of the underlying multicomputer platform. However, placing and arranging the processes does not guarantee effective speed increases; each process must have an equal amount of data to work on.

The distributed-memory organization of multicomputers implies that the entire data set does not reside in a shared-memory pool but, instead, is disseminated among the n processes of the process-structure graph. You must perform this data decomposition to make the best use possible of the processors. All the processors in the multicomputer must simultaneously operate on nearly identical portions of the distributed data set so that they can execute in the shortest time possible.

The term data decomposition describes the data set's proportional distribution to each multicomputer node. Highly symmetrical computation domains, such as grids, parallelepipeds, and cylinders, all possess degrees of symmetry. You can exploit this symmetry to yield congruent data decompositions. A data decomposition is called congruent when the same quantity of data has been placed on each multicomputer node (see figure 4).

An irregularly shaped domain, such as a protein molecule or the airframe of the proposed National Aerospace Plane, requires a data decomposition that is not easily “eyeballed” into a congruent decomposition. Obtaining a congruent data decomposition for irregular domains requires a more sophisticated technique.

Sharing the Load

When all processors have equal quantities of data to work on, then a load balance occurs. A load balance must exist for a multicomputer to obtain linear increases in execution speed.

To understand why a load balance must exist, imagine, for example, two processes that communicate via message passing. Suppose that one process, process A, has a data set twice the size of the data set for its companion, process B. During their respective computations, process B requires a piece of data (e.g., a message) from process A. But process A requires twice as long to complete its computation as process B needs. So

LOAD-BALANCE PROFILES

Figure 4: (a) A strong load imbalance will produce a poor increase in performance when performed on a multicomputer. (b) By contrast, a near-perfect load balance will produce linear improvements in performance. (Note that the y axis elements are not labeled because specific numbers are not being shown.)
Mitsubishi Monitors Open More Windows Of Opportunity.

Windows™ 3.0 enables you to push your PC to new levels of performance and productivity. To take full advantage of its application versatility and powerful features, upgrade your monitor to the Diamond Scan 16L from Mitsubishi Electronics.

With a 16" CRT, the Diamond Scan 16L provides 42% more display area than conventional 14" monitors but without taking up additional desktop space. This larger screen size enables you to see more of the Windows™ graphical environment and work more easily with a variety of on-screen applications at the same time. With the Diamond Scan 16L and Windows 3.0, opportunities are unlimited!

In addition, the Diamond Scan 16L supports today's high resolution graphic standards.

From VGA™ through 1024 x 768, this microprocessor-enhanced monitor is compatible with any Windows 3.0 application resolution.

The Diamond Scan 16L— and Diamond Scan 20L (the larger 20" model)— are both engineered with the latest technology and manufactured using only the finest materials and components available. It's the reason why Mitsubishi continues to be the proven leader in monitor quality, performance and value.

Call or write Mitsubishi Electronics today and we'll show you how our high performance 16" and 20" color display monitors can help you open more windows of opportunity. For more information on these or other models in Mitsubishi's comprehensive monitor product line, call 1-800-843-2515.

MITUBISHI

See us at PC Expo, Booth #2022, and SIGGRAPH, Booth #1626

Mitsubishi Electronics America, Inc., Information Systems Division, 991 Knox Street, Torrance, CA 90502
Mitsubishi Electric Sales Canada, Inc., 8835 Woodbine Avenue, Markham, Ontario L3R 5G1

© 1991 Mitsubishi Electronics America, Inc. Mitsubishi is a registered trademark of Mitsubishi Electric Corp., Tokyo. Windows is a trademark of Microsoft Corp. VGA is a trademark of International Business Machines Corp. Actual unretouched screen images produced from the following companies (trademarked software package name follows company name): Microsoft Corp. (Windows 3.0 and PowerPoint), AutoDesk, Inc. (AutoCAD Release 10), Computers Support Corp. (Arts & Letters).

Circle 199 on Inquiry Card (RESELLERS: 200).
**PUT dBASE® ON TOP**

Dr. Switch-ASE puts dBASE on top. On top of the charts, spreadsheets, word processors or on top of DOS. Right where it belongs, on top of any graphics or text program when you need it. Neatly tucked away when you don't. Dr. Switch-ASE turns any dBASE language program into a 16-20K RAM resident program. So now you can have dBASE power at the touch of a key, anywhere, any-time and from any program.

**dBASE TSR's, easy as ASE**

With Dr. Switch-ASE you don't have to be an Assembly language whiz or a C code maven to create TSR's. The Doctor includes an integrated cut & paste feature for transferring data between programs. It also supports both Expanded and Extended memory and is fully network compatible.

**The doctor speaks your language**

Dr. Switch-ASE supports all of the dBASE dialects. So it works directly from Clipper, dBASE III PLUS, dBASE IV, FoxBASE +* and FoxPro.* No need to learn a new dBASE syntax and no new environments to wrestle with.

When the doctor's in, dBASE is on top.

**Call and place your order today!**

212-787-6633

**DR. SWITCH-ASE**

$179.95*

Black & White International Inc.

PO Box 1040

Plandome Station

New York, NY 11024-0141


1Includes totally free runtime version

---

**SCALING UP**

Process B must wait, or **block**, for a message from process A.

When a process blocks, it does no work, and the portion of the program that process B performs does not proceed. A load imbalance produces this unwanted interruption, and it diminishes a multicomputer's efficiency; the maximum increase in speed possible is proportional to the execution time for the work on the most heavily loaded computation node.

A few load-balancing techniques are known. The one you use depends on your problem domain. Highly symmetrical data-parallel computations can usually be "eyeballed" to obtain a data decomposition that produces a load balance.

Irregular domains (e.g., those found in the solution to large, sparse linear systems) require a more sophisticated technique. **Simulated annealing** is a successful and popular method for equalizing multicomputer load imbalances. This method is used in the Transpiler (see "Configuring Parallel Programs," December 1989 BYTE), a multicomputer software compilation suite that performs load-balancing functions on transputers.

To achieve a load balanced, simulated annealing evaluates a near-optimal value for an objective function that expresses the cost of computing some portion of the data set while accounting for the message-passing effects. The equation

\[ S = \sum_{i=1}^{N} \left( W_i \right)^2 + t_{\text{comm}} \sum_{\text{p,q}} C_{p,q} \]

where \( W_i \) = workload of processor \( i \), \( C_{p,q} \) =communications overhead between data elements \( p \) and \( q \), \( N \) =number of processors, \( t_{\text{comm}} \) =typical communications time per element, and \( t_{\text{exec}} \) =typical time for floating-point operations per data element (see reference 2), is typical of the kind used in simulated-annealing load balancing.

The simulated-annealing algorithm optimizes this equation. It forces the relocation of data elements to different nodes, based on an initial scattered decomposition of the data. By supplying an initial data decomposition that may be randomly scattered throughout the multicomputer, the simulated-annealing algorithm, when applied to an objective function, directs the placement of the data elements so that the computation and message passing are near optimal.

The multicomputer performance measurement is physically dependent on individual processor speeds and on the rate at which messages can be communicated.

---

**the UnMouse™**

**Incredibly Productive. Ingeniously Creative.**

Move the cursor effortlessly. Just slide your finger over the glass, then press to click. Plus it comes with special templates, each offering up to 60 programmable function keys. And it even works with a stylus.

- So Easy, It's Intuitive
- Faster than a Mouse
- Programmable
- KeyPad
- Stationary
- Saves Space
- Draw, Trace, Doodle

**Call**

1-800-UNMOUSE

TEL: 508-694-9900

FAX: 508-658-9150
Choose Your Tools Carefully

The right graphics software is the key to powerful presentations

Throw away your pencils, T-squares and sketch pads, because you won't be needing those tools anymore. All you really need is your imagination and software from AT&T Graphics Software Labs.

We have software that will help you meet all your graphics challenges. From simple business graphics to sophisticated 3D modeling and animation, AT&T offers the widest range of TARGA®-based graphics software—and we also have software for VGA graphics boards and the Macintosh.*

So whether you're interested in multi-media business presentations, architectural renderings, slide or video production, or any other type of presentation graphics, we have the right tools for you—graphics software from AT&T.

For more information about TOPAS®, RIO® or any of our full line of graphics applications, call 317-844-4364.

Choose AT&T Graphics Software Labs

For Macintosh inquiries circle 388 on Inquiry Card.
For IBM/compatible inquiries circle 389 on Inquiry Card.

*TARGA is a registered trademark of Thomson CSF. Numbers is a registered trademark of Apple Computer Inc.
between nodes. This differs from the situation found on typical shared-memory multiprocessors, where memory bandwidth and processor speed are the critical factors influencing performance.

Choosing a Topology

The logical-concurrency, data-decomposition, and load-balancing issues are central to a multicomputer’s software design. Deciding how to abstract the work into a logically concurrent description and then transform it into the physical concurrency of the multicomputer are key elements. But you must arrange the computation to execute so that message passing proceeds expeditiously between processes, taking the most direct route and avoiding bottlenecks and circuitous paths.

Often, the topology of the multicomputer is closely linked to the geometry of the problem at hand. Two-dimensional meshes are useful for the finite-difference problems found in weather forecasting; hypercube configurations are useful for sorting; and toroids, which are interconnections of nodes arranged in a circular fashion, are used for n-body problems in molecular dynamics. (In this class of problem, you must compute the interaction between each particle and every other one in the system; hence the name “n-body.”)

The connection scheme that you select fixes the topology of the multicomputer. Inmos transputers serve as a cost-effective computation element and are easily configured into almost any topology. Commercially available multicomputers, such as the Touchstone Delta from Intel Scientific Computers (Beaverton, OR) or the Ncube II from Ncube (Beaverton, OR), let you configure a specific interconnect pattern by extracting topologies from a processor farm.

A processor farm is a collection of processor resources (nodes) from which you reserve an arbitrary subset and configure it into a topology for a problem solution. Processor farms permit several users simultaneous access to a multicomputer resource.

The notion that you can design a scalable piece of software, acquire the precise number of computation nodes to implement it, wire the nodes up, load them with the software, and start your computation demonstrates the potential and opportunity presented by multicomputer technology. Whether you construct your own multicomputer from transputers—virtually anyone can do it—or purchase a multicomputer system, you still must write the software.

You now have the freedom to engineer custom multicomputer solutions from off-the-shelf parts. These scalable computation systems, based on the so-called “killer micros” (microprocessors), have emerged as important alternatives to mainframes and supercomputers.

The Cost Factor

Software development costs, even for modest-size projects (10,000 to 50,000 lines of code), are enormous. The Department of Defense spends billions of dollars each year for software to support defense-related acquisitions. The DoD, through the Defense Advanced Research Projects Agency, has funded much of the basic R&D manifest in today’s shared-memory multiprocessor and multicomputer systems.

Now, with the availability of massively parallel multicomputer systems such...
as the Connection Machine from Thinking Machines (Cambridge, MA), it is only a matter of time before these machines find their way into defense-system acquisition. This leads to an important question: How do you estimate software-engineering costs for a multicomputer system?

In data-parallel situations, where a single process is replicated $n$ times, once for each multicomputer node, you only need to write a single piece of software. Therefore, data-parallel software-engineering costs are comparable to those for sequential systems. The logic needed to implement the message-passing scheme, which depends on the topology, is insignificant compared to the body of the code, which requires the majority of the specification, design, code, integration, and testing efforts.

Data-parallel computations use the same piece of software to operate on small portions of a large data set that is data decomposed over all multicomputer nodes. A data-parallel computation would be similar to evaluating a spreadsheet over 100 personal computers simultaneously: Each personal computer would update one spreadsheet cell.

Alternatively, if you need to compute 100 spreadsheets, you would save time by calculating them in parallel, each one on a separate personal computer via Lotus 1-2-3 or Microsoft Excel, rather than waiting for 100 serial computations to complete on a single personal computer.

The logical concurrency of data-parallel computations is usually minimal, and the process-structure graph is comparatively sparse; one process is replicated $n$ times. The solitary process does need communications interfaces to exchange data with its peers, but this is a simple edifice to construct.

However, contrast a simple data-parallel situation with the complexity of an articulated system, such as the avionics control system for the space shuttle. The articulated system requires an extraordinary number of unique processes to implement. The process structure's logical concurrency grows enormously as more granularity is added to the process-structure graph. Process-structure refinement adds successively greater levels of complexity to the system, and this balloons into even more software to write.

For the space shuttle's avionics control system, you must be able to create $m$ unique processes, but their interactions, the message-passing interfaces, are more numerous and varied. The software-engineering costs rise in proportion to $m$, the number of processes.

You can reduce this cost factor if you can substitute or coerce your process structure into a data-parallel context. Data-parallel computations are easier to design and less costly to implement than articulated systems in multicomputers.

How Fast Will It Go?
Estimating performance for multicomputers is another challenge. From the logical concurrency expressed in the process-structure graph, you can evaluate approximately the amount of computation and I/O resources needed to complete a single iteration of the design.

If the system contains many unique, replicated processes on each processor, you may be concerned about the CPU context-switch time. If you use the Inmos transputer, a process context-switch requires 2 microseconds. So, even if you...
have 100 processes per transputer, it will take just 200µs for each iteration through the process queue. This is a small price to pay for executing 100 processes simultaneously.

The transputer's greatest asset as a multicomputer computation element comes from its multiprocess support for concurrently executing contexts. You can easily execute a logically concurrent process structure on a single transputer.

You can simply and painlessly transform that process structure to an n-processor, physically concurrent multicomputer. The transputer is a scalable computation element, and as long as your system's process structure possesses scalable concurrency characteristics, an n-processor multicomputer will supply an equivalent increase in performance.

A utility that evaluates a process structure graph and returns a scalability factor (i.e., the slope of the expected speed-increase curve) for a given process structure would be most useful. It is hard to say if such a computer-aided software engineering tool can be created for multicomputer software engineering, but it would be of tremendous value.

Clearing the Final Hurdle

Linearly scalable software is a special breed of system. Multicomputers are best used on problems that possess a high degree of symmetry in their data. Not all problem domains are sufficiently symmetrical to produce a linearly scalable system. Increases in speed, which grow according to the square root of the number of processors (n) or the logarithm or some other power of n, are also possible.

Parallel processing is a rising star, but it will flame out unless more engineers and scientists are trained to organize logically concurrent systems. A scalable system is a reusable system. You can always refine the data decomposition to accommodate more physical concurrency; for example, you can rerun an eight-processor system on 8192 processors, provided the problem domain is explicitly parallel.

Multicomputer software requires a blend of discipline, intellect, creativity, and desire to build. Applying these skills and your software-engineering knowledge to create linearly scalable software is a challenge, but a highly rewarding one when it is successfully met.

The hardware issue has already been solved, thanks to the Inmos transputer. Software remains the final hurdle to clear if parallel processing via multicomputers is to emerge as a popular alternative to sequential processing.

Acknowledgment

I wish to thank Mr. Philip Presser of the Parallel Software Group, who inspired my awareness of software engineering metrics.

References


Richard Marlon Stein is a software consultant and freelance writer from Van Nuys, California. He has a B.S. in physics from the University of California at Irvine. You can reach him on BIX c/o "editors."
PC System Programming
An encyclopedia of PC technical and programming knowledge. Features parallel working
examples written in Pascal, C, Turbo Pascal and BASIC. Explains how to use extended and
expanded memory, hard disks, PC ports, mouse drivers, graphics and sound. Also explains
memory layout, DOS operations, fundamentals of BIOS and TSR programs. Includes complete
appendices. 920 pages and 2 companion disks with over 1 MB of programs.
#9936 ISBN 1-55755-036-0 $39.95 with 2 companion disks.

Turbo Pascal Internals
Gives you “know how” to program faster, easier, tighter and better. Find out how to use Turbo
for system programming tasks; writing TSRs; performing multi-tasking; using SAA windowing
and implementing extended memory. Learn how Turbo generates machine code, handles
the keyboard, uses UNITS and OOPS, performs fast screen display and more. 750 pages with 2 disks of more than 800K of source code.
#8880 ISBN 1-55755-084-8 $49.95 with 2 companion disks.

Turbo Pascal Internals

BASIC Programming Inside & Out
In-depth coverage for ALL BASIC, QuickBASIC, GW-BASIC and Turbo BASIC programmers. 
Explains how to use sound and graphics; create help screens and pulldown menus; manage
windows in BASIC; use ML with BASIC; create business presentation graphics; print multiple
columns and sideways for professional results and program serial and parallel interfaces. It has
dozens of demo programs and routines you can easily adapt to your own programs. 600 pages
with companion disk.
#9984 ISBN 1-55755-084-8 $34.95 with companion disk.

Programming VGA Graphics
VGA is the standard display mode for PC applications. Learn techniques for writing
by using the flexible and powerful VGA hardware and software. Includes new, unique DOS
commands to perform dozens of VGA functions. Turbo Pascal and BASIC extensions for VGA
display modes, 670 pages with 2 companion disks.

Upgrading & Maintaining Your PC
Shows you how to turn your PC into a high performance machine. Describes what you’ll see
when you open the “hood” and how all of the parts work together. You’ll see how to add a hard
drive, increase memory, upgrade to a higher resolution monitor, or turn your XT into a fast AT
or 386 scramble without having to be an electronics wizard. 240 pages.
#9992 ISBN 1-55755-092-1 $24.95

QuickBASIC Toolbox
Packed with powerful, ready-to-use programs and routines to help you write your own
programs faster and better. Includes complete routines for SAA interfacing; pull-down menus; window; dialogue boxes and file requestors and BASIC scanner program for printing
completed project listings. 260 pages with companion disk.
#8104 ISBN 1-55755-104-9 $34.95 with companion disk.

Batch File PowerTools
Boost your computing productivity with this package for making truly powerful batch files.
Includes dozens of new batch commands for saving time-saving, easy-to-use “power” batch
files. Companion disk contains powerful “Batch BASIC” commands for writing even more
useful batch programs. 240 pages with companion disk.
#8102 ISBN 1-55755-102-2 $34.95 with companion disk.

PC File Formats & Conversions
For every PC user who ever wanted to know how to exchange file formats, describes file
formats for major software applications in detail. Use IMPORT/EXPORT functions in many
applications. Includes conversion program. 280 pages with companion disk.
#8097 ISBN 1-55755-069-7 $34.95 with companion disk.

PC Assembly Language: Step by Step
Teaches you PC assembly and machine language from the ground up. You’ll learn at your own
pace using the unique simulator which shows you how each instruction works as the PC
executes it. 620 pages with 2 companion disks. Includes evaluation version of A86
Assembler and D86 Debugger.
#8096 ISBN 1-55755-096-4 $34.95 with 2 companion disks.

Need information fast? Send us your name and fax number (or address if you prefer) and we will send you more information.

In US & Canada Order Toll Free 1-800-451-4319 ext. 26

Yes, please rush the following items
Yes, please rush your free PC catalog

To: [Name]

Address:

City: State: Zip:

Phone:

Depto:

Optional options:

- Assembly Language Step by Step $34.95
- Programming VGA Graphics $39.95
- QuickBASIC Toolbox $34.95
- Batch File PowerTools $34.95
- PC File Formats & Conversions $34.95
- Tips & Tricks/PC Printer $34.95
- PC System Programming $59.95
- Upgrading & Maintaining Your PC $24.95

In US and Canada add $5.00 postage and handling. International orders add $13.00 per book (surface rate). For Fast International Courier service (except Asia, India, Africa and South America) add $30.00 per book.

Card:

Margins:

Payment:

Signature:

Bill me

Apply to my: O Visa O Master Card O Am.Express

I have enclosed a check M.O.

Dept. B6
INDUSTRY LEADING PERFORMANCE, PRICE AND RELIABILITY

386™-33 FC Cache System

ORDER YOURS TODAY FOR...

$3,195

complete

(lease $39/mo., 48 mos.) 386-25FC price $2,195

Non-cache model shown. Tower case available.

"ACT's 33MHz mini-tower machine is a class act all the way around. The ACT 386-33FC is a well-made machine with easy drive access, good performance, and impressive attention to construction detail. This computer is easy to recommend."

December 25, 1990

Customized Solutions for 286, 386™ and 486™ Systems • Free TRW One-Year, On-Site Warranty • Lifetime Toll-Free Technical Support • 30-Day Money-Back Guarantee • Guaranteed 48-Hour Burn-in • Plus, Free Shipping

M4 Tower M1 Tower Desktop SF M2 Tower M3 Tower M5 Tower

Automated Computer Technology Corporation
10849 Kinghurt • Houston, TX 77099
Telephone (713) 568-1778 • Fax (713) 568-1779

A.C.T. NOW Toll-Free
1-800-521-9237

Lease Terms, Qualified P.O.s Accepted
Dealer and VAR Inquiries Welcome

© 1991 Automated Computer Technology Corporation. All rights reserved. Other product names and trademarks used for comparison may be the properties of other companies. Prices and specifications are subject to change without notice. A.C.T. cannot be held responsible for errors in photography or typographical errors. The equipment above is FCC Class A approved. AST, AUX, NODELL, UNIV, XENIX, OCGS and TRW are trademarks of their respective corporations. TRW on-site service is available in most U.S. locations. The numbers 386 and 486 are trademarks of Intel Corporation.
Superior Service and Support

386 SX™-20 Cache System

COMPLETE SYSTEM FOR...

$2,195
(Lease $64/mo., 48 mos.)

• Intel 80386SX-20MHz CPU
• 2MB 80ns RAM (exp. to 32MB)
• 32K Cache Memory
• 1.2MB and 1.44MB High-Density Floppy Drives
• 89MB Formatted IDE Hard Drive (19 ms)
• 2 High Speed Serial Ports and 1 Parallel Port
• 8 Expansion Slots (6 available)
• 102-Key Enhanced Keyboard
• AMI BIOS w/ Setup and Diagnostics in ROM
• Real-Time Clock with 10-Year Battery
• 200-Watt Power Supply
• Super-VGA Monitor (1024 x 768 at .28mm d.p.)
• Super-VGA Video Card w/512K (exp. to 1MB)
• Microsoft DOS 4.01 or 3.3 (installed)
• Choice of Tower or Desktop Case
• Free Delivery
• Lifetime Toll-Free Technical Support
• TRW One-Year On-Site Warranty
• Wide Variety of Options Available

386SX
Notebook Laptop Available!

486™-33FC Cache System

UPGRADE TODAY FOR...

$4,695
(Lease $143/mo., 48 mos.)

• Intel 80486-33MHz CPU
• 4MB 80ns RAM (exp. to 16MB)
• 64K 20ns Cache Memory
• 1.2MB and 1.44MB High-Density Floppy Drives
• 210MB Formatted IDE Hard Drive (15 ms)
• 2 High Speed Serial Ports and 1 Parallel Port
• 8 Expansion Slots (6 available)
• 102-Key Enhanced Keyboard
• AMI BIOS w/ Setup and Diagnostics in ROM
• Real-Time Clock with 10-Year Battery
• 200-Watt Power Supply
• Super-VGA Monitor (1024 x 768 at .28mm d.p.)
• Super-VGA Video Card w/1MB
• Microsoft DOS 4.01 or 3.3 (installed)
• Microsoft Windows 3.0 (installed)
• Microsoft Serial Mouse
• Choice of Tower or Desktop Case
• Free Delivery
• Lifetime Toll-Free Technical Support
• TRW One-Year On-Site Warranty
• Wide Variety of Options Available

All ACT Systems are NOVELL, UNIX, XENIX, and OS/2 COMPATIBLE

Circle 34 on Inquiry Card (RESELLERS: 35).

ADVANTAGES

1-800-521-9237

“The Complete Integration”

Customize your Professional Level System with your choice of hard drives, memory, video, software, printers, accessories and case options. Our Account Executives will assist you in choosing the best components for the ideal Desktop Publishing, Work Processing, AutoCAD, Accounting, Graphics, Networking Systems or any other demanding application.
Our Systems Stack Up To Be The BEST!

SYSTEM FACTS
* Rugged, Reliable 19" Rackmount
* 18 inches deep with 3 drive bays
* 24 inches deep with 6 drive bays
* Accepts Motherboards
* Accepts Passive Backplanes
* EISA and ISA bus architectures
* 8, 12 or 16-slot configurations
* Cortex Split Backplanes
* 200W to 350W power supplies
* Custom Power Supplies available
* Front mounted keyboard socket
* Rackmount monitors
* Rackmount keyboard drawer
* MS-DOS, OS/2, Unix, Xenix
* Dual card cage cooling fans
* Master Control 16 controller
* Quick disconnect extending slides
* Tilting and extending slides

SYSTEM USAGE
* Network File Server / Duplexing
* Data Acquisition
* Factory Automation
* Motion Control / Robotics
* Communication Networks
* Voice Mail / Message Systems
* Broadcast Communications
* Military / Defense Systems
* Video Editing Studios
* Test System Controllers

ENGINEERING
* Steel Enclosure
* EMI/RFI Plating
* Hard Coat Anodized Face Plate
* Custom Configurations
* Custom Engineering / Design

Cortex Corporation
1-800-888-RACK
12274 Nicollet Ave. S
Burnsville, MN 55337
(612)894-3354 Fax (2414)

Circle 82 on Inquiry Card.
Symmetric multiprocessing (SMP) yields dramatic improvements in Unix server power, throughput, and upgradability by uniting multiple processors into a single system. However, to date, implementations of Unix/SMP have not conformed to open industry standards—arguably the single most significant feature of Unix. Without a widely endorsed standard for Unix running across multiprocessors, implementations will lack the broad applications portability, enterprise-networking capabilities, and other open-systems hallmarks that have made Unix a success.

In the fall of 1989, in an attempt to fill this void, Intel gathered together several companies focused on Unix. At the time, each of the companies was working independently on Unix/SMP variants. To avoid a proliferation of incompatible interfaces, NCR, Okidata, Olivetti, and Unisys joined the Intel Multiprocessor Consortium to produce a single Unix version for SMP systems based on AT&T Unix System V release 4.0 (SVR4).

Over the last year, engineers from the participating companies have spent their workdays at Intel as members of a single engineering team. The result of their efforts is due for delivery in mid-1991 to AT&T's Unix Systems Laboratories (USL), which will package and sell it as Unix System V release 4, Multiprocessor version 1 (SVR4/MP): the new standard for open multiprocessor systems.

What does this standard multiprocessor Unix include? I'll look at SVR4/MP with an eye for the challenges met and the technologies used to design an open multiprocessing system.
Living in a Uniprocessor World
How do you fit multiprocessing into an open-systems model when many of the
design principles drove SVR4/MP's architectural decisions:

- Complete compatibility with uniprocessor SVR4 application-binary interface
definitions. To fulfill the open-systems promise of shrink-wrapped portable
applications, SVR4/MP will run any SVR4 ABI-compliant software and most
other SVR4 software without any change-without even recompiling. It
will pass all conformance tests (e.g., X/Open Portability Guide, IEEE Posix,
and Unix International's SVI) to the same level that SVR4 does.
- Minimal changes to SVR4 source code. It's easy to imagine producing an SVR4/MP
standard that follows the first principle but violates the second, starting from
scratch to produce cleaner multiprocessing code. However, changes to the SVR4
kernel are minimal in SVR4/MP--just enough to ensure efficient multiprocessor
operations. Minimizing changes helps to ensure that the system meets its
compatibility goals and eases future implementation of the same multiprocessing
enhancements to new releases of standard uniprocessor Unix.
- Easy hardware porting. SVR4/MP supports Intel 386 and i486 microprocessors.
However, any operating system requires some porting to move it to a different
machine architecture. SVR4/MP is designed for fast and easy porting. In
development, porting to a new machine has required only three to four days for a single
programmer familiar with the code.

The code is also as portable as possible to new microprocessor architectures. The code
specific to a given microprocessor is isolated, easing efforts currently in progress to port the system to the
Intel i586 and other microprocessors.

The Intel Consortium developed a separate but closely related (and standard)
hardware interface that supports multiprocessor and uniprocessor systems. While standards such as
Posix 1003.1 and SVID define source code portability for applications, and
while the ABI and BCS focus on binary portability for applications, the
DDI/DKI specification defines a standard set of services for system device
drivers. It removes all the operating-system-dependent information from device
drivers, streams modules, and streams drivers to ensure that drivers are portable
both in source and binary form among DDI/DKI-compliant systems.

Reaching Its Goals
The SVR4/MP system adheres to specifications in the Unix System V Roadmap
(Unix International, January 1990), which specifies the essential components of an open-systems Unix/SMP solution.
The best attainable scalability for a multiprocessor system is 100 percent of the first processor; that is, an n-processors
configuration with 100 percent scalability will perform n times better than a uniprocessor configuration. However, both
the hardware and the application mix being run strongly affect scalability. It is rare to see 100 percent.
The goal for SVR4/MP is to achieve 85 percent scalability (i.e., each processor
adds at least 85 percent of uniprocessor throughput) for up to six processors
across a wide range of applications--a target appropriate for entry-level and
midrange multiprocessing machines.

Performance is also measured by how much the SMP enhancements degrade a uniprocessor. Under SVR4/MP, application
performance on a uniprocessor system degrades no more than 5 percent from performance on the same system
under SVR4. System performance is established using a variety of industry-standard benchmarks, including AIM,
Neal Nelson, and AT&T's GAEDE.

Setting Up the Target
SVR4/MP supports multiprocessor architectures that are symmetric with respect to memory; that is, each processor has access to all system memory. This
includes most multiprocessor architectures, except for high-end massively parallel systems (e.g., the Connection Machine from Thinking Machines in Cambridge, MA) with large numbers of processors, each with its own memory.
The target hardware has to support automatic coherency among all memory caches within the system. Typically, SMP systems have high-speed caches for each processor to eliminate some of the overhead required for continual memory access. The most recently used data goes into the cache, where it can be reaccessed more readily than from system memory.
In a multiprocessor system, however, processors execute common kernel code and operate on common data structures. If one processor modifies the data in its cache, then the corresponding items in other processors' caches become obsolete, unless all are updated to reflect the new value. Most multiprocessor systems use hardware to ensure consistent values for data in these memory caches. SVR4/MP assumes that this control is present.
Typically, however, multiprocessor hardware does not provide the capability to ensure coherency in translation lookaside buffers, which cache virtual-memory translation information. SVR4/MP provides its own TLB synchronization method (see the text box "Lazy TLB Flushing" on page 248).

I/O access can be symmetric or asymmetric; that is, all I/O devices can--
Open Intel's new 386/486 C Code Builder™ Kit. And tear into the increased memory and performance of 32-bit DOS protected mode.

Inside, you'll find everything you need to develop 32-bit applications. That means you get a Microsoft and ANSI compatible C Compiler and Libraries, Linker, Librarian, Make Utility, and Source Level Debugger. We've even included a DOS Extender that's DPMI-compliant. Compliancy that enables easy migration to Windows® from Microsoft.

To make moving up even simpler, we've also included free Intel support and a $695 price tag. With no royalties to pay. Ever.

Try it at no risk. Purchase it from your Intel dealer with a 30-day, money-back guarantee. Or call 1-800-525-3019 for fax document #9901, or Intel customer service at 1-800-538-3373. Because with Code Builder, the hardest thing about getting into 32-bit programming is opening the box.

©1991 Intel Corporation. *DPMI compatibility with these operating environments is based upon publicly stated intentions of Microsoft Corporation. Intel is a registered trademark, Intel 386, Intel 486, and Code Builder are trademarks of Intel Corporation. Windows is a registered trademark of Microsoft Corporation.

Circle 154 on Inquiry Card (RESELLERS: 155).
Lazy TLB Flushing

A particularly interesting feature of Unix SVR4/MP is how it makes translation look-aside buffers coherent under software control. TLBs are common to the many Unix multiprocessors that have virtual memory. A translation is needed between virtual addresses (which the program uses) and physical addresses (which the memory system and the bus use). Typically, some type of hardware translates the virtual addresses in the program to the physical addresses used outside the processor.

To speed these translations, chip designers often create a cache of address translations—much like normal data caches. If a processor translates an address, it places the virtual and physical addresses in the cache for the next translation, if required.

This cache is called a TLB, and it presents the same problem within multiprocessor architectures as data caches do. If one processor changes an address translation, then the same translation already in another processor's TLB will be outdated; that processor could use it to translate a virtual address to an obsolete physical address.

The most obvious solution would be to broadcast every changed translation via an interprocessor interrupt, but that costs too much in overhead: A uniprocessor SVR4 system running a fairly moderate load changes translations about 200 times per second. Instead, SVR4/MP uses the "lazy TLB-flushing algorithm." In the uniprocessor code, whenever a processor changes a translation, it updates the uniprocessor's own TLB. The algorithm piggybacks on that local flushing. No broadcast is necessary as long as no other processor tries to use that address.

If another processor does try to use the address, there's no problem if the second processor flushes its own TLB between the time the first processor changes the translation and the time the second processor tries to use it. It's not necessary to do an expensive broadcast operation in these cases. The tricky part is determining when a broadcast is necessary.

SVR4/MP's solution is to create a systemwide generation number that is incremented every time any processor flushes its TLB. Each processor keeps a local copy of what the generation number's value was the last time that processor flushed its TLB. Every time that a processor changes the translation for a virtual address, the current systemwide generation number is associated with that address.

If the generation number associated with the address a processor is going to use is greater than any processor's local number, an old translation of the address may exist and the requesting processor's TLB may need to be flushed. If it does, the system executes a broadcast and global flush. If the generation number associated with the address is less than all other local generation numbers, then all other processors have already flushed their TLBs since the last time that address translation was changed.

SVR4/MP still performs 200 or so local flushes a second, as does the uniprocessor. However, this method almost never requires a broadcast and global flush.

Balancing the Load

Various mechanisms make it easier to fully use the parallelism inherent in multiprocessor systems; the most notable are threads. To date, however, the industry has not agreed on the proper interface for parallel programming. At least four separate standards organizations are currently working on interface definitions, including the Unix International Workgroup on Multiprocessors and the Posix P1003.4 Real-Time Committee.

So far, commercial computing markets have shown little demand for applications parallelism. Until recently, scientific users, whose applications (e.g., modeling windflow over a wing) show significant benefits from parallelism, have dominated the multiprocessing market. These users typically run single, monolithic applications, and they are willing to invest the substantial programming efforts required to obtain the highest possible performance.

Corporate installations usually have many users running a variety of applications. It's more critical that the system balance the load evenly across all available processors than that it run a single application very fast. For this reason, as well as the lack of standards, few commercial applications support threads.

Thus, SVR4/MP won't include extensive parallel-programming enhancements until the industry reaches consensus. This means that a uniprocessor application running by itself will not benefit from additional processors. But SVR4/MP does provide automatic load balancing—an easy task based on the standard SVR4 uniprocessor scheduling method.

On a uniprocessor system, one of the kernel's main tasks is to arbitrate competition among processes (i.e., programs that are executing) for the single processor. The kernel selects a process that is ready to run from among those with the highest priority and allocates the processor to it. The process then executes until the kernel performs a context switch (i.e., it stops the current process and allocates the processor to another one).

In SVR4/MP, the kernel operates essentially the same way. At any particular time, if you have n processors, you have n active processes. Each processor schedules processes, switches contexts, and reschedules independently. Because each processor always wins when processes are waiting, and because the self-scheduling processors always pick the highest-priority process that is available, the load spreads out automatically and evenly.

Keeping the Door Locked

Far greater challenges occur in designing a multiprocessing operating system...
Effectivity in developing MS Windows or OS/2 Presentation Manager programs

If you are building sophisticated C++ applications for MS Windows or OS/2 PM, you could benefit from
- A toolbox with standardized Graphical User Interface (GUI) parts
- An Interface Builder which constructs the standard parts of your program for you
- A Browser so that you can examine and edit the numerous pieces of code of your application

We introduce our GUI_Master (CLASS-TREE for C++) which we originally developed for our own use to lessen the burden of writing programs so that one can focus on the application parts and not on the GUI part.

You don't really want to invest your valuable time in reinventing the GUI-wheel
- Neither do we, so we included over 85 classes containing a wide range of GUI building blocks. Anything that could be accomplished through "normal" programming can be done if you use our product. It's just a lot easier.
- Many of the things you might not include in your application because they're too complex or time-consuming to program, are easy to make with our GUI_Master (CLASS-TREE for C++)
- We provide the Interface Builder, with which you specify all properties of the visual objects of your program. The interface builder then generates the necessary source code, the resource specifications and even the make file.
- The Browser enables you to examine your own code and code made by others, and to understand the class structure of that code. From the Browser you can launch the editor of your choice to modify a C++ program.

You may want detailed reference documentation
- We supply nearly 1200 pages of detailed class descriptions, method reference etc. An index is included, of course.

You may need a cookbook and example programs
- We provide 7 functional example programs and a cookbook explaining the "how to's".

From our experience developers want to use products from someone who knows what he is talking about.
- Vleermuis Software Research (VSR) is an independent R&D organization, which, over the past 3 years, spent over 40 person-years on OO development on a broad spectrum of commercial workstations.

To use our GUI_Master (CLASS-TREE for C++) you must have:
- A C++2.x compiler, as we do not supply a compiler with our product. We suggest using the Zortech compiler, but we have also tested most of the others. Write for details.

We try to keep our prices reasonable
- $495.= OS/2 PM version
- $545.= MS WINDOWS 3.0 version
Prices include airmail delivery (may take three weeks)
Add $50.= for courier service.
General availability in January 1991 for the OS/2 version
MS Windows version in May 1991.

Write or fax your order details to:
Vleermuis Software Research bv
P.O. Box 2584
3500 GN Utrecht
The Netherlands
Fax: Intl. + 31 30 310426

Use Mastercard (number and expiration date) or certified cheque.

Circle 354 on Inquiry Card.
starting from a uniprocessor porting base. One major assumption pervades the entire SVR4 kernel: The code runs on one processor. Whenever a process runs in the kernel, it knows it has complete control of the machine (except for device interrupts) until it explicitly gives up control.

This "single-minded" control ensures the integrity of all the kernel's data structures (which contain data accessed for system calls or kernel functions). Examples of these structures are the Process Table, which keeps track of all processes in the system, and the File Table, which tracks all open files. If any of the structures become corrupted, the system will either crash or develop a bad limp.

Multiprocessing breeds anarchy, however, and dramatically violates the assumption of a single thread of control. Multiple processors run processes independently. It's easy to imagine a situation where multiple processes simultaneously access and even modify the same data structures.

For example, consider a data structure called count, an integer that is continually incremented; the process reads the integer, adds 1 to it, and writes it back to memory. If two processes are performing this same operation, they could both read the value 5 simultaneously, increment it, and write it back as 6. The system would miss one increment; the count should actually be 7.

The only type of protection that even remotely addresses this problem in SVR4 is the system-priority-level mechanism for blocking selected device interrupts to the processor. These are interrupts that could themselves modify or look at the data structures the interrupted process is using. But SPLs don't stop those same device interrupts from occurring on another processor; nor do they keep other processes from simultaneous access.

The major effort in multithreading SVR4 was to implement a type of lock, called a mutual-exclusion (mutex) lock, associated with every data structure in the kernel. Before accessing any data structure, a process must acquire the lock associated with it. When the process is finished with the data, it releases the lock. This mechanism ensures that only one process at a time is manipulating the data associated with the lock.

Some Unix/SMP variants have implemented locks only on those portions of the kernel that the majority of applications use most often. In those systems, atypical applications that use less popular system calls will not benefit from multiprocessing. To ensure that all applications scale properly, the SVR4/MP kernel has implemented locks throughout and is entirely multithreaded.

**The Flexibility Stretch**

The mutex locks were designed to minimize modification of SVR4 source code.
SYMMETRY, THY NAME IS UNIX

and to allow flexibility for code optimizations. For instance, many multipro­
cessing lock models distinguish between locks that spin and locks that sleep. Spin­
ning, or waiting for the lock rather than switching contexts, is usually for­
duced between

turning, or waiting for the lock rather than switching contexts, is usually used for
locks that a process holds for a short pe­
period of time; conversely, if a given lock is
typically held for a long time, the process
goes to sleep by switching contexts.
The mutex locks can either spin or
sleep, and their mode of operation is de­
termined under software control during
initialization. That means that a given
lock can be switched between spin and
sleep simply by changing the one place in
the code where it’s initialized, rather
than by replacing the lock throughout the
kernel. Or, if you wish, the spin/sleep
parameter can also be changed only at
specific locations.

Another parameter that a lot of sys­
tems typically lock in is the exclusive or
shared option. An exclusive lock is a
normal kind of lock that requires other pro­
cesses to wait while it is held. When
shared locks are acquired, the calling
process can choose to acquire them in
either shared or exclusive mode. If the
choice is “shared,” new rules apply.
Other processes can also acquire the
lock, but only in shared mode. Thus,
multiple processes can hold a shared
lock, but only one process can ever hold
an exclusive lock.

Shared locks decrease contention on a
given lock when a process needs to pro­
tect a data structure that it will be look­
ing at for a while but not modifying.
Shared locks are also known as reader/
writer locks: Readers acquire shared
locks in shared mode, and writers obtain
them in exclusive mode.

Innovative and Recursive
A couple of other features in the mutex
locks are worth a brief discussion as
well, because they are not commonly
used in other multiprocessing systems.
The first is recursion; the second is au­
tomatic release on sleep.

In the basic model, if a process tries to
acquire a lock that is already held, it must
wait. But what if the process that already
has the lock tries to acquire it again? The
holding process will find that the lock is
held and will wait for it forever because it
is the one holding the lock—a classic case
of single-processor deadlock.

Other multiprocessing systems don’t
allow this: The code always knows what
locks the process already holds. SVR4/
MP’s second design principle—minimal
changes to the SVR4 source code—made
it difficult to use that model.

SVR4’s design permits various kernel
subsystems to make calls to each other
without concern for whether the sub­
system is being reentered. For example,
many common operations cause the file
system to call the virtual memory sys­
tem, which again calls the file system.
Although not a bad design, this feature
makes it hard for any one subsystem to
know what locks are being held when it is
called. Even locks that belong exclusively
to the subsystem may already be held
as a result of an earlier nested call into it.

SVR4/MP’s solution to deadlock is re­
cursion. If the process already has the
lock and tries to acquire it again, a coun­
ter is incremented to indicate how many
times the process has acquired the lock
so it knows how many times to release it.
In this way, functions are more isolated
and don’t have to be concerned with what
locks the process that is calling the func­
tion has already acquired.

Recursive locks are a bit more expen­
sive in terms of overhead, so locks that
don’t require recursion are declared to be
nonrecursive at initialization. The only
other disadvantage to the recursion mod­
el is aesthetic: Elegant code would be
more “lock-aware.”

Automatic Release
What happens to all the locks that a pro­
cess holds when it goes to sleep? Keeping
all the locks would severely degrade sys­
tem performance. A process that goes to
sleep waiting for a disk I/O operation
may sleep for many milliseconds while
holding onto valuable data resources. All
the other processes that need the locks
have to wait as well, even though the pro­
cess is not actually changing anything
while it sleeps.

Many multiprocessing systems are de­
sign ed so that processes won’t go to sleep
holding locks that other processes re­
quire. However, such a model would re­
quire rewriting substantial portions of
the SVR4 source code to make explicit
which locks a process holds when it goes
to sleep and which ones it should or
should not release. There are hundreds
of places in the kernel where processes go
to sleep, and it is not at all obvious at
these points which locks they hold.

In fact, a multiprocessing port of Unix
SVR3 using such a model was written. It
involved changing all the sleeps in the
kernel to know which locks are held.
This was enormously difficult, and it
took nearly three years to come up with a
properly debugged system; one lock or
another was always missed. SVR4/MP’s
unorthodox solution was to automatically
release all locks upon sleep and rely on built-in uniprocessor mecha­
nisms to maintain data consistency.

In the uniprocessor model, the data
structures can be in any indeterminate state while the processor executes a process. If the process is going to switch contexts (i.e., go to sleep), the built-in uniprocessor mechanism ensures that the data structures are in a consistent state such that other processes can look at them and retrieve meaningful information. Thus, points where a process goes to sleep are significant in the uniprocessor model; that's where the data structures are consistent.

In the strict multiprocessor model, however, data structures either must be consistent or, if they aren't, must be locked so that no other processes can access them. But eliminating the uniprocessor model would require major changes to the SVR4 source code.

So, SVR4/MP reconciles the two models, using both multiprocessor locking mechanisms and standard uniprocessor mechanisms to ensure data consistency. Whenever a process goes to sleep, all the locks it holds are automatically released, without the process's knowledge. When the process wakes up again, it automatically reacquires all the locks. This solution works because the existing uniprocessor code already ensures that everything is consistent when a process goes to sleep. Thus, the mutex locks really only protect data structures between sleep points.

Enhancements built into the context-switch mechanism ensure that a process reacquires all its locks by keeping a list of all acquired locks in a lock stack. Before a newly reawakened process recommences executing code, the mechanism looks at the lock stack and reacquires all the locks the process held when it went to sleep.

The solution maintains the Unix uniprocessor model, but, again, because locks are released without a formal release procedure, multiprocessing purists may consider it aesthetically—although clearly not functionally—impaired.

In case the need arises to replace existing uniprocessor mechanisms that protect data structures during sleep with a more general multiprocessor mechanism, SVR4/MP also implements another type of lock, called a resource lock. Resource locks do not release upon sleep and are used rarely, so changes to existing uniprocessor code are minimized.

Block and Tackle
Another uniprocessor mechanism that SVR4/MP maintains is the SPL mechanism, which blocks device interrupts to the processor. Generally, if a processor is executing a process and a hardware device interrupts it, the processor will save the state of process and immediately start executing code in the interrupt handler. A problem occurs, however, if the interrupt routine needs to access a data structure that the process was working with when the interrupt occurred. The interrupt will spin, waiting to acquire the associated lock. However, the lock will never be released, because the interrupted process holds it. Deadlock will occur.

In fact, deadlock threatens any data structure accessed at interrupt level, so SVR4/MP contains an SPL level built into the locking primitives. Whenever a process acquires a lock, an SPL level is one of the function parameters.

Bound and Gagged
Multiprocessing locks are not just for the kernel. Multithreaded device drivers, streams modules, and streams drivers that conform to the new DDI/DKI specification also use lock interfaces. Just like
kernel code, device-driver code may also run on more than one processor at a time, making it necessary to lock data structures internal to the driver.

But DDI/DKI uses different types of locks, developed through long-term negotiations among the Consortium, USL, and other industry vendors to ensure an industry commitment to standardization. The new DDI/DKI specification also cleans up some of the ambiguities in the original specification.

SVR4/MP also provides support for single-threaded device drivers that conform to the original DDI/DKI specification. It permits them and their interrupts to be "bound" to a specified processor, thereby eliminating the need for locks.

Support for device-driver binding solves yet another problem: supporting hardware with asymmetric I/O. If the hardware only lets a specific processor access a certain device, the device driver is effectively bound to that processor.

**Private Access**

In uniprocessor SVR4, there are several processor-specific data structures that must be available for every processor in a multiprocessor. Examples of such variables are fpkind, which indicates what kind of FPU is on the processor; id, which indicates the set of interrupts the processor is currently masking; and curproc, which is a pointer to the processor currently running on the processor.

There are two ways to replicate these variables on a per-processor basis. Each variable could be changed into an array of variables, but this would require many changes throughout the code. Instead, SVR4/MP provides processor-private variables, which use the virtual memory system to map the same virtual address to a different physical address and memory location for each processor. This solution required changing only the mapping of the processor-specific variables; the numerous usages of these variables (e.g., fpkind, curproc) were not changed at all.

**An Easy Migration**

Unix SVR4/MP and the enhanced DDI/DKI specifications provide an easy migration path to Open Unix/SMP. Broad compliance with SVR4/MP’s three main principles—complete compatibility with uniprocessor SVR4 ABI definitions, minimal changes to SVR4 source code, and easy hardware porting—will be key to the success of this new standard Unix for open multiprocessor systems.

Mark Nudelman is manager of multiprocessor software for the Unisys Unix Systems Group in San Jose, California. He was one of the initial architects of Unix SVR4/MP and was part of the Intel Multiprocessor Consortium’s joint engineering team. You can reach him on BIX c/o “editors.”

---

**New · Compact · Low Profile PC and Notebook Power Supplies**

Proven. New. Potrans’ 25 and 40 watt switch-mode power supplies are perfect for Notebook style and larger PCs and peripherals. Pocket-size—4.3” and 6.0” lg, 0.75 and 1.4 lbs. Competitively priced with OEM quantity discounts. Call us today at (714) 975-1222.
Even This Is More Confining Than Clipper.

Just as the vast expanse of the American West gave its settlers a new perspective on opportunity, Clipper's open architecture lends unprecedented freedom to application development.

Unlike fixed systems, Clipper never forces you to "make do". Its language is fully extensible with user-defined functions and new user-defined commands. You can extend the language with routines written in Clipper itself, or integrate code from other languages like C, Assembler, dBASE® and Pascal. Odds are, you already have knowledge you can use with Clipper!

But if a customizable language isn't enough, there's even more elbow room. Database and I/O drivers can be supplemented or replaced. Even Clipper's linker knocks down barriers by allowing you to develop applications larger than available memory, without defining overlays! And when you're done, Clipper's compiler generates stand-alone, executable files for cost-free, unrestricted distribution.

So, don't let the bounds of fixed systems fence you in. Unleash your imagination in the wide-open spaces of Clipper. To find out more, give us a call today.

Clipper® 5.0
The Application Development Standard

213/390-7923
Ask For Department-A

Circle 208 on Inquiry Card.
RESOURCE GUIDE

Multiprocessing Systems

Advanced Logic Research, Inc.
9401 Jeronimo
Irvine, CA 92718
(800) 444-4257
(714) 581-6770
fax: (714) 581-9240
Circle 1036 on Inquiry Card.

Alliant Computer Systems
One Monarch Dr.
Littleton, MA 01460
(800) 622-1113
(508) 466-4950
fax: (508) 488-6786
Circle 1035 on Inquiry Card.

American Megatrends, Inc.
1346 Oakbrook Dr., Suite 120
Norcross, GA 30093
(800) 828-9264
(508) 486-1398
Circle 1037 on Inquiry Card.

Axon, Inc.
468 Totten Pond Rd.
Waltham, MA 02154
(800) 644-2287
(408) 422-1160
fax: (408) 432-0866
Circle 1038 on Inquiry Card.

Apricot in Canada, Inc.
111 Granton Dr., Suite 401
Richmond Hill, Ontario, Canada L4B 1L5
(416) 492-2777
fax: (416) 492-2513
Circle 1039 on Inquiry Card.

Arche Technologies, Inc.
48881 Kato Rd.
Fremont, CA 94539
(800) 623-3584
(415) 623-8100
fax: (415) 683-6754
Circle 1040 on Inquiry Card.

AT&T Computer Systems
1 Speedwell Ave.
Morristown, NJ 07960
(800) 247-1212
(201) 898-8000
fax: (201) 644-9768
Circle 1041 on Inquiry Card.

Cognet Research, Inc.
2010 Northeast 25th Ave.
Hillsboro, OR 97124
(503) 681-8910
fax: (503) 640-5966
Circle 1043 on Inquiry Card.

Circle 1044 on Inquiry Card.

University of California
15201 Northwest Greenbrier
Beaverton, OR 97065
(503) 629-9147
fax: (503) 629-7926
Circle 1053 on Inquiry Card.

Mckoi Scientific
Reservoir Place
1601 Trameo Rd.
Waltham, MA 02154
(617) 890-7676
fax: (617) 890-5042
Circle 1054 on Inquiry Card.

Mercury Computer Systems
600 Suffolk St.
Lowell, MA 01854
(508) 458-3100
fax: (508) 458-9580
Circle 1055 on Inquiry Card.

MicroWay, Inc.
P.O. Box 79
Kingston, MA 02364
(508) 746-7341
fax: (508) 746-4678
Circle 1056 on Inquiry Card.

Mylex Corp.
47650 Westinghouse Dr.
Fremont, CA 94539
(800) 446-9539
(800) 733-1500
(415) 683-4600
fax: (415) 683-4662
Circle 1057 on Inquiry Card.

Nec Systems
1825 Northwest 167th Place
Beaverton, OR 97006
(503) 356-2823
(503) 629-5085
fax: (503) 645-1737
Circle 1058 on Inquiry Card.

NetFrame Systems, Inc.
1545 Barber Lane
Milpitas, CA 95035
(800) 821-0806
(800) 852-3726
(408) 944-0600
fax: (408) 434-4100
Circle 1059 on Inquiry Card.

Omnivision Corp.
245 West Roosevelt Rd.
Building 9, Unit 61
West Chicago, IL 60185
(708) 293-9500
(708) 293-9525
fax: (708) 293-9525
Circle 1059 on Inquiry Card.

Sequent Computer Systems
15450 Southwest Koll Pkwy.
Beaverton, OR 97006
(503) 854-9969
(503) 626-5700
fax: (503) 578-9890
Circle 1108 on Inquiry Card.

Solbourne Computer, Inc.
1900 Pike Rd.
Longmont, CO 80501
(800) 356-8785
(303) 772-3400
fax: (303) 772-3646
Circle 1109 on Inquiry Card.

Topology, Inc.
4700 Ward Rd.
Denver, CO 80033
(303) 421-7700
Circle 1116 on Inquiry Card.

Tricord Systems, Inc.
3750 Annapolis Lane
Plymouth, MN 55447
(800) 852-3726
(713) 370-0670
(713) 370-0567
Circle 1110 on Inquiry Card.

Troque Computer, Inc.
81 Franklin St.
New York, NY 10013
(212) 925-1715
fax: (212) 925-3029
Circle 1111 on Inquiry Card.

Unisys Corp.
P.O. Box 500
Blue Bell, PA 19424
(215) 986-4011
Circle 1112 on Inquiry Card.

Wyse Technology
3471 North First St.
San Jose, CA 95134
(408) 473-1200
fax: (408) 922-4316
Circle 1113 on Inquiry Card.

Zenith Data Systems
2150 East Lake Cook Rd.
Buffalo Grove, IL 60089
(708) 699-4800
Circle 1114 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 as a negative judgment. The information here was believed to be accurate at the time of writing, but BYTE cannot be held responsible for omissions, errors, or changes that occur after compilation of the guide.

JUNE 1991 • BYTE 255
Electronic and Computer Products to Break All Performance Barriers

Whether you are driving a screaming racing machine down the track, propelling an electronic design toward market or revving up a business dependent on personal computers...it's all about performance. At Jameco, we dynamically tune our products, customer support, quality assurance, and competitive pricing—to make sure your purchases do exactly what you want them to do...perform.

Jameco's wide product choices give you the inside track. Select from a full price/performance lineup...from the most advanced computing tools available, to mid-range, to starter systems. Select from our catalog of over 4000 Jameco products. And, our comprehensive customer support keeps things running smoothly for everyone from power users, to corporate managers, and to the hobbyist. Our technically expert staff members answer your questions by phone and discuss your needs, starting with your purchase plans and continuing through the life of the product.

The Jameco crew has spent 16 years synchronizing distribution of quality electronic components, computer products, and test and measurement equipment. We track the latest technology,
Jameco 16MHz 80386SX Computer Kit
- 2MB RAM (expandable to 8MB)
- 200 Watt power supply
- 101-key Keyboard
- Multi I/O Card
- Toshiba 1.44MB 3.5" Floppy Drive
- DR DG5 5.0 and AMI diagnostic software
$999.95 /JE3816A

Video monitor/adapter not included

buy globally for the best quality and value, thoroughly prequalify each vendor and product, and constantly test products received into stock.

Our customers buy with confidence because of Jameco’s consistent quality, wide selection, latest technology, solid customer support, and competitive prices. Shift into high gear and join our large family of satisfied customers from big and small businesses, schools and universities, government and individuals.

Break through the electronic and system performance barrier. Call Jameco for a complete product catalog or to place an order 24 hours a day. Or, stop by our catalog-store/headquarters located in Belmont, CA, serving Silicon Valley and the Stanford technology park area.

JAMECO®
ELECTRONIC COMPONENTS
COMPUTER PRODUCTS

1355 Shoreway Rd.
Belmont, CA 94002
(415) 592-8097
FAX: (415) 592-2503

All trade names are registered trademarks of their respective companies.

Circle 164 on Inquiry Card.

© 91 Jameco Electronic Components/Computer Products
Until recently, many graphics professionals refused to consider the personal computer as a tool for serious color work. The reason was simple: 8- and 16-bit color systems were not able to display the range of hues available from paint and other traditional media. But now that's changed. Macintoshes were the first to provide 24-bit display capabilities out of the box, which meant Macs could process 16.8 million colors for true-to-life coloration—hence the term true color for 24-bit colors. This is more than enough hues to satisfy the needs of many artists, illustrators, and desktop publishers. More recently, Intel-based PCs heightened their true-color presence, thanks in part to new or lower-priced color boards from Hercules, Truevision, and RasterOps.

While the price of even a minimum true-color painting system isn't cheap on either platform, the rewards are significant. The main advantage is that you can readily print or transmit electronic artwork. For example, an artist in Duluth might produce thumbnails for a magazine cover and send the sketches via modem to a New York art director for immediate feedback. The finished, full-color image can subsequently travel cross-country just as efficiently. Similarly, a desktop publisher might exploit the full range of colors in these paint packages to retouch and enhance electronic images for an advertising insert. In addition, these programs provide graphics professionals with a wide range of special-effects tools, such as gradient fills, embossing, and drop shadows.

You will need sophisticated software with a boatload of features to electronically duplicate canvas and paint (see the features table). This is where the BYTE Lab stepped in. We judged five Mac-based and three PC-based 24-bit-color paint applications that were shipping at press time to see how well they met the requirements of professional artists. (A sixth Mac product, Microlusions' Photon Paint 1.1, didn't arrive in time for testing.) The Amiga platform also has its share of...
WHAT 24-BIT PAINTING DOES
Provides color palettes of 16.8 million colors and a range of painting, drawing, and special-effects tools.

LIKES
Using an almost unlimited range of colors, you can create or enhance artwork for publications, presentations, or exhibitions and readily print or transmit the images electronically.

DISLIKES
Hardware and software costs can be staggering. For a complete Mac or PC system, plan to spend at least $7500—much more if you have special needs, such as a 19-inch display for full-page artwork.

RECOMMENDATIONS
On the Mac high end, choose Studio/32 for its efficient color and printing control, plus its support for Pantone color matching (however, beware of the program's large appetite for RAM). If you need a paint program that produces color separations, PixelPaint Professional is your only current option. Zedcor's DeskPaint is the best buy on the Mac low end. Tempra gets our nod for PC-based programs. It's the least expensive of the lot and handles a variety of image formats.

REQUIREMENTS
For the Mac, you'll need a 20-MHz IIsi or better with an 80-MB hard disk drive, no less than 4 MB of RAM (you'll want 8 MB of RAM for full-page images), a 24-bit graphics board, and a monitor. PC systems must consist of at least a 386SX machine with a minimum of 80 MB of hard disk space and 640K bytes of base memory, enough EMS memory to support your choice of software, a 24-bit display board, and a multiscreening monitor.
### Comparing 24-Bit Paint Features

How can you tell paint programs apart? Here's a summary of price and capability choices for Mac and PC packages.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Color</th>
<th>MacCheese 2.07</th>
<th>DeskPaint 3.03</th>
<th>Oasis 1.0</th>
<th>PixelPaint Professional 1.0</th>
<th>Studio/32 version 1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mac programs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum RAM</td>
<td></td>
<td>1 MB</td>
<td>2 MB</td>
<td>5 MB</td>
<td>2 MB</td>
<td>5 MB</td>
</tr>
<tr>
<td>Customizable brushes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Anti-aliasing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zoom or magnify</td>
<td>100%-900%</td>
<td>6.25%-1600%</td>
<td>No</td>
<td>1</td>
<td>Limited only by memory</td>
<td>Limited only by memory</td>
</tr>
<tr>
<td>Number of open documents</td>
<td>Limited only by memory</td>
<td>Limited only by memory</td>
<td>Limited only by memory</td>
<td>Limited only by memory</td>
<td>Limited only by memory</td>
<td></td>
</tr>
<tr>
<td>Mask support</td>
<td>No</td>
<td>Only to remove colors</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Color models</td>
<td>RGB, HSV</td>
<td>RGB</td>
<td>RGB, HSV, CMY, HSL</td>
<td>RGB, HSV, CMYK</td>
<td>RGB, HSV, CMY, HSL</td>
<td></td>
</tr>
<tr>
<td>Pixel depths (bits)</td>
<td>1, 2, 4, 8, 16, 24, 32</td>
<td>1, 2, 4, 8, 16, 24, 32</td>
<td>1, 2, 4, 8, 16, 24, 32</td>
<td>8, 16, 24, 32</td>
<td>8, 16, 24, 32</td>
<td></td>
</tr>
<tr>
<td>Import format</td>
<td>MacPaint, PICT, TIFF, EPSF²</td>
<td>MacPaint, PICT, TIFF</td>
<td>PICT, TIFF, TGA</td>
<td>MacPaint, PICT, TIFF, EPSF²</td>
<td>MacPaint, PICT, TIFFF, EPSP²</td>
<td></td>
</tr>
<tr>
<td>Export format</td>
<td>PICT, MacPaint, TIFF</td>
<td>PICT, MacPaint, TIFF, TIFF, TGA</td>
<td>PICT, TIFF, TGA</td>
<td>PICT, TIFFF, EPSF²</td>
<td>PICT, TIFFF, JPEG, EPSF²</td>
<td></td>
</tr>
<tr>
<td>PMS support</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Color separations</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Price</td>
<td>$99</td>
<td>$199.95</td>
<td>$795</td>
<td>$695</td>
<td>$695</td>
<td>$695</td>
</tr>
</tbody>
</table>

1. Magnification depends on a combination of the screen and a detail window's magnification.
2. Only the preview bit map is read and edited; the PostScript code is not altered.
3. Can read raw data if user supplies header length and pixel size.
4. Hercules Art Dept. price includes display board with 2 MB of VRAM and additional software.

24-bit paint packages; however, the integration of processing and display hardware isn’t as straightforward on the Amiga as it is on Macs and PCs (see the text box “Amigas Grapple with 24 Bits” at right).

In addition to the hands-on evaluations that were done in the BYTE Lab, we asked two professional artists, Roger Goode and Cal Vornberger, to use these applications to create original illustrations and rate each program for its facility and power. Their personal perspectives appear in the text boxes “A Painter’s Brush with Mac Color” and “State-of-the-Art PC Art” on pages 262 and 270, respectively.

Those diving into the world of 24-bit color painting need a grounding in some special terminology, much of it borrowed from the lexicons of traditional painting and printing. In the text box “How to Choose the Right Color Application” on page 275, we define paint programs and discuss two related graphics applications. “Tools and Terms: A True-Color Glossary” on page 273 presents definitions and illustrations of many other important terms you’ll need to know.

**Real Systems**

Graphics professionals may have a corollary when confronted with the price tag for 24-bit systems. For the Mac, nothing less than a 20-MHz IIsi will do unless your creativity can take a backseat to lengthy screen redraws. You’ll need a hard disk with a minimum capacity of 80 megabytes to store images and no less than 4 MB of RAM. You’ll want 8 MB of RAM if you create large images. Then there’s the matter of a 24-bit display, which can raise the bill steeply, depending on your needs. If a 13-inch monitor will do, both Apple and RasterOps offer display boards for well under $1000. If you need a 19-inch behemoth to display full-page or larger images, plan to spend over $7000 for the monitor and board.

Mac prices have been falling, so some fine Mac systems are within the financial reach of professional studios. A complete system consisting of a Mac IIsi with 9 MB of RAM and a 13-inch 24-bit display will cost about $8750, list. You can get some better deals if you take third-party vendors for RAM and display hardware. You can also trim the bill if you opt for a 16-MHz 68030-based Mac.

PC-based artists will need at least a 386SX machine with a minimum of 80 MB of hard disk space and 640K bytes of base memory (your software choice will determine the minimum amount of EMS memory you’ll need; the more the better). Also, you’ll need a display board such as the Hercules Graphics Station Card ($1024) or Truevision’s TARGA (Truevision Advanced Raster Graphics Adapter) ($2500 for the TARGA + 64), plus a multiscan monitor. Total cost: approximately $5000.

For our BYTE Lab evaluations, we used a Mac IIfx with 8 MB of RAM and a Hercules by SuperMac Technology’s 19-inch monitor and Spectrum/24 PDQ board. We also ran a Mac IIfx with 8 MB of RAM and an Apple 8*24GC board. On the PC side, we used a Gateway 386SX with 4 MB of RAM, a Hercules Graphics Station Card, and Truevision’s TARGA + 64 display board. We printed images on a Tektronix Phaser II PX thermal-wax color printer with 10 MB of RAM.

The mouse’s lack of precision and control made us feel like cavemen daubing lard on the walls with a stick. Digitizing tablets with a stylus solve this problem. We used Wacom’s SD-510C tablet on the Mac and a Numonics GridMaster on the
Amigas Grapple with 24 Bits

Bob Ryan

At a comparable resolutions and depths, you won’t find a faster personal computer for graphics than the Amiga. Its speed is a function of the tight integration of the CPU and the video display system, which includes a blitter and a video coprocessor.

While delivering speed, this integration is also a curse, making it extremely difficult to upgrade the resolution and depth of native Amiga graphics while maintaining compatibility with current software. In fact, except for the addition of some minor (but not very useful) display modes, native Amiga graphics have remained unchanged since the Amiga 1000 was introduced in 1985.

This situation has retarded the development of paint and all other 24-bit applications for the Amiga. Amiga users and software developers have waited for years—thus far in vain—for Commodore to either upgrade the Amiga custom chip set or decouple the Amiga graphics library from the current chip set. Recently, hardware developers have stepped in to fill the void by creating alternate displays that are—to greater or lesser degrees—incompatible with current Amiga software. As a result, these display systems have little software support; the paint programs that work with them are bundles.

**Composite Solutions**

Amiga true-color display systems fall into two categories: composite systems and RGB systems. The composite systems manipulate 24-bit images, but due to the limitations of the composite video color space, they can only display 20 or 21 bits of information. (This isn’t as great a limitation as it seems, given that the human eye can’t discern 24 bits of color information, either.) The two major composite display devices for the Amiga are Digital Creations’ DCTV and Newtek’s Video Toaster (see “Newtek’s Video Toaster Makes Professional Video Affordable,” March BYTE).

The Video Toaster comes with a 24-bit paint program that allows you to manipulate 24-bit images, although not directly. What you see and work on are indirect 12-bit approximations of the image displayed by the native Amiga graphics. When you want to see the actual image, you have to download it to the Toaster.

Unlike the Toaster’s paint program, DCTV Paint (which is bundled with Digital Creations’ DCTV) lets you manipulate 24-bit images as they are displayed by DCTV—no indirection here. Like the Toaster, DCTV Paint provides features you normally find in high-end video paintboxes, such as the Quantel Paintbox. It is also an ideal tool for video work.

**RGB Color**

While it is not a 24-bit display device, HAM-E from Black Belt Systems outputs an effective 18 bits of color and requires only minor modifications to existing Amiga software. It comes with a paint program that lets you modify 24-bit images, though you see only an approximation of the image.

Direct 24-bit RGB paint programs are not yet available for the Amiga, but that will change as more 24-bit display devices appear. For example, a paint program for Firecracker 24, a 24-bit display currently available from Impulse, is in beta test. Another program will be bundled with an as-yet-unnamed 24-bit display due this summer from Great Valley Products.

Until Commodore announces how it intends to pursue 24-bit graphics, true-color applications for the Amiga will probably be limited to what third-party display manufacturers bundle with their hardware. This will necessarily limit the choices of Amiga users for the foreseeable future.

Bob Ryan is a BYTE technical editor and author of Amiga DOS II Companion (IDG Books, 1990). You can reach him on BIX as “b.ryan.”
A Painter's Brush with Mac Color

Roger Goode

As a professional artist and magazine art director I've worked with a number of paint programs, mostly on the Amiga. The features I appreciate most are a good gradient fill, a blend or transparency tool, a magnifying glass for close-up work, and a handy means of choosing and matching colors. Also of considerable importance to me are brush, edge-softening, and dithering tools. Accordingly, I spent little time studying manuals and referred to them only when I met problems.

PixelPaint's a Pro
PixelPaint Professional is my favorite among these paint programs. PixelPaint is not quite as easy to learn as Color MacCheese, but its operation is straightforward and elegant, and the program offers the little extras that make it a powerful tool. One feature I particularly like is PixelPaint's transparency control. At the bottom of the picture window is a small slider control that allows you to set the level of transparency for any tool and any color quickly and accurately. This is the feature I use most. Because it is so near at hand and easy to use, it sped up my work tremendously.

However, I don't care for PixelPaint's zoom option, because it limits the size of the zoom window. This makes having a 16-inch screen seem like a waste.

Color MacCheese is an awfully close second choice. The deciding factor is the fewer number of options it offers, although, to be honest, I'm not sure how important it is to have a lot of little extras like perspective and 3-D tools. Sure they can be nice to have on hand, but they're certainly not necessary.

I like MacCheese because it's so incredibly easy to use. All the tools are clear and obvious in their application, and all the important options are kept handy in open windows. There's even a Help window that can remain open.

MacCheese doesn't fall short in power or results. I was gratified by the simplicity and excellent results of the gradient fill tool. I also liked the color-selection windows: One palette lays out standard preset colors in rows by value; a second palette has a rainbow-style color wheel that lets you pick a general color that you can then quickly modify with a value slide. This arrangement makes color selection about as fast and intuitive as it can be.

MacCheese let me whip through the creation of my graphic in record time. I don't want to make speed a virtue in the creation of art, but that facility let me focus more on my internal creative forces. I appreciated spending less time on the technical side and more on the creative side of painting.

Mixed Results
Studio/32 was easy for me to learn due to my familiarity with Electronic Arts' Deluxe Paint, my favorite Amiga paint program. The two programs are different, but their basic feel gave me a reference point.

Studio/32 is intuitive, and there was not much need to decipher the tools and menu items. However, some tools worked in unpredictable ways. I was particularly distressed by the gradient fill. For the purposes of my picture, I was looking for a clean, linear gradation of color in the fill areas. I was troubled by the way that irregular shapes within the filled area and irregularities in the bounding shape created castoffs of the graded fill. This is most evident in the jacket of the foreground figure (see the screen at right). The irregular gradation under the figure's right sleeve was an unplanned artifact of the program. For the sky fill, I was forced to remove all the drawing elements down to the horizon, fill the sky, and then replace the elements.

On the plus side, with Studio/32's gradient fill you can define gradients of more than two colors. For example, the sky goes from a deep violet-blue to a lighter blue-green, and then to light blue. All this in one fill and with complete control over the speed of the transitions. All the other programs use a more common gradation of one color to another without intermediates. I also liked opening multiple windows for a variety of control elements (e.g., the extended palette and a color-mixing window).

DeskPaint is among my least favorite programs because it is cumbersome and painfully slow in operation. When I'm in the process of creating artwork, I don't want to have to wait for the program. Although DeskPaint has all the tools to get the job done, it doesn't lend itself to a very fluid style of work. For example, to apply gradient fills, I had to enter a setup window cluttered with a set of preset options for fill direction, density, and so on. Going through all those options takes time, and the results were not always what I expected. So I had to go back into the setup procedure and try again. In other programs, I simply clicked on an area to be filled and dragged out a line to indicate the direction of the gradient. Simple and elegant: That's how it should be.
Studio/32's gradient fill created unwanted "castoffs," as seen in the foreground figure's jacket.

Oasis was not to my liking at all. First, there is no magnifying glass, so I did all my work in one size. Although this is not a disaster, it's nowhere near as easy as being able to zoom into an area and work up-close on details. The program is also extremely slow. I found myself spending a lot of time waiting while Oasis struggled with surprisingly simple tasks.

I found the gradient fill the most difficult to use. For this and other functions, you must define an area by tracing it with a lasso or a marquee before the program applies the effect. I can't imagine anything more cumbersome. To create the gradation in the sky, I had to wipe out the entire upper portion of the picture, including the horizon, then create a filled rectangle, and finally redraw everything back over it.

But Oasis's methods for controlling transparency levels and brush sizes are very nice. Both methods use a small window in a lower corner that you simply click on and enter a number. It would have been nicer still to have a slider, like the one in PixelPaint, but this was still a nice feature.

The tools worked well, but it sure felt like more work than it was worth. If I really wanted to put in that kind of labor, I'd drag out my oils and canvas; at least I'd be able to smell the paint.

Roger Goode studied painting at the Art Students League of New York and has been an art director for two computer magazines. He now is the principal of the Proper Pup Studio, a graphic arts, desktop publishing, and illustration studio in Hillsborough, New Hampshire. You can reach him on BIX c/o "editors."
24-BIT PAINT PROGRAMS

The documentation of this package is like Zen in the Art of Archery: At first glance, both look too brief to cover their subjects adequately. In the case of Color MacCheese, though, the software’s interface is so intuitive you'll be able to navigate through the program with only a few retreats to the manual.

Color MacCheese capitalizes on the windowing system built right into the Mac. Thus, you can resize the canvas window and move tool windows anywhere on the screen. Color MacCheese offers a “handy palette” in a small window that provides a scrollable view into a subset of all available colors and patterns. You can add to the palette by selecting a region with either the lasso or the marquee selection tools and activating an entry on the selection menu. Similarly, you can remove anything new you add to the palette and easily customize it to hold colors and patterns for a specific drawing.

Color MacCheese’s color wheel is perhaps its best feature. In a single 2-inch-square window, the entire color spectrum is available to you. You control the transparency or opacity of colors (including blends) as they are applied to the artwork. There are also tools for skewing or distorting portions of the artwork. Interestingly, DeskPaint sports an Image Control dialog box, where you can adjust the artwork’s contrast or colors in much the same way that you can with retouching software.

The page layout function lets you adjust the document’s dpi setting (including values for typesetters, not just color PostScript printers), scale, and pixel size. Other printing functions include previewing the output and cropping the artwork. But we encountered problems when attempting to print artwork that was deeper than 8 bits to a PostScript printer. Zedcor’s technical-support staff was helpful as we discussed the problem and tracked it down to a bug in the program’s printing code. Now aware of the problem, Zedcor promises a fix.

Currently, DeskPaint doesn’t support the Wacom tablet’s pressure feature, although this is planned in a future release. While it doesn’t have zillions of special effects, DeskPaint is quite versatile. As a DA, it’s always there at a moment’s notice. And there’s nothing wrong with the price: $199.95 buys you both DeskPaint and DeskDraw, a drawing DA.

continued
"When I bought my TARGA® board back in '85, it was the most sophisticated product on the market. It still is."

Just look at us now. Today's TARGA+ supports multiple platforms, including PS/2, and multiple display resolutions in both interlaced and non-interlaced modes. And, with our new VGA overlay feature, you can superimpose VGA graphics directly onto your non-interlaced output. Looks like we've done it again.

Introducing the Truevision TARGA+. The next generation TARGA for the next generation TARGA user.

TRUEVISION®
Providing Solutions With Vision™
Oasis can handle a variety of special effects, such as a gradient fill inside the text, as shown here. The tools can be configured for a wide range of effects, but, unfortunately, there's no magnify or fatbits capability for detailed work.

Oasis ($795) is a latecomer to the Mac, introduced last March, but a number of significant features make it a powerful contender in this crowded market. You can tear off tool palettes and some menus to arrange the layout of the screen to your taste. Similarly, using a matrix of attributes, you can adjust the size and density of the painting tools. This feature lets you modify the tools' behavior so that you can paint with the electronic equivalent of pastels, inks, pencils, oils, or watercolors. With a Wacom tablet, you can further configure the tools so that ink flow and smears vary for realistic effects. For example, we set up the eraser tool so that it stripped off varying levels of color. The final results looked just like a pastel sketch on which we had used a rubber eraser. We achieved the most realistic color-pencil effects using this package.

Oasis also has a slew of special effects. For example, you can flow a gradient fill within text characters to produce a logo. A "lightbox" function lets a background scanned image show through dimly so that you can trace over the image or copy portions of it using a reveal function. An emboss effect lets you give a stamped appearance to an image, and you can control the lighting direction to vary the results. Oasis works with Truevision's NuVista and NuVista+ video boards and with RasterOps's 364 video boards to capture live NTSC video. It also can use software modules to operate color scanners.

Oasis's features would have made it an easy winner except for two problems. First, printing support is limited: You can't adjust the document beyond 72 dpi, which makes scaling for printing difficult. Even worse, there's no zoom function. There's simply no way to tweak the artwork at the pixel-by-pixel level. If you cannot adjust the artwork as it stands on the screen, you're stuck. Time Arts promises that version 1.1 (due this summer) will have a magnifying function. We hope so, because this fatal flaw cripples what stands to be a fine painting application.

Introducing Pocket Edition 2400

The people who wrote the book on modems proudly present the Pocket Edition. The first Hayes modem specially designed for people who use laptop and notebook computers.

Introducing Pocket Edition 2400

Weighing in at a slight three ounces, the Pocket Edition 2400 comes with everything you need to take it on the road—a 9-pin connector, cables, a handy carrying case, and our simple-to-use Hayes Smartcom EZ communications software.

And, because it gets all its power from the phone line and your computer's serial port, you'll never find yourself searching for an outlet to plug it into.

The Pocket Edition is incredibly compact yet it contains many of the features you expect from our "full-size" Hayes modems. It's ideal for working remotely with your
Compared to the other painting applications, the $695 PixelPaint Professional is an old-timer: It started shipping in 1989. While it’s starting to show signs of age, PixelPaint Professional still has some features, such as the ability to print separations, that are unmatched by even the latest entries in the 24-bit paint competition.

If you first mastered Mac graphics using MacPaint, you’ll find PixelPaint Professional’s tools and behavior similar. It has good fill controls and an army of special effects, such as emboss, neon, and fractal. You can toggle these effects on or off individually for each tool. Drop shadows, whose position and color you can set, can be applied to any graphics operations.

You can zoom in on an image to work on fine details. A “split screen” mode lets you view your changes to the artwork at normal size while you work on a magnified section of the image. You adjust the dpi setting of the document by clicking on a setting at the window’s bottom. Clicking on a bar at the top of the painting window opens a palette, where you choose colors or mix custom blends. Another button controls masking. You create masks by painting into a window or by copying a section of artwork from the Clipboard.

PixelPaint Professional is not without a few annoying quirks and limitations. It lets you work on only one document at a time, and its response to screen updates and tool action can sometimes be sluggish. TIFF files are limited to grayscale.

Despite these quirks, PixelPaint Professional is the only package we looked at that can print color separations—a must for some applications. It also provides support for the Pantone color-matching system (PMS). Based on our look at a beta version of PixelPaint Professional 2.0, which should be shipping by the time you read this, the new version promises many improvements, including the ability to handle 24-bit TIFF files and support for the Wacom tablet’s pressure feature.

It’s time you gave your laptop a new traveling companion.

Hayes
Our technology has the computer world talking.
More than ever.

Circle 134 on Inquiry Card.
24-BIT PAINT PROGRAMS

Studio/32

Studio/32 lets you tear off certain tools, such as the Palette, Magnify/Reduction, and Gradient tools. You can set the document’s dpi easily for exact printing control.

This $695 painting application has a voracious appetite for RAM: In 24-bit mode, Studio/32 requires 5 MB of RAM right out of the gate. Along with this huge initial memory demand, Studio/32 also creates a disk-swap file for virtual memory management when you’re working with large pieces of artwork. As a result, performance slows to a crawl.

Tear-off palettes provide you with ready access to such tools as the magnification and color selectors. This means that you won’t have to constantly be moving the mouse to the left side of the screen.

You can configure the magnification selector to work in an expanded view of the artwork or in a split-screen view that shows both the magnified area and the artwork at normal size. At first we found the gradients selector confusing to work with, but then we discovered that dragging the slider onto the gradient bar sets up the color blends. Gradient blends can have several different color blends, so you can easily create imitations of the gleam of metal pipes or mirrors, for example. In addition, the Blend, Sharpen, Smudge, Antialias Brush, and Airbrush tools all support the Wacom digitizing tablet’s pressure feature.

Studio/32 also offers you a variety of special-effects capabilities, including embossed text, shear and skew operations, shadow effects, and a unique “define perspective” function that fills a plane with a user-defined pattern. Masking operations can make use of a selection of colors (e.g., all the colors in a painting of a red Trans-Am) and a tolerance level (i.e., how closely a color in an image matches the color that you have selected).

Studio/32’s support for printing is good. You get the advantage of PMS, and changing the document’s dpi setting is just a menu selection away. You simply preview the print page and choose PostScript, color Postscript, or QuickDraw printing mode. You can even use binary PostScript, which requires less data sent over the network and makes for faster printing.

continued

Graphics Co-Processors

PC Tech manufactures a full line of Texas Instruments 34010 and 34020 based PC compatible graphics co-processors.

340010: Monochrome 2048 x 1536, MDA/CGA emulation
   Color 1280 x 1024, VGA pass-through
   MS/Channel 1400 x 1024, VGA capture
34020: Color 1280 x 1024, VGA pass through
   CMS34082 optional, with 128k private static RAM
TIGA: Supplied with all boards
   Microsoft Windows 3.0 TIGA driver standard
   AutoCAD ADI 4.1 display list driver optional
   CCITT G3 and G4 decompression optional
   C compiler and 340XO assembler available

Call, write, or FAX PC Tech for complete specifications, benchmark results, and retail or OEM terms. All PC Tech products are available in complete systems as well as components for retail, OEM, and private label sales.

PC Tech also designs and manufactures high performance PC compatible motherboards and passive backplane CPUs based on the 386SX, 386DX, and 486 processors.

Designed, Manufactured, Sold and Serviced by:

Voice: (612) 345-4555
Fax: (612) 345-5514
Modem: (612) 345-4656

907 N. 6th St., Lake City, MN 55041

PC Tech is a trademark of PC Tech, Inc. Other brand and product names are trademarks or registered trademarks of their respective companies.

Don’t Move!
without telling
BYTE

Clip out form below
and mail to:
BYTE Magazine
P.O. Box 555
Hightstown, NJ 08520

At least 8 weeks before you move, please give us your new address and/or name change
(Please Print)

New address, name
Name ____________________________ Apt. ______
Address ____________________________ Apt. ______
City ____________________________ Address ______
State ____________________________ City ______
Zip ____________________________ State ______

Print current name and address
(or affix the mailing label from your current issue of BYTE here)

Current address, name
Name ____________________________ Apt. ______
Address ____________________________ Apt. ______
City ____________________________ Address ______
State ____________________________ City ______
Zip ____________________________ State ______

PC Tech 15 a trademark of PC Tech, Inc. Other brand and product names are trademarks or registered trademarks of their respective companies.

268 BYTE • JUNE 1991 Circle 234 on Inquiry Card.
You don’t have to look hard to see the windows with the new Optiquest 1000 non-interlaced color monitor. Its flicker-free high-resolution images make it the perfect partner for today’s demanding software applications like Microsoft Windows 3.0.

The 14" Optiquest 1000’s .28 dot pitch and maximum resolution of 1024 x 768 non-interlaced deliver razor sharp text and graphics. Unlike interlaced monitors, the Optiquest 1000 continually refreshes every pixel on every line. The result, remarkable clarity and a flicker-free picture.

VGA, Super VGA and IBM 8514/A compatible, the Optiquest 1000 also features an infinite palette of colors. And for clear, sharp images on a larger scale, ask about our 15", 17" and 21" non-interlaced color monitors utilizing Optiquest’s flat-square technology.

<table>
<thead>
<tr>
<th>OPTIQUEST NON-INTERLACED MONITORS.</th>
<th>Screen Size</th>
<th>Dot Pitch</th>
<th>HighRes.</th>
<th>72Hz VESA Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optiquest 1000</td>
<td>14&quot;</td>
<td>.28</td>
<td>1024 X 768 non-interlaced</td>
<td>yes</td>
</tr>
<tr>
<td>Optiquest 2000</td>
<td>15&quot;</td>
<td>.28</td>
<td>1024 X 768 non-interlaced</td>
<td>yes</td>
</tr>
<tr>
<td>Optiquest 4000</td>
<td>17&quot;</td>
<td>.26</td>
<td>1280 X 1024 non-interlaced</td>
<td>yes</td>
</tr>
<tr>
<td>Optiquest 5000</td>
<td>21&quot;</td>
<td>.31</td>
<td>1280 X 1024 non-interlaced</td>
<td>yes</td>
</tr>
</tbody>
</table>

Non-interlaced monitors from Optiquest—"The Non-interlaced Company."

See us at Booth W2647

Optiquest's "The Non-interlaced Company"...

Optiquest, Inc., 9830 Alburite Avenue, Santa Fe Springs, CA 90670, (213) 948-1185, Fax (213) 949-2231, (800) THE-OPTI

All product names are registered trademarks or trademarks of their respective manufacturers.

Please see our list of resellers on page 330.

Circle 226 on Inquiry Card (RESELLERS: 227)
State-of-the-Art PC Art

Cal Vornberger

Having beta-tested my fair share of graphics programs, I am well acquainted with the idea of a "bug report." I sometimes wonder whether there really might be some insects that thrive on the silicon in computers. This idea inspired my work "Bug Reports" (see the screen).

In giving these 24-bit paint programs a thorough workout, I tried to create the type of image that might be found in a production environment and to use tools and techniques that I incorporate in my work. From within TIPS, I used a video camera to capture the image of a circuit board with a chip pulled from its socket. I saved it as a TIPS "window." The illustrations also make use of freehand drawing tools, masks, gradations, and other digital drawing techniques. I sent the three "Bug Reports" images for output to 35mm slides (at 4000 lines of resolution) to Graf Werck in New York City, which used an Agfa Forte system.

While the version of Lumena I tested came bundled with the Hercules Graphics Station card and is called Hercules Art Dept., it is virtually identical to the stand-alone version from Time Arts that I have been using for the last four years in my commercial work. I also teach computer illustration at the Pratt Institute in Manhattan, where Lumena and TIPS are the mainstays of our computer illustration curriculum. When I began writing this review, I was not at all familiar with Tempra. The version that I tested was designed to run only on the Hercules board. Its similarity to TIPS made it easy to learn.

Type Control

Smooth gradations from one color to another are a basic function of all three programs. Tempra, however, gives the designer greater control over the type, direction, strength, and amount of dithering used in creating gradations. You can vary the amount of dithering between colors to create smooth transitions or stonelike textures. This technique worked well for the simulated stone in the border (see small screen shot).

Tempra also lets you employ this type of dithered gradation as a tint or wash with varying degrees of transparency. I used this technique to texture the main background in the Tempra illustration by laying down a nondithered gradation and then going over the original gradation with one that used the same colors, in the opposite direction. I set dithering to "full" and used a very slight tint level. This ability to transparently layer effects on top of each other lets designers create many interesting textures and add depth to an illustration.

Another feature I like about Tempra is its ability to open other file formats, notably TARGA, PCX, TIF, and PC Storyboard. It can also save in all those formats except PC Storyboard. I opened my image of the chip coming out of its socket (saved in TIPS window format) directly from within Tempra. I had to resave the window as a TARGA file, however, to open it in Lumena.

Lumena is in a class by itself. The program has an overwhelming number of tools, modes, and other image-processing effects. I spend the better part of a semester teaching Lumena at Pratt.

The program has no Undo function per se. Lumena does let you make buffers that serve as temporary holding places for your work. You must remember to continually save to the buffer as your work progresses. If you make a mistake, you can retrieve from the point at which you last saved to the buffer. You can also have multiple buffers and cut and paste from one to the other.

The real power in Lumena comes from its ability to combine drawing tools with different modes to create hundreds of interesting effects. Lumena also can import various alien file formats but saves in its unique PIX format. There is an option to save in TGA or TARGA format.

Venerable TIPS

If Lumena is king of the high-end paint programs, then TIPS is its grandfather. Venerable and stable, TIPS has been around since the TARGA board's beginnings. It still acquits itself well. While it is nowhere near as complex as Lumena, all tools and functions are logically laid out in the menus.

TIPS gives you all the standard drawing tools plus gradations, blends, tints, and a range of other effects. The masking tool is very effective. I liked TIPS's masking feature the best out of all the programs. You can turn on the masking function and draw a mask with any of the drawing tools (e.g., filled rectangles, hollow circles, and brushes). TIPS also lets you turn on dithering for gradations, although its dithering is not as coarse as Tempra's. TIPS has a handy Undo function.

Of these three programs, Lumena is best when it comes to font manipulation. Its fonts are vector based and infinitely scalable, and can even be saved in a vector file for cleaner output. Both Tempra and TIPS use bit-mapped fonts, but Tempra doesn't do a very good job of font scaling. There isn't a great range of font sizes in Tempra, and when I scaled down my choice to the size I wanted,
Tempra offered the best control of gradations among the three PC packages. It also did an excellent job of creating textures like this simulated stone.

text became ragged. TIPS has a greater choice of fonts and seems to antialias scaled fonts better. The programs let you do gradations easily within fonts, and all support font antialiasing.

I sorely missed in the Hercules version of Lumena the ability to zoom in and out using the keyboard. I find it much easier to press a function key to zoom in on a particular area of my drawing to do small touch-ups than to select a menu item and drag a bounding box around the area to be magnified. Lumena is best used with a graphics tablet. You can get by with a mouse in both TIPS and Tempra, although both work well with a tablet.

One pet peeve I have about TIPS and Tempra is their modality. Often I have to click through too many menu layers to get to the tool or effect I want. One reason I like Lumena so much is that its menu system has an immediacy. I can “flick” off my drawing screen and onto the menu screen, change my tool, and be back at work in a lot less time than it takes to click through several layers of menus in Tempra and TIPS.

My dream 24-bit paint program would combine the best of these three. Is such a thing possible? I don’t know. Do spiders eat silicon?

Cal Vornberger is a principal in Tumble Graphics and Animation, Inc., a New York City design firm that specializes in interactive multimedia presentations as well as 2-D and 3-D animation. Vornberger is on the faculty of the Pratt Institute in Manhattan, where he teaches computer illustration and multimedia production. You can reach him on BIX as “cvornberger.”
Lumena’s toolbox appears on a monochrome display. (You need both color display and monochrome display to run Lumena.)

Lumena, a PC program, needs the “right stuff” to run effectively, including at least 2 MB of EMS 3.2 memory. The version we tested required the Hercules Graphics Station Card ($3995 for the bundle, as tested; $2495 for the software only), as well as a monochrome adapter.

Why two displays? Lumena doesn’t offer pop-up menus. The display connected to the Graphics Station becomes your canvas, while the monochrome display is your command control console—sort of a toolbox.

During operation, the cursor is active on either the canvas display or the control display. You toggle between the two by pressing the space bar or by moving the pen off the digitizing pad. (The second technique of switching screens uncovered an annoying feature of Lumena. Whenever we let the stylus wander or even tilted it in the hand, the system would flip the cursor to the alternate display and emit an irritating beep.) We used the space bar because we occasionally lost the cursor in digital limbo whenever we moved the stylus off the bitpad.

We’re not convinced that Lumena’s dual-display arrangement is better than a single-display system. You might argue that the Lumena system allows you to view an entire uncluttered canvas screen. However, other packages work quite well with one display.

Although you can use a mouse, the documentation strongly discourages it in favor of using a digitizing pad. Actually, we found the software wouldn’t respond to a Microsoft Mouse clone; we had to switch to a true MicroMouse. Then we noticed “blind spots” on the canvas display. These were pixel-wide horizontal stripes that the mouse pointer refused to land on. We gave up on a mouse and switched to the GridMaster pad.

Lumena’s copy-protection technique is too protective. Included in the package is an EPROM chip. You have to open your machine, pull out the Graphics Station card, locate its BIOS EPROM, and replace it with the new chip. Apparently, that chip has been programmed with a serial number that corresponds to a serial number hidden in your copy of the Lumena software. When you execute Lumena, the software checks its serial number against the one in the EPROM. Beyond being a pain in the neck, this procedure is one more thing to go wrong.

In operation, we found that Lumena suffered two great flaws. First, while its fatbits appear in a kind of pop-up window, changes you make in the magnified view do not appear on the canvas until you close the pop-up window. (Canceling the pop-up window causes Lumena to “forget” any changes you have made.)

Worse is Lumena’s lack of a true undo function. You’ve got to train yourself to regularly save images to disk. Fixing your picture after a slipup is then a matter of reloading the image file. Heaven help you if you’ve got a slow disk drive. This also discourages experimentation, which is critical in using paint packages.

One advantage of Lumena is that the palette window can remain on-screen while you’re working, so you can dip into the palette to pull up a new color. This is in contrast with the other PC paint packages that keep the palette attached to the tools menu, which forces you to close the pop-up tools and palette menu while you are painting.

Tempra ($495) is a one-screen package for the PC with its own windowing system. We tested it with a two-button mouse (Tempra also accepts Summagraphics-compatible tablets, including the GridMaster) and the Hercules Graphics Station card. Pressing the right mouse button calls up the Tempra menu, which is composed of the tools menu and the palette bar. From there, menu buttons call up individual functions and their associated parameters. For example, one menu button accesses draw functions, such as freehand drawing and geometric shapes.

The color map lies below the pop-up menu. It’s a rectangular bar of 256 colors. Clicking on any selection makes that color the current painting color. While you’re working, Lumena’s pop-up menu disappears, taking the color palette with it. Some users could be distracted by switching between the canvas and the menu to get colors; we were not bothered by it.

You alter the current color by clicking on the color icon. This activates the color menu, from which you select one of four color models to “mix” a custom color. Through the color menu, you can build a...
Tools and Terms:
A True-Color Glossary

airbrush A fine-mist paint tool used to create halos, fog, clouds, and similar effects. Most paint programs let you control the size and shape of the application area. Some packages provide a transparency adjustment that determines the density of the applied color.

antialiasing A blending effect that smooths sharp contrasts between two regions of different colors. Properly done, this eliminates the jagged edges of text or colored objects.

blend The smooth transition from one color to another. Blending tools give a realistic look to a drawing, especially if you want to create a smooth shadow.

brush A paint package’s most basic image-creation tool. Most packages let you select a variety of sizes and shapes. Many let you customize shapes.

CMY A color model used by the printing industry that is based on mixing cyan, magenta, and yellow. It’s also referred to as CMYK, with the K denoting black. The K was added after printers discovered they could obtain a darker black using special black colorants rather than by combining cyan, magenta, and yellow alone.

color model A technique for describing a color (see CMY, HSL, HSV, and RGB).

curves and arcs Paint packages handle curves and arcs in a variety of ways. Examples include spline curves, wherein you specify a series of points and the package draws a curve that smoothly approaches those points, and “three-point” curves, in which the first two points anchor the ends of the curve and the third selects the apex.

drawing tools The means of creating freehand lines or basic geometric shapes. Paint packages often provide an ellipse-drawing function as a variation of the circle (or vice versa) and a square-drawing function as a variation of the rectangle. Virtually all packages offer filled geometric figures, the fill item being either a solid color or a pattern.

fills Designated areas that are flooded with a particular color. Most paint packages let you create geometric shapes in filled form. All packages also let you fill irregular closed regions. Two types of such fills exist: A seed fill floods all connected regions with the color specified by the mouse or stylus pointer; a boundary fill floods a color until the algorithm encounters a specified boundary color.

gradient fill A fill composed of a smooth blend from a starting color to an ending color. There are many variations on this theme. Most programs let you fill with patterns, some packages let you apply textures, and others have “smart” gradient fill routines that lend a three-dimensional appearance.

HSV A color model based on hue, saturation, and value. Hue specifies the color, as in the HSL model. In this model, saturation specifies the amount of black pigment added to or subtracted from the hue. Value identifies the addition or subtraction of white pigment from the hue.

lines The line tool draws straight lines, typically from point to point. Most paint packages let you continue lines in a fashion that permits rapid creation of polygons.

mask The electronic equivalent of placing transparent tape over selected regions of an image, a mask marks pixels that remain unchanged by subsequent painting operations. For example, you might mask out a mountain range and add background clouds to the sky. In the final image, the clouds will appear between the peaks.

PMS The Pantone Matching System, a universal language for solid-color specification and reproduction. Colors defined by PMS receive a unique number and mixing formula. Consequently, when artists specify a PMS number, they can be sure that the final printed product will match the chosen color.

RGB A color model based on the mixing of red, green, and blue.

shear A tool for distorting a selected area vertically or horizontally.

skew A tool that slants a selected area in any direction.

zoom (see fatbits).
24-BIT PAINT PROGRAMS

continued

color spread by specifying two "endpoints" in the color map. Tempra automatically alters the color-map entries between the two endpoints so they evenly blend from one to the other.

The zoom function activates a movable rectangle whose contents are magnified and projected in the zoom window. You can change the size of the rectangle in discrete steps, thus increasing or decreasing the magnification. Although you can alter only single pixels in the zoom window, some effects (e.g., tint) are active. Furthermore, four tools associated with the zoom window—the most notable being "local undo"—allow you to undo any mess you've made in the zoom window. While you're working in zoom mode, you can observe the changes you make on the canvas.

TIPS

A supernova illustration shows off some of TIPS's blending and gradient-fill capabilities. Notice that the menu and color palette must share screen space with the drawing.

Truevision's TIPS (for Truevision Image Processing Software) supports the TARGA+ video board, which makes it a more expensive alternative to the Hercules-compatible products.

At a casual glance, you could easily mistake TIPS for Tempra. Both share the same general pop-up menu layout. The menu is a rectangle of square icons arranged in a grid. The leftmost row of icons changes the remainder of the main menu into icons that represent lines, rectangles, circles, and other function settings. Clicking on the rectangle icon leads you to a text submenu, where you can select attributes (e.g., whether or not the rectangle is filled). The menuing system is easy to learn; once you understand its underlying logic, you can navigate without problems.

You select drawing colors from the TIPS palette bar, which stretches below the menu and gives you instant access to 256 colors. TIPS logically groups the colors by hues. However, if you prefer, you can click on the current drawing color to call up a color-mixing menu and then fabricate a custom palette. Furthermore, you can click on an on-screen pixel to make its color the current drawing color.

TIPS's magnification capability is the easiest to work with of all the PC packages. By pressing the F10 key, you increase magnification by a factor of 2. For image editing, TIPS can magnify the picture eight times—enough to enlarge individual pixels to discernible rectangles. The F7 key returns you to normal magnification.

In other PC paint packages, working with a magnified image is sometimes restrictive. But in TIPS you can smoothly scroll about the full canvas even in magnified mode. Because scrolling is hardware-assisted, working with fatbits is a joy rather than a pain. (You can also activate the magnification while the menu is on-screen. This capability is especially useful if you want to home in on a specific pixel to use its color as the current drawing color.)

TIPS's most unique drawing implement is the fractal tool, which allows you to select a triangular region that acts as a frame within which TIPS generates horizons of fractal-guided triangles. The net effect simulates mountains or hilly terrain. Although we explored the fractal tool only peripherally, applying the proper fill routines could yield rapidly constructed landscapes.

TIPS comes with printer drivers for a variety of color printers. The documentation also points out that Truevision makes available a public domain printer driver design specification. Knowledgeable programmers can use this to create custom printer drivers.

Finally, although we didn't test it for this review, TIPS can work with the TARGA+ video board to accept live video and overlay the video with graphics images on-screen.
How to Choose the Right Color Application

There's a plethora of color applications on the market, so it's easy to assume that you'll find one that suits all your needs. Unfortunately, this is not the case.

The variety of applications speaks to the fact that color manipulation requires different tools for different jobs. We divided these jobs into three categories: painting, drawing, and retouching.

Painting with Pixels
Painting applications, the group we chose to evaluate in this review, handle artwork as a collection of pixels, or a pixel map. These applications operate much like the artist's traditional canvas and palette, with electronic tools functioning like their studio counterparts. You can select a hue from a color palette, mix it with other hues, and then freely apply it to the screen by painting, smearing, or spraying. Many artists will find themselves on familiar ground when using painting applications. The great flexibility that this software provides for laying down colors on the screen lets artists produce work with a distinctive style.

The difficulty comes when you want to modify an image. For example, if you misplace a colored oval, it becomes part of the image and you cannot remove it easily. That's because everything in the image—including text—is simply pixels. If you erase the misplaced oval in a complicated illustration, the eraser tool removes all pixels, whether they belong to the oval or to the background.

Text suffers as well, because it's reduced to pixel patterns on the artwork.

Furthermore, pixel maps undergo serious distortion when they're scaled down, either for printing or inclusion in a document. This occurs because information—pixels—must be discarded to reduce the artwork's size. You can reduce printing distortion by printing the image at multiples of the output device's resolution—say 150 or 300 dots per inch. At such resolutions it's possible for the printer to reduce the size of the pixels themselves, rather than throwing them away.

Drawing Programs
Drawing, or object-based, applications treat artwork as geometric objects (hence the term object-based). These applications operate much like drafting tables, T-squares, and templates, in that specialized tools make circles, rectangles, and curves on the screen. You make color blends by selecting a starting and an ending color for an object and requesting a fill operation.

The drawing application's advantage is that it provides you with precision and control over the artwork. As an object, an oval can be placed into position using electronic rulers and guides. Also, you can pick up and move a misplaced oval.

Drawing programs create text as characters of a certain typeface and point size, so you can use outline fonts to display the text on-screen or download it to a printer for clean output. Since these programs describe artwork using geometric formulas, you can easily resize the work with no loss of information. This also lets the artwork take advantage of high-resolution output devices such as typesetters.

The disadvantage of these applications is that drawing a picture requires that you define it as sets of objects, which can be a very rigid and confining way to draw.

Image Retouching
Finally, there are instances where you might want to work with an existing pixel-mapped image, typically from a scanner. You might want to crop the telephone lines out of a forest image or enhance the contrast in a catalog's product photo. Retouching applications handle these tasks. Like paint applications, retouching software works with pixel maps. It typically has few painting tools. However, the programs can modify the color balance in a image, change its contrast, or apply filtering operations to remove visual artifacts from a poor image. Since scanners supply the data that retouching software works with, many of these applications have special menus or software modules to operate them.

Because we're evaluating painting packages here, we obviously won't be looking at drawing applications such as Corel Systems' Corel Draw (see Reviewer's Notebook, April), Adobe Illustrator (see "An Artist's Old Tool Learns New Tricks," February), or Al­dus FreeHand (see Short Takes, May).

We qualified Adobe's Photoshop (see Short Takes, April 1990) and Letraset's ColorStudio as retouching packages.

Because painting and retouching software works with pixel maps, determining which category some of the software fell into was a challenge. For example, ColorStudio has as many painting tools as any paint application, but its real strengths lie in image manipulation. The same can be said for PC-based packages such as Desktop Computing's Desktop Artist and Micrografx's Picture Publisher Plus (see "High-Quality Image Editing Develops on the PC," May), which will support 24-bit color display by mid-year.

On the other hand, paint packages sometimes blur definitions, too. For example, DeskPaint has color-correction control, and Oasis can capture images from several NTSC video boards and perform some clever scanned-image manipulations.

The point is, before you buy any color software, you should first determine what jobs it must handle. If your work requires a lot of text or fine precision, you should seriously consider a drawing package. Artwork demanding a unique style or look requires a painting package. Fixing scanned photos is the domain of retouching software. Once you have determined what category your job fits into, shop around for the software that fits your budget.
Choosing the right paint program is a subjective matter based as much on individual tastes as on specific tools and features. The following selections represent our professional artists because of its good color and printing end to its RAM binges. If you absolutely control, plus support for PMS. We wish, only option, despite its age and Jack of Painter's Brush with Mac Color" and "State-of-the-Art PC Art" to find out which packages our professional artists rated highest.

At the high end, we chose Studio/32 as the overall best Mac painting package because of its good color and printing control, plus support for PMS. We wish, though, that Electronic Arts could put an end to its RAM binges. If you absolutely have to produce color separations, and has graphic, tinker with it, and then drop it into a document. As a DA, DeskPaint is the System 6.0.x crowd. The company says that Wacom tablet support will be added sometime this summer. Delta Tao Software receives an honorable mention for Color MacCheese's incredibly low price, which comes (as the vendor freely admits) at the expense of variety in file-input format and document resolution.

On the PC side, Tempra gets our nod. It's the least expensive of the lot and handles a variety of image formats. Another plus is that Tempra doesn't require additional hardware beyond the single 24-bit monitor and adapter.

On the question of which is the better paint platform, the Macintosh is our machine of choice. Its operating system, 32-Bit QuickDraw graphics software, and printer drivers are mature and have been field-tested for several years. Even many of the tool icons (e.g., the paintbrush and the lasso) have become standardized among the different applications. Furthermore, the Mac's integrated application environment means that you can easily place artwork created in any of the Mac painting packages into other documents.

Now that 24-bit graphics has arrived on PCs, the Mac isn't standing still, as planned upgrades to much of the Mac painting software indicate. The 24-bit paint competition will continue to be an interesting race—one in which, for once, the user—the artist—will come out the winner.■

Tom Thompson is a BYTE senior editor at large. Rick Grehan is the director of the BYTE Lab. They can be reached on BIX as "tom_thompson" and "rick_g," respectively.

---

**COMPANY INFORMATION**

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Address</th>
<th>Phone</th>
<th>Fax</th>
<th>Inquiry Card Number</th>
</tr>
</thead>
</table>
| Delta Tao Software, Inc. | Color MacCheese 2.07  
760 Harvard Ave.  
Sunnyvale, CA 94087  
(408) 730-9351  
fax: (408) 730-9337 | Circle 1401 on Inquiry Card. |
| Electronic Arts | Studio/32 version 1.1  
1820 Gateway Dr.  
San Mateo, CA 94404  
(800) 245-4525  
(415) 571-7117  
fax: (415) 570-5137 | Circle 1402 on Inquiry Card. |
| Hercules Computer Technology, Inc. | Lumina/Hercules Art Dept.  
921 Parker St.  
Berkeley, CA 94710  
(415) 540-6000  
fax: (415) 540-6621 | Circle 1403 on Inquiry Card. |
| Mathematica, Inc. | Tempra  
402 South Kentucky Ave.  
Lakeland, FL 33801  
(813) 682-1128  
fax: (813) 686-5969 | Circle 1404 on Inquiry Card. |
| SuperMac Technology | PixelPaint Professional 1.0  
485 Potrero Ave.  
Sunnyvale, CA 94086  
(800) 345-2888  
(408) 245-2202  
fax: (408) 735-7250 | Circle 1405 on Inquiry Card. |
| Time Arts | Oasis 1.0  
1425 Corporate Center Pkwy.  
Santa Rosa, CA 95407  
(707) 576-7722  
fax: (707) 576-7731 | Circle 1406 on Inquiry Card. |
| Truevision, Inc. | TIPS  
7340 Shadeland Station  
Indianapolis, IN 46256  
(317) 841-0332  
fax: (317) 576-7700 | Circle 1407 on Inquiry Card. |
| Truvtion, Inc. | (GridMaster)  
101 Commerce Dr.  
Montgomeryville, PA 18936  
(215) 362-2766  
fax: (215) 361-0167 | Circle 1409 on Inquiry Card. |
| RasterOps | (RasterOps 24L)  
2500 Walsh Ave.  
Santa Clara, CA 95051  
(408) 562-4200  
fax: (408) 562-4065 | Circle 1410 on Inquiry Card. |
| Tektronix, Inc. | (Phaser IIPX)  
26600 Southwest Pkwy.  
Wilsonville, OR 97070  
(800) 835-6100  
fax: (503) 682-3408 | Circle 1411 on Inquiry Card. |
| Tektronix, Inc. | Targa+ 64  
7340 Shadeland Station  
Indianapolis, IN 46256  
(317) 841-0332  
fax: (317) 576-7700 | Circle 1412 on Inquiry Card. |
| Wacom, Inc. | (SD-510C)  
West 115 Century Rd.  
Paramus, NJ 07652  
(800) 922-6613  
(201) 265-4226  
fax: (201) 265-4722 | Circle 1413 on Inquiry Card. |
256 Color Graphics Doesn’t Have To Cost A Lot.

Make kids play out of high resolution color graphics with Trident’s new TVGA 8916 series VGA boards. With 256 colors in all high resolution modes, faster graphics processing speed, and a flicker-free monitor refresh rate, an 8916 board can help make anybody look good.

More Colorful Hi Res Drivers
Of the 45 boards listed in PC World’s (May 1990) Buyers Guide on Super-VGA Boards, only Trident’s 8916-8 gives you 256 colors in 1024 x 768 resolution for Windows 3.0, Presentation Manager, AutoCAD, Ventura, and GEM. We also support most of your other favorite applications, some great new rookies, and 8514/A emulation.

Fastest in its Class
And when it comes to speed, we don’t kid around. According to PC Magazine (the 8916)… “was about 20% faster than all other direct-access boards in both Microsoft Windows and AutoCAD tests.”

Our unique sequencer directs traffic between video memory and the system processor for faster screen updates without costly video RAM. The 8916’s built-in cache memory, 32-bit memory bus, non-interlaced or interlaced modes, and 72Hz refresh rate deliver a flicker-free display while maintaining the high speed CPU expressway.

To find out more reasons why the 8916 should be your choice in a VGA graphics board, visit your local dealer for a complete test drive.

The Trident 8916 Series. The new leader in high end PC/XT/AT and PS-2 Model 30 color graphics at a remarkably low end price.

© 1990 Trident Microsystems, Inc. TVGA is a registered trademark of Trident Microsystems, Inc. Other trademarks mentioned are trademarks of their respective owners.

Circle 331 on Inquiry Card.
OPEN ACCESS III
by Software Products Intl.

Turn your ideas into market-ready applications in just weeks with Open Access III! Easily edit, run, and debug your programs in the integrated programming environment. Get data entry and report forms and support for windowing, light-bar menus, and 3-D graphics to make creating your applications a snap! Open architecture with a C language interface lets you add change or add features. And Open Access III even has its own compiler!

LIST: $695

WATCOM C 8.0/386 Prof.
by WATCOM

WATCOM C 8.0/386 is 100% ANSI C optimizing compiler/ runtime library for Intel’s 80386 architecture, generating applications for 32-bit protect mode. Features include: protected mode version of the compiler; video full-screen source-level debugger; MS library- & source-compatibility; execution proiler; high performance linker; graphics library; SAA compatible.

LIST: $1295

386 DEVELOPMENT

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>386 Max 5.1</td>
<td>$109</td>
</tr>
<tr>
<td>386/DOS Extender</td>
<td>479</td>
</tr>
<tr>
<td>DESCrview 386</td>
<td>189</td>
</tr>
<tr>
<td>F77-EM 2 + Ergo OS/386</td>
<td>1149</td>
</tr>
<tr>
<td>FoxBASE +v386</td>
<td>479</td>
</tr>
<tr>
<td>Metaware High C 386/486</td>
<td>935</td>
</tr>
<tr>
<td>NDP Fortran 386</td>
<td>828</td>
</tr>
<tr>
<td>OEM 386</td>
<td>89</td>
</tr>
<tr>
<td>WATCOM C8.0/386 Prof.</td>
<td>1155</td>
</tr>
</tbody>
</table>

ASSEMBLY

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS MASM</td>
<td>105</td>
</tr>
<tr>
<td>Spontaneous Assembly</td>
<td>179</td>
</tr>
<tr>
<td>Turbo Debugger &amp; Tools</td>
<td>119</td>
</tr>
</tbody>
</table>

BASIC & ADD-ONS

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAS-C Commercial</td>
<td>829</td>
</tr>
<tr>
<td>d/B Lib Professional</td>
<td>179</td>
</tr>
<tr>
<td>Microsoft BASIC PDS</td>
<td>349</td>
</tr>
<tr>
<td>MS QuickBASIC V4.5</td>
<td>69</td>
</tr>
<tr>
<td>QuickPak Prof. V3.21</td>
<td>189</td>
</tr>
</tbody>
</table>

C LANGUAGE COMPILERS

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C Video Course</td>
<td>275</td>
</tr>
<tr>
<td>Instant C</td>
<td>479</td>
</tr>
<tr>
<td>Quick C</td>
<td>89</td>
</tr>
<tr>
<td>Microsoft C 8.0</td>
<td>349</td>
</tr>
<tr>
<td>WATCOM C Professional</td>
<td>439</td>
</tr>
</tbody>
</table>

CASE & PROTOTYPERS

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demo II V3.0</td>
<td>239</td>
</tr>
<tr>
<td>EasyCase Plus</td>
<td>279</td>
</tr>
<tr>
<td>EasyFlow</td>
<td>135</td>
</tr>
<tr>
<td>Instant Replay III</td>
<td>139</td>
</tr>
<tr>
<td>Layout</td>
<td>239</td>
</tr>
<tr>
<td>MetaDesign</td>
<td>329</td>
</tr>
<tr>
<td>Pro-C w/Workbench</td>
<td>735</td>
</tr>
<tr>
<td>ProtoFinish</td>
<td>289</td>
</tr>
<tr>
<td>Show Partner F/X</td>
<td>295</td>
</tr>
</tbody>
</table>

COMMUNICATIONS ADD-ONS

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blast PC Plus</td>
<td>245</td>
</tr>
<tr>
<td>C Asynch Manager 3.0</td>
<td>159</td>
</tr>
<tr>
<td>Essential COMM</td>
<td>249</td>
</tr>
<tr>
<td>Greenleaf Comm Library</td>
<td>329</td>
</tr>
<tr>
<td>HyperAccess/V</td>
<td>75</td>
</tr>
<tr>
<td>Procomm Plus</td>
<td>99</td>
</tr>
<tr>
<td>QuickComm</td>
<td>129</td>
</tr>
</tbody>
</table>

DATABASE

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha 4</td>
<td>549</td>
</tr>
</tbody>
</table>

Clipped 5.0 | 550
| dBASE IV   | 540
| dBASE/PLUS | 315
| dBMAN V    | 219
| dBXL       | 179
| Force dBASE Compiler | 269
| FoxPro     | 495
| FoxBASE + V2.1 | 279
| QuickSilver | 429

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artful Two</td>
<td>269</td>
</tr>
<tr>
<td>BALER Spreadsheet Compiler</td>
<td>399</td>
</tr>
<tr>
<td>CLEAR + for dBASE</td>
<td>179</td>
</tr>
<tr>
<td>CodeBase 4</td>
<td>279</td>
</tr>
<tr>
<td>CodeBase++</td>
<td>279</td>
</tr>
<tr>
<td>Comet Multiport</td>
<td>169</td>
</tr>
<tr>
<td>CommTools for Cliper</td>
<td>269</td>
</tr>
<tr>
<td>C Works</td>
<td>649</td>
</tr>
<tr>
<td>dBASE Online</td>
<td>129</td>
</tr>
<tr>
<td>dBDx/dBport w/source</td>
<td>865</td>
</tr>
<tr>
<td>dGE 4.0</td>
<td>279</td>
</tr>
<tr>
<td>dQUIERY MU</td>
<td>179</td>
</tr>
<tr>
<td>dSalvage Professional</td>
<td>195</td>
</tr>
<tr>
<td>Essential B-tree</td>
<td>149</td>
</tr>
<tr>
<td>Faircom o-tree Plus</td>
<td>529</td>
</tr>
<tr>
<td>Flippier Graphics Library</td>
<td>279</td>
</tr>
<tr>
<td>FUNCxy,LIB</td>
<td>229</td>
</tr>
<tr>
<td>Gentler</td>
<td>289</td>
</tr>
<tr>
<td>Net Lib</td>
<td>119</td>
</tr>
<tr>
<td>Novell BTrieve</td>
<td>479</td>
</tr>
<tr>
<td>Pro Clip</td>
<td>185</td>
</tr>
<tr>
<td>R&amp;R for dBASE &amp; Comp.</td>
<td>229</td>
</tr>
<tr>
<td>R&amp;R Code Generator</td>
<td>129</td>
</tr>
<tr>
<td>Smerge</td>
<td>139</td>
</tr>
<tr>
<td>UI2 Developer's Release</td>
<td>449</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAS-C Translator</td>
<td>795</td>
</tr>
<tr>
<td>BAS-C Comm:rcial S375</td>
<td>$349</td>
</tr>
<tr>
<td>BAS-C Comm:rcial S375</td>
<td>$349</td>
</tr>
<tr>
<td>WATCOM C Professional New!</td>
<td>919</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>WindowsMaker™</td>
<td>670</td>
</tr>
<tr>
<td>WindowsMaker™ Professional New!</td>
<td>775</td>
</tr>
</tbody>
</table>

THE PROGRAMMER’S SHOP 1-800-421-8006
more than just products...

Sourcerer’s Apprentice—Version Control for the Professional by Solution Systems
From the company that brings you BRIEF: version control with single keystroke accessibility from BRIEF. Sourcerer’s Apprentice tracks all changes, who made them, when, and why. Easily recreate or combine previous versions of code. Experiment freely. Sourcerer’s Apprentice can always bring you back. Teams take note: Sourcerer’s Apprentice prevents simultaneous updates to the same files.
LIST: $499 PS Price: $459
FastFacts 722-137

BLAST by Communications Research
BLAST puts powerful data transfer, remote control, scripting, terminal emulation, data compression, and other communications magic into one product for PC, UNIX, XENIX, VAX, Macintosh, and even mainframe communications...all with the same look, feel, menu interface, protocol, and script language! Easy for developers to link into existing applications for automated, 100% error-free data transfer and fast, reliable remote control.
LIST: $295 PS Price: $235
FastFacts 1674-001

Recital by Recital Corporation, Inc.
Yes, it runs your dBASE, FoxBASE and Clipper applications on UNIX, XENIX and AIX (also VAX/VMS and ULTRIX). But that’s only the beginning of Recital. It’s a complete relational database and 4GL for developer and end-user alike. It’s also got a powerful data dictionary, SQL interface and over 350 additional commands.
LIST: $995 PS Price: $600
FastFacts 2039-001

RE:Source by Ganesoft
SoftProbe 86/TX 295
Source 486 w/BIOS pre-proc. 149
Trapper 189

DEVELOPMENT TOOLS
AllClear 269
ASMFLOW Prof. 179
Buzzwords DANALYST Gold 199
C-DOC 179
Charge 95
CLEAR+ for C 179
Codan 349
Easy Flow 195
INSIDEI 119
Install 219
INSTALIT w/source 239
MKS Make 129
MKS RCS 175
PC-Link 115
Pilk/LTO 499
PolyMake 159
PVCS Professional 439
RTLINK Plus 419
Sourcerer’s Apprentice Prof. 459
The Documentor 229
TULB 5.0 Version Control 125

EDITORS
BRIEF Call
Cheetah 75
dBrief 119
Emacs 279
Epsilon 175
KEDIT 139
Sage Professional Editor 249

CHEETAH 2.2 by Software Science
Over 900 features make Cheeta the world’s most powerful editor for dBASE, FoxBASE, Clipper, QuickSilver, Force and word processing. Pull-down menus give you all the editing features you need and expect, and let you compile, link, and run your application inside Cheeta. Extensive language help, direct access to creating and viewing indexed dBASE files, built-in calculator, source formatter, and spelling checker are just the tip of the iceberg.
LIST: $145 PS Price: $75
FastFacts 1843-008

MICRO PLANNER by Micro Planning International
MICRO PLANNER with its unique graphic interface will have you building a step-by-step model of your project in less than a day, allowing you to create impressive reports—including PERT charts and bar charts—that look as powerful on paper as on the screen. From there, Critical Path Method will calculate start dates and deadlines, forecast bottlenecks, and optimize crucial resources. MICRO PLANNER is available for PC’s & Mac’s with interchangeable files between machines.
LIST: $395 PS Price: $235
FastFacts 1387-003

Graphics Dev’t Toolkit by Graphic Software Systems
Get to the market quicker with graphics that don’t compromise performance. Have access to more than 100 high-level graphics functions and GDT-based applications that will support over 300 graphics devices. The GDT is a time-proven solution for programs written in C, FORTRAN, Pascal, BASIC Compiler or Micro Assembler. It has been optimized through eight years of refinement and application to produce high-quality, high-performance graphics.
LIST: $795 PS Price: $599
FastFacts 221-073

RE:Source by Ganesoft

EXTENDED TOOLS
SP/FPC - V2.1 195
Vedit + 159

GRAPHICS
Essential Graphics v3.0 349
GFX Graphics Library 139
Graphic 319
graphics-Menu 165
GSS Graphics Dev’t Toolkit 699
HALO 279
MetaWIDOW/PLUS 369
PCX Effects 95
PCX Programmer’s Toolkit 229
Vidar w/source 279
VID and DIG Graphics 249
Z-Phigs Lite 169
Z-Phigs Professional 769

HARDWARE
2C87-20 329
80387-33 675
Boca 1024 VGA 219
FastMath 80387-16 359
Logitech Mouse 100
Model 2000L UPS 189
Model 450AT UPS 329
ST-251-1 339
ST-4096-1 639

BY GRAPHIC SOFTWARE SYSTEMS

THE PROGRAMMER’S SHOP 1-800-421-8006
The Programmer's Shop is

Other Products

- BlueMAX
- Carbon Copy Plus
- Dan Bridden's PageGarden
- FastI
- FastBack Plus
- Flow Charting III
- Grasp
- HEADROOM
- HiJaak
- LapLink III
- Link & Locate ++
- Mace Utilities
- Math Advantage
- Norton Anti-Virus
- Norton Utilities 5.0
- pCANYWHERE IV
- PC Tools Deluxe 6.0
- PC-KWIK Power Pak
- Pre Cursor
- Remote2
- SpinRite II
- System Sleuth
- Timesheet Prof.
- Turbo EMS

Pascal

- MetaWare Prof. Pascal
- Microsoft Pascal
- Oregon Pascal
- Quick Pascal
- Turbo ASYNCH PLUS
- Turbo Pascal 6.0
- Turbo Professional

Text Screen Add-Ons

- C Worthy w/Forms w/ARCH
- Greenleaf DataWindows
- HI-SCREEN XL Professional
- Lexical Resolution
- MEWEL Window System
- POWER SCREEN
- Vitamin C - source, menus
- VC Screen - painter
- Vermont Views Obj. + source

UNIX/XENIX

- C++ for Unix 386

Fast Facts 97-1-07

LIST: $249
PS Price: $179

Computer Innovations C++

LIST: $495
PS Price: $395

ESIX Systems

LIST: $395
PS Price: $329

Informix SQL

LIST: $259
PS Price: $209

Interactive Systems

LIST: $199
PS Price: $169

Architech Appl. Platform

LIST: $149
PS Price: $129

Architech Appl. Developer

LIST: $99
PS Price: $89

Architech Wkstn Platform

LIST: $149
PS Price: $129

Architech Wkstn Developer

LIST: $249
PS Price: $209

LPI-FORTRAN

LIST: $395
PS Price: $329

M+ for Unix

LIST: $199
PS Price: $169

M+ for Unix w/ source

LIST: $395
PS Price: $329

Norton Utilities for Unix

LIST: $249
PS Price: $209

Santas Cruz Operations

LIST: $249
PS Price: $209

UNIX Operating System

LIST: $895
PS Price: $795

UNIX Development System

LIST: $895
PS Price: $795

V Piez

LIST: $495
PS Price: $429

XENIX Operating Sys.

LIST: $595
PS Price: $519

XENIX Developer. Sys.

LIST: $595
PS Price: $519

UniK System V4 Complete

LIST: $1495
PS Price: $1295

WordTech QuickSilver

LIST: $1295
PS Price: $1095

WINdows & OS/2

- ACTOR
- ACTOR Professional
- BRIEF for OS/2
- Case: FM (for C or C++)
- Case: W Corporate Version
- CinkleViews
- C-Trieve/Windows
- dBASE/Windows
- Graphics Server SDK
- Instant Windows
- KnowledgePro Windows
- MS Windows V3.1
- MS Windows DDK V3.0
- MS Windows SDK V3.0
- Multiscope OS/2 Debugger
- Multiscope Windows Debug.
- Object1
- ObjectVision by Borland
- OS2 PM Toolkit 1.2
- ProtoGen
- ProtoView
- Smalltalk/V PM
- Tempo for Windows 1.1
- ToolBook
- Windows Maker
- Windows Maker Professional

LIST: $249
PS Price: $209

LIST: $495
PS Price: $429

FREE DEMO

LIST: $99
PS Price: $79

LIST: $395
PS Price: $329

LIST: $199
PS Price: $169

LIST: $249
PS Price: $209

LIST: $249
PS Price: $209

LIST: $1495
PS Price: $1295

HALO Professional

LIST: $595
PS Price: $519

NEW PRODUCT

By MediA Cybernetics

HALO Professional is the new graphics tool for developers of large, complex applications. No other graphics library offers you as many ways to break the 640K barrier.

- 200 powerful graphics subroutines
- DDD Extender support
- Support for today's most powerful language compiler
- International character support
- Efficient memory usage
- Support for popular graphics adapters, printers, image scanners, and plotters
- Supporting Programmer's Guide and documentation

LIST: $259
PS Price: $219

LIST: $395
PS Price: $329

LIST: $199
PS Price: $169

LIST: $249
PS Price: $209

LIST: $495
PS Price: $429

LIST: $249
PS Price: $209

LIST: $495
PS Price: $429

LIST: $249
PS Price: $209

LIST: $495
PS Price: $429

LIST: $1495
PS Price: $1295

Actor & Prof. Actor

By The Whitewater Group

Actor is the ideal way to learn how to apply modern object-oriented programming techniques to create Windows applications fast. Move on to Actor Professional three powerful tools for the developer who's ready to get serious about Windows development: the professional version of Actor; ObjectGraphics for adding sophisticated graphics to your Windows applications; and Windows Resource Toolkit for visually programming its look and feel.

LIST: $249
PS Price: $219

LIST: $495
PS Price: $429

LIST: $849
PS Price: $739

LIST: $501
PS Price: $429

LIST: $801
PS Price: $699

THE PROGRAMMER'S SHOP 1-800-421-8006
KnowledgePro Windows by Knowledge Garden Inc. Use KnowledgePro to build fast, complete, royalty-free Windows applications in record time. Get started quickly with interactive design tools. Use KnowledgePro's rich, OOP language for rapid development capability and low-level control. Give your applications depth with hypertext and hypermedia. Access expert systems technology to create smart solutions. Use simple DDE commands to write intelligent front-ends for Excel, Word, and Superbase. Write DLL extensions to KnowledgePro with low-level languages like C and C++. Work SMART. Order KnowledgePro. PC Magazine "Best of 1990".

LIST: $695
PS Price: $589
FastFacts 1419-012

Run Your 386™ to the MAX! by Qualitas
386MAX (for 386-based machines) and BlueMAX (For 386-based PS/2a) give your system maximum performance with Windows™ 3.0 support. Exclusive technologies include FlexFrame, to load more programs into high DOS than any other memory manager, and Instancing, which allows many resident programs to run reliably under Windows.

LIST: $130
PS Price: $109 123-004

Clipper 5.0 by Nantucket Corp.
Clipper's open architecture lends unprecedented freedom to application development. Its language is fully extensible with user-defined functions and new user-defined commands. You can extend the language with routines written in Clipper itself, or integrate code from other languages like C, Assembler, dBASE® and Pascal. Develop applications larger than available memory, without defining overlays. Clipper's compiler generates stand-alone, executable files for cost-free, unrestricted distribution.

LIST: $795
FastFacts 1119-003

Quattro Pro 3.0 by Borland International
Award winning Quattro Pro was the first spreadsheet that went beyond mere number-crunching and delivered enhanced decision support, data access and presentation capabilities. By seamlessly integrating multi-page consolidation, external database access, goal seeking technology, spreadsheet publishing and presentation graphics, Quattro Pro gave you the power to better understand your data and the tools to turn dry, numerical data into spectacular visual presentations. Now Quattro Pro 3.0 gives you a fully integrated WYSIWYG ("What You See is What You Get") display, new drawing tools, Banner sideways printing and Print to Fit on one page features. Plus, you can add visual transition and sound effects to your electronic slide shows. And thanks to Borland's exclusive VROOMTM (Virtual Runtime Object-Oriented Memory Management), you can use any PC with a hard disk — from an XT with as little as 512K to a 486 with 8 meg. It's network ready right out of the box! Look for specially marked boxes that include a FREE Pro View PowerPack. A $300 collection of presentation tools, the ProView PowerPack includes fonts, clip art, free slide processing, presentation guide and macro library.

LIST: $495
PS Price: $415 777-069

What is FastFacts?
Access literature on any of our products via FAX machine. FREE!

Call 617-740-0025 from any fax phone!
Follow the voice computer's instructions and enter your product's code number. Then await your instant print out of product literature.
Hard

No-Compromise Notebooks with 386SX Power

STEVEN J. VAUGHAN-NICHOLS

Once upon a time, if you wanted to take a computer on the road, you had a choice: You could have a full-powered computer, or you could take a laptop. Portability wasn’t a problem—just give up your hard disk drive, possibly your floppy disk drive, a decent screen, and any pretenses of power. Times have changed.

First came the spate of notebook-size 286 machines, followed by Compaq’s LTE 386s/20—the first notebook-size SX machine (see “Perfectly Portable,” February BYTE). Now, a flood of notebook-size 386SX computers has hit the streets. These no-compromise systems have more power than many desktop computers and can accommodate an external monitor and keyboard. BYTE has rounded up the first of this new breed: Advanced Logic Research’s (ALR) Venture/16, the AST Premium Exec 386SX/20, the Dataworld NB320SX, the Everex Tempo LX, the Grid 1450SX, the Samsung NoteMaster 386S/16, the Texas Instruments (TI) TravelMate 3000, and the Toshiba T2000SX. Serious computing power is ready to hit the road.

Powerful Selection

Computing road warriors have never had more of a selection. BYTE asked vendors to supply systems configured with 1 megabyte of system memory, a 20-MB hard disk drive, and one high-density 3½-inch floppy disk drive. With these configurations, prices range from $2650 to $5499—quite a spread. I tested both 16- and 20-MHz SX machines. A rundown of the system configurations and options appears in the features table.

Having this kind of power in a laptop is nothing new, but until now such machines were always tied to the nearest power outlet. Notebook computers are much smaller and lighter than their AC-powered counterparts. Any of them will fit into your briefcase. And except for the Grid 1450SX, these are under-8-pound wonders that won’t tire your arm during the daily commute. But to shed weight, these systems have made the AC power supply an external component. With their maximum battery life just over 2 hours on average and just under 4 hours at best, you’ll have to make room in your briefcase for the brick-size power supplies that come with them.

The BYTE Lab ran each of the machines through its notebook computer test suite, a scaled-down version of the standard BYTE benchmarks that includes low-level and application benchmarks and a battery-life test that simulates a word processing session. (For more on these benchmarks, see the text box “From the Testing Notebook,” February BYTE, page 152.) The results are shown in the graph; I’ve included Compaq’s LTE 386s/20, a 20-MHz SX notebook computer, for comparison.

Key Subsystems

Notebook computers have many vices, one of which is cramped keyboards. The keyboards on all the reviewed machines except the Toshiba T2000SX are barely adequate for extended typing, although most are tolerable for brief periods. Even the models that use extensive overlays to fit all the keys into limited space are tolerable only for short work sessions. Only the models that use extensive overlays to fit all the keys into limited space are tolerable only for short work sessions. Only the Everex and Grid keyboards have full-size function keys, and none of the systems has a detachable keyboard like that on the Compaq LTE 386s/20.

Short key travel makes working on these keyboards like running on concrete: It doesn’t hurt at first, but the pounding wears on you the longer you work. Notebook-computer keyboards are fine for small jobs, such as writing a memo, but their charm quickly evaporates when they’re used for bigger tasks. The supertwist LCDs in these systems have come a long way. Characters are sharp and clear, although you will see some smudging when the screen images change quickly. Despite this, text-based applications like WordStar 5.5, Procomm 1.1B, and Quattro Pro 2.0 are as usable here as on any desktop PC. But only the most fanatic Windows users should attempt running that environment on a notebook computer. The CPUs have the horsepower for the assignment, but you’ll quickly lose track of the cursor.

Improvements

Improvements in backlighting, side-lighting, and LCD technology have made these systems usable in conditions
from near dusk to bright noon light. These machines even work under the glare of office lighting. If there’s light enough to work, there’s light enough to use these computers.

Processors have grown more powerful, disk storage has increased, and screens have become sharper, but batteries have lagged behind. Battery life has increased, but through better battery management rather than better batteries. Dataworld’s Phoenix BIOS, for instance, lets you set time-outs that shut down each subsystem after a period of inactivity. Other systems use similar schemes either in software or in ROM. Despite these efforts, battery life is still a major headache for notebook users.

The exception to this rule is the Toshiba T2000SX—the first laptop to use nickel-hydride batteries. BYTE’s battery-life tests show that these batteries deliver power for longer periods than do the nickel-cadmium batteries used by Toshiba’s competitors (see the bar chart). Nickel-hydride batteries aren’t prone to nickel-cadmium batteries’ charge memory woes. (Unless a nickel-cadmium battery is discharged completely before you recharge it, the battery capacity is reduced.) The T2000SX delivered 3-plus hours of battery-powered work time, and its power management software is as good as it gets.

All these notebook computers include ample hard disk storage. Every system comes with at least a 3½-inch 20-MB hard disk drive, with 40-, 60-, and even 120-MB drives available as options. While none of these drives is a speed demon, all have average access times of under 25 milliseconds, and all turned in good performance times.

In the last generation of notebook computers, some laptop makers gambled that users wouldn’t miss a floppy disk drive if they had a file transfer program like Traveling Software’s LapLink in ROM. Users didn’t buy it. Even with a hard disk drive installed, users still want floppy disk drives. Vendors have responded: In this latest generation, notebook computers include a high-density 3½-inch floppy disk drive. Some continue to bundle LapLink or similar file transfer utilities, but they provide them on standard floppy disks rather than in ROM.

Field Tested
I carted these systems with me on several business trips. None broke down, but a few of them seemed better suited for life on the road than others. The TI TravelMate 3000 felt too flimsy to be bouncing around in a briefcase. Nothing ever went wrong with it, but in the back of my mind I was always a little worried about its durability. At the other extreme, the Grid 1450SX felt sturdy enough to cart to Kuwait and back.

On a more minor point, the I/O port covers often didn’t work well. Specifically, the TravelMate 3000 and Tempo

---

**BYTE ACTION SUMMARY**

- **386SX NOTEBOOKS**
- **LIKES**
  - Display quality that’s better than ever and performance that rivals most SX desktop machines. All accept an external keyboard and monitor when you’re in the office.
- **DISLIKES**
  - Ergonomically abysmal keyboards, except for the Toshiba T2000SX’s. Most units run for just over 2 hours between battery charges.
- **RECOMMENDATIONS**
  - Buy the Toshiba T2000SX.
  - Display quality, performance, and battery life are all excellent. And the outstanding keyboard makes all the difference between wanting to use a notebook computer on the road and leaving it in your suitcase.
LX port covers don’t fasten tightly. I almost had to pry open the port covers on the ALR Venture/16. And the Grid 1450SX doesn’t even have port covers; its design relies on sturdy ports to withstand travel wear and tear. A short review of each machine follows.

**ALR Venture/16**

The Venture/16 base system includes a 16-MHz 386SX CPU, 1 MB of RAM, and a 20-MB hard disk drive for $2795. The unit is slightly bigger than an 81/2-by-11-inch notebook. A special connector accepts an external hard disk drive.

The backlit supplertwist LCD supports standard 640-by-480-pixel VGA graphics with 32 gray scales and is easy on the eyes. The contrast and brightness controls, which sit flush with the display panel surface, are hard to adjust.

BYTE’s benchmarks put the Venture/16 in the upper performance bracket, but the presence of an 80387SX skewed the results. The other systems would have fared better relative to the Venture/16 had they been comparably equipped.

ALR is unique in bundling Digital Research’s DR DOS 5.0 with the Venture/16 instead of MS-DOS 3.30 or 4.01. Best of all, the Venture is one of the least expensive 386SX notebooks around.

That’s what you’ll like. Here is the rest of the story. The keyboard layout is good, but tiring to use. The function keys (10 dedicated keys, with F11 and F12 overlaid on F1 and F2) are half the size of other frequently used keys.

The keyboard by itself isn’t that big a deal, but there’s more. The general system assembly leaves much to be desired. The Venture/16 has a toylike feel to it. The floppy disk drive worked intermittently until I opened the unit and reseated the disk drive cables. But I couldn’t do anything about the slightly loose hinges connecting the display panel to the rest of the computer. I was also annoyed with the port panel, which pushed slightly into the system every time I exerted pressure on it when attaching cables.

While the Venture/16 had a healthy battery life compared to the other systems, its early warning system gave just a 30-second warning before the battery gave out. That’s not enough time.

The Venture/16’s fit-and-finish problems gave me pause. Still, it’s hard to argue with ALR’s pricing. A few small improvements in construction quality would go a long way toward making this machine a top contender.

**AST Premium Exec 386SX/20**

The Premium Exec is another inexpensive system from a well-known company. The standard configuration includes a 20-MHz 386SX processor, 2 MB of system memory, and a 20-MB hard disk drive for $2995. AST also offers this machine with a 12-MHz 286 processor, and your dealer can upgrade the CPU as 386SL processor modules become available. You can also expand the memory to 8 MB—more than all but the Toshiba and Dataworld systems.

The VGA screen supports 32 gray scales and is about on a par with its competitors. The slide-bar brightness and contrast controls are a cinch to use. This 61/2-pound machine is lighter than all but TI’s TravelMate 3000. It’s not the equal of its lighter cousin in performance, but the Premium Exec has more than enough processing power to take care of any computing chores that you are likely to run into while you’re on the road. The important numbers here, though, aren’t measured in pounds and milliseconds, but in dollars and cents. The Premium Exec is almost as good as the TravelMate, for $2500 less.

As with most of these systems, the keyboard is the Premium Exec’s Achilles’ heel. The 2-millimeter key travel, typical of most machines that I tested, is 1.5 mm less than that of a standard desktop keyboard. That doesn’t sound like much, but an hour of typing will definitely convince you that you want another keyboard. The pint-size Control, Alt, and function keys all sit next to each other in the bottom row of the keyboard; WordPerfect users will have fits on this machine.

More minor fit-and-finish issues include inadequate display latches and port covers. A moderate bump can spring either open.

The Premium Exec has a mediocrine keyboard, but it earned my respect in most other areas. If you don’t touch-type, this relatively inexpensive machine is a good choice.

**Dataworld NB320SX**

Dataworld is well known in the direct-sales world, but its name hasn’t spread far from there yet. The NB320SX may change that. At $2650, this is the least expensive SX notebook I tested. And the NB320SX isn’t a stripped-down system. It comes with a 20-MB hard disk drive and 2 MB of RAM. Memory upgrades require a trip to your dealer, but the machine can accept up to 16 MB of RAM using 4-MB single in-line memory modules.

The NB320SX’s application performance lags behind that of the 20-MHz AST Premium Exec, the TI TravelMate, and the ALR Venture/16. While its raw processing power is impressive on the low-level tests, this system isn’t as well integrated as the others. Still, the differences are small, and the backlit VGA display is almost as good as those in the TI and AST units.

The keyboard is nothing special, but it worked better than other shrunk-down
Introducing an inexpensive solution to America's savings crisis.

You've always wanted to own a tape drive. Unfortunately one small thing has always stood in your way. Your savings account.

Well, now you can buy an internal tape drive that can back up from 40 to 120 megabytes for as little as $419.* Or a whopping 80 to 250 megabytes for just $519.*

Our Irwin SX Series™ Tape Backup Systems are ready to go right out of the box. Unlike others, they're complete systems—with all the hardware and software you need—as well as a tape cartridge.

But that's not all. Every Irwin SX drive comes bundled with Central Point Backup™ software. This award-winning program works with a wide array of IBM AT, PS/2 and compatibles.

Whether you choose an internal or an external system, you can back up a 40 megabyte hard drive in less than 12 minutes.

Visual file selection, unattended backup and mouse support are just a few of the features that make this the favorite backup utility of over one million PC users.

To save you even more money, we also include a coupon that lets you buy Central Point PC Tools Deluxe™ for just $50. A $99 savings from its usual $149 price tag.

So if you want to back up on tape without emptying your bank account, pick up an SX Series system at your nearest Irwin dealer.

Or, call 800-BACKUP1 for more information. And we'll help end your savings crisis.

In more ways than one.

*Manufacturer's Suggested Retail Price. ©1991, Irwin Magnetic Systems, a subsidiary of Archive Corporation, 255 Commerce Way, Ann Arbor, MI 48108-1649. Irwin and the Irwin logo are registered trademarks and the SX Series by Irwin is a trademark of Irwin Magnetic Systems, Inc. Central Point Backup and PC Tools Deluxe are trademarks of Central Point Software, Inc. All other trademarks or registered trademarks are the property of their respective holders.
The most noticeable difference between notebook computers is price; nearly $3000 separates the low-cost Dataworld NB320SX from the high-end TI TravelMate 3000. You'll want to think twice, however, about picking a machine by price alone. All machines include a high-density 3½-inch floppy disk drive, an 80387SX math co-processor socket, and ports for an external keyboard and monitor. All also carry a one-year warranty and an FCC Class B rating.

### Computer Specifications

<table>
<thead>
<tr>
<th>Computer</th>
<th>ALR Venture/16</th>
<th>AST Premium Exec 386SX/20</th>
<th>Dataworld NB320SX</th>
<th>Everex Tempo LX</th>
<th>Grid 1450SX</th>
<th>Samsung NoteMaster 386SX/16</th>
<th>TI TravelMate 3000</th>
<th>Toshiba T2000SX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor/speed (MHz)</td>
<td>386SX/16</td>
<td>386SX/20</td>
<td>386SX/20</td>
<td>386SX/16</td>
<td>386SX/16</td>
<td>386SX/16</td>
<td>386SX/16</td>
<td>386SX/16</td>
</tr>
<tr>
<td>Memory (min./max.; MB)</td>
<td>1/5</td>
<td>2/8</td>
<td>2/16</td>
<td>1/5</td>
<td>1/5</td>
<td>1/5</td>
<td>2/16</td>
<td>2/16</td>
</tr>
<tr>
<td>Memory upgrades</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>System Unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions (inches: W x D x H)</td>
<td>12.2 x 8.6 x 2.1</td>
<td>11.4 x 9 x 2.25</td>
<td>11.8 x 8.5 x 2.2</td>
<td>10 x 12 x 2</td>
<td>12.5 x 11.5 x 2.6</td>
<td>11 x 8.5 x 2.1</td>
<td>11 x 8.5 x 1.8</td>
<td>12.2 x 10 x 1.9</td>
</tr>
<tr>
<td>Weight (pounds)</td>
<td>7.5</td>
<td>6.5</td>
<td>6.9</td>
<td>11.2</td>
<td>7.0</td>
<td>5.7</td>
<td>6.9</td>
<td>6.9</td>
</tr>
<tr>
<td>External power supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions (inches: W x D x H)</td>
<td>3 x 6.5 x 2</td>
<td>3.1 x 8.4 x 2.2</td>
<td>3 x 6.4 x 2</td>
<td>3.1 x 8.2 x 2.1</td>
<td>3.5 x 5.9 x 2.1</td>
<td>3.5 x 5.9 x 2</td>
<td>3 x 6.1 x 1.75</td>
<td></td>
</tr>
<tr>
<td>Weight (pounds)</td>
<td>1.5</td>
<td>1.3</td>
<td>1.5</td>
<td>1.5</td>
<td>1.2</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Keyboard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of keys</td>
<td>82</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>79</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Key travel (min)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Display</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCD type</td>
<td>Backlit</td>
<td>Backlit</td>
<td>Backlit</td>
<td>Backlit</td>
<td>Backlit</td>
<td>Backlit</td>
<td>Backlit</td>
<td>Backlit</td>
</tr>
<tr>
<td>Graphics resolution</td>
<td>640x480 VGA</td>
<td>640x480 VGA</td>
<td>640x480 VGA</td>
<td>640x480 VGA</td>
<td>640x480 VGA</td>
<td>640x480 VGA</td>
<td>640x480 VGA</td>
<td>640x480 VGA</td>
</tr>
<tr>
<td>(maximum) in pixels</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Grey scales</td>
<td>5.2 x 7</td>
<td>5.2 x 8.9</td>
<td>5.2 x 6.8</td>
<td>5.3 x 6.5</td>
<td>5.3 x 6.8</td>
<td>5.3 x 6.8</td>
<td>5.1 x 6.8</td>
<td>5.1 x 6.8</td>
</tr>
<tr>
<td>Viewable screen area</td>
<td>5.8 x 7.6</td>
<td>6 x 8</td>
<td>6 x 8</td>
<td>6 x 8</td>
<td>6 x 8</td>
<td>6 x 8</td>
<td>6 x 8</td>
<td>6 x 8</td>
</tr>
<tr>
<td>Battery life (hours)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Battery recharge time</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>1.5</td>
</tr>
<tr>
<td>Device ports</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Parallel</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Expansion options</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal modem?</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Expansion chassis?</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bundled software</td>
<td>DOS 5.0 and U.L.P utilities</td>
<td>DOS 3.3, LapLink III, Battery Watch, other utilities</td>
<td>DOS 4.0, FastFlow, other utilities</td>
<td>DOS 4.0, and utilities</td>
<td>DOS 3.3 and utilities</td>
<td>DOS 4.01, LapLink, Windows 3.0, GWBASIC, and utilities</td>
<td>DOS 4.01 and utilities</td>
<td>DOS 4.01 and utilities</td>
</tr>
<tr>
<td>Price</td>
<td>$2795</td>
<td>$2955</td>
<td>$2650</td>
<td>$2099</td>
<td>$4795</td>
<td>$3999</td>
<td>$5499</td>
<td>$4999</td>
</tr>
</tbody>
</table>

*7.9 pounds without detachable external battery pack.

### Other Observations

I was especially pleased by the full-size Control key next to the A key. The good spacing between the 12 small function keys on the keyboard's top row makes them easy to use.

The NB320SX’s one weakness is the battery. The test machine ran out of juice in just 1 hour, 40 minutes during BYTE's battery-life test. That put it in last place, along with the Grid 1450SX. (You might do better in actual use—BYTE runs the battery test with the power conservation functions disabled.) The battery also takes 4 hours to recharge—longer than that of any other machine tested except the Samsung NoteMaster.

You get what you pay for, so the saying goes. Dataworld's model isn't the smallest, lightest, or fastest system I tested, but it's definitely the least expensive. This system is the loss leader—but don't forget to bring the power supply along.

**Everex Tempo LX**

The Tempo LX is Everex's first attempt at a laptop. This 16-MHz system comes with 1 MB of RAM and a 20-MB Conner Peripherals Intelligent Drive Electronics hard disk drive for $2999. The machine accepts up to 5 MB of system RAM, but your dealer has to install it.

Everex fans will be disappointed to learn that the Tempo is not a performance leader. It posted relatively slow video benchmark scores, and its application benchmark scores were about on a par with the other 16-MHz SX machines. The Tempo's nickel-cadmium battery held out for 2½ hours during the battery test, matching the results for Samsung's NoteMaster. Only the AST and Toshiba computers did better here.
To see the future of motherboards, look at the past.

You'll discover since 1985, one company has consistently given both resellers and endusers the highest level of performance, quality and support at the lowest possible price. ATronics.

In fact, we were the very first company to produce AT-compatible motherboards. The result is ATronics delivers the best choice for quality U.S. designed-and-made products.

And with standards that meet or exceed other motherboards that would cost you far more. ATronics offers one of the lowest failure rates in the business. Standard benchmark tests prove their performance.

No other motherboard company delivers it all like ATronics. Prove it to yourself right now. Pick up the phone and call toll free for information and documentation on current and upcoming products. You'll be on your way to a bigger, better and brighter future.

1-800-488-7776.

Ask us about our FCC Class B Bare-bone Systems!

ATronics

1830 McCandless Dr., Milpitas, CA 95035-6844, USA
Tel. (408)942-3344, Fax (408)942-1674

ATronics 1991©. ATI-1000, ATI-386/82 and ATI-486/82 are trademarks and ATI is a registered trademark of ATronics, International, Inc.
All other products mentioned are trademarks of their respective holders.
Notebook computer benchmarks aren't directly comparable with the standard system benchmarks. The battery-life test results are in minutes. For all other benchmarks, the results are indexed and show relative performance: for each index, an 8-MHz IBM AT running MS-DOS 3.30 = 1.

The BYTE low-level benchmark suite identifies performance differences at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. Application indexes include tests using the following programs: Word processing: XyWrite 3.55, Database: Borland Paradox 3.0, and Ashton-Tate dBase IV; Compilers: Microsoft C 5.1 and Turbo Pascal 5.5; Scientific/Engineering: Stata 2, MathCAD 2.5, and PC-Matlab 3.5; and Spreadsheets: Lotus 1-2-3 release 2.2 and Quattro Pro 1.0.

The BYTE Lab introduced the notebook benchmarks in the February issue (see "Perfectly Portable"). To obtain a copy of the benchmarks or join the list of benchmarks for conferences on BIX or contact BYTE directly.

The Compaq LTE 386s/20, AST Premium Exec 386SX/20, and Toshiba T2000SX offer the longest battery life. The Premium Exec, TI TravelMate 3000, and LTE 386s/20 outperformed the rest of the group. The ALR Venture/16 also did well, due in part to its math coprocessor—no other machine had an 80387SX installed.

The Tempo has a good-quality backlit LCD. It could have been a little bit brighter, but that's all I would ask. The Tempo's default character font is also more attractive than those on the other systems. Graphics adjustments are simple thanks to the sprocket controls that Everex mounted on the side of the keyboard. That's good, because it's easy to hit them by accident.

The Tempo keyboard has a tinny feeling that I didn't care for. I approve highly of the key arrangement, however, which features oversize Control, Alt, and Enter keys. The price for the roomy keyboard is a large case, but the Tempo still weighs in at a hair under 7 pounds.

The Tempo's slow video won't help with graphics-intensive applications, and the keyboard is mediocre. Still, the machine has relatively good battery life, quality construction, and the Everex name to recommend it.

Grid 1450SX
Grid Systems' 1450SX is bigger, heavier, and a little older than the other systems. The 1450SX, with 1 MB of RAM, a 20- MB hard disk drive, a floppy disk drive, and a 16-MHz microprocessor matches up feature-for-feature with other systems and performs about as well as its peers. The $4795 asking price is high, but its impeccable construction quality should please field-service technicians and others who need a sturdy machine for the road.

The 1450SX reminds me of an expensive European touring car. It may not get to your destination any faster than other systems, but you'll enjoy the ride more. It's the Rolls-Royce of laptops, with a keyboard, display, and casing that are handsome and a pleasure to use.

Ergonomic and psychological factors aside, there's little to recommend the 1450SX. One minor annoyance is that memory upgrades require a trip to the dealer. A more serious problem is the oversized battery (11 ½ by 12½ inches), which covers the bottom of the computer and brings the total system weight to 11.2
THE WINDOWS™ 3.0 SOLUTION:

FASTCache-SX™ — Triples your AT speed with a 386™ SX from $495.

FASTCache-SX/Plus™ — SPEED plus the MEMORY you need on a single board!

FASTCache-SX is your most cost effective upgrade path to the world of 386-based computing. Designed to work in most ATs and compatibles, FASTCache-SX or FASTCache-SX/Plus converts your 286 into a 16 or 20 MHz 386SX powerhouse that outperforms most 386SX and some 386DX based systems. You’ll run all your old 16-bit software plus new applications customized for the 386’s speed and 32-bit memory, like Windows 3.0 in “386 enhanced mode.”

Speed ... Memory ... Compatibility

Both FASTCache-SX and SX/Plus are 100% compatible with your AT’s hardware and software. Their 32K (optional 64K), four-way set associative cache gives your AT zero-wait-state performance accessing 16-bit memory. Most applications run two or three times faster, providing the equivalent performance of more expensive 386/387DX-based systems.

- Features a genuine Intel 386SX running at either 16 or 20 MHz.
- Quick and easy installation with our user friendly manual.
- Optional 387™ SX delivers up to 1.7 MegaWhetstones, making it ideal for AutoCAD, Lotus and PostScript interpreters.
- Runs Windows 3.0 in “386 enhanced mode,” DESQview-386, and OS/2.
- Landmark ratings of 21.3/27 MHz and Norton SI ratings of 18/22 at clock frequencies of 16/20 MHz.
- Outperforms most 386SX-based motherboards and accelerators!
- Runs in over fifty 286™ systems including: AST, AT&T, Acer, Compaq, CompuAdd, Epson, EVEREX, HP, IBM (AT, PS/2-30-286, XT-286), NEC, NORTHGATE, Packard Bell, Tandy, Unisys, Wang, Wyse, Zenith and ZEOS.

FASTCache-SX/Plus includes sockets for up to 8 megabytes of extended memory. Since 386 multi-tasking applications such as Windows 3.0 run faster with more memory, FASTCache-SX/Plus is the ideal Windows solution.

The 16 MHz and 20 MHz FASTCache-SX list for $495 and $595. Add $100 to each for the Plus versions. An installation kit (required) costs between $50 and $95, depending upon the type of 286 socket. Both boards include a 5-year warranty and are backed by the best technical support in the PC industry. Installing the FASTCache-SX is easy. TRW installation is also available for a nominal fee (U.S. only).

No Risk Offer: FASTCache-SX and SX/Plus come with unconditional, 30-day, money-back guarantees. Your complete satisfaction is guaranteed — or your money back!

Call (508) 746-7341 to order your FASTCache-SX today!

Summer Special
Order FASTCache-SX or SX/Plus by August 1st and receive a FREE 32K cache upgrade (a $70.00 value).
Count yourself in with the Wildcard 88™

- Supports XT Turbo mode CPU clock speeds of 4.77, 7.15 and 9.54 MHz
- 10 MHz CPU clock frequency
- Supports up to 32K Bytes of onboard BIOS EPROM
- Small 2" x 4" form factor
- BIOS available for easy integration
- Onboard DRAM controller for easy system design
- Onboard bus controller supports XT I/O channel

Megatel is expanding the Wildcard family to offer you more development flexibility.

The Wildcard family offers the lowest cost, smallest footprint solution for your XT class system. It integrates all functions of the IBM PC, XT® motherboard minus DRAM and DRAM drivers. All on a circuit

- Supports 8087 co-processor operation (with socket) for high speed numeric data processing
- Reduces XT parts count by 75%
- Supports up to 640K of system DRAM
- Onboard sound generator supports speaker control
- Improves total system reliability
- Reduces overall system costs and factory overhead
- Onboard Keyboard Controller card the size of a business card.

For more information call us today.

Megatel Computer Corporation
125 Wendell Ave., Toronto, Ontario M9N 3K9
(416) 245-3324
FAX (416) 245-6505

Wildcard 88™ is a trademark of Megatel Computer Corp.
IBM PC, XT are registered trademarks of IBM Corp.

386SX NOTEBOOKS

pounds. What’s worse, it barely keeps up with those of the other systems: It quit after 1 hour, 40 minutes. Strong low-level video and disk benchmark scores didn’t distinguish the 1450SX in the application benchmark suite. If Grid would improve the battery life, shrink the bulky battery down a bit, and lower the price, this would be the notebook for everyone.

Samsung NoteMaster 386S/16
The NoteMaster looks like the other SX computers. It has the same essentials: a 16-MHz 386SX CPU, 1 MB of RAM, a 20-MB hard disk drive, and a high-density floppy disk drive for importing and exporting data. Its $3999 price puts it in the same ballpark as the Everex Tempo.

This machine falls short in many respects, however. It ran slightly behind its competition in most performance categories. The screen is harder to adjust than those of the other systems. But by far the most annoying feature is the keyboard. In a word, it’s lousy. The keyboard has small, inappropriately located special-purpose keys, and the key travel and feedback are poor. I tried to write part of this review on each machine, but the NoteMaster was just too frustrating for even that simple task.

Now for the good points. The NoteMaster did well on the battery-life tests. It went 2 hours before shutting down and gave plenty of advance warning when the battery went low. Samsung also paid attention to preserving battery life. The computer beeps if you try to close the case while the machine is running and lets you set time-outs that shut down the CPU, display, and other subsystems after a period of inactivity. This is not enough to redeem the machine, but it is enough to make me regret that the rest of the system didn’t live up to this area.

continued
Focus on Precision Illustration With New Designer 3.1

See for yourself. New Designer 3.1 turns your PC into a precision illustration tool, running under the Microsoft® Windows™ environment. You'll get more accuracy in technical illustrations, greater performance in graphic designs and higher speed in desktop publishing layouts. It's now easier to turn what you can imagine into an image all can see. Call for your free trial software and feel the high performance yourself.

△ Higher performance in Designer 3.1 speeds up drawings with faster wide styled lines—even wide dashed lines. Object snap points make precision a given.

The view from out front. With new Designer 3.1 you're ahead of the pack no matter how you look at it. With more usable features, higher performance operation and more flexible file handling, you'll be able to create and manipulate an image until it's just right. That's precision.

△ “The power-users choice... a customizable toolbox has a tool for just about anything: precise and accurate autotrace utility, CAD-like layering and superb color-publishing capabilities,” says PC Magazine.

△ Desktop published articles become clearer with precision illustration from Designer 3.1. Multiple file formats speed up import and export of files.

Outside perspective reflects well. “Designer is an outstanding illustration package that receives Editor's Choice recognition. Designer is perhaps the most sophisticated of all the illustration packages,” writes PC Magazine.

Software Digest reports that “Designer provides the best overall graphics package. The program offers state-of-the-art features, good performance, and unmatched ease of learning and use in a sophisticated package. Designer can handle virtually any free-form graphics or design task with ease.” Designer was awarded a top-of-the-class rating.

Circle 191 on Inquiry Card.

Free hands-on trial. Call now, for a free working model of the new Designer, 800-733-3729, ext. 5050.

This ad was created using Micrografx Designer. Micrografx, Inc. 1303 Arapaho, Richardson, TX 75081 - (214) 234-1769 Copyright © 1991, Micrografx, Inc. All Rights Reserved. Micrografx is a registered trademark, and Micrografx. Designer is a trademark of Micrografx. All other products are trademarks of their respective owners.
TI TravelMate 3000

TI is back, and this time it means business. The 5½-pound TravelMate 3000, with its 20-MHz CPU, is the fastest and lightest system in this roundup. Its good all-around performance placed it in the company of the AST Premium Exec and the ALR Venture/16.

The TravelMate has a few drawbacks. The bare-bones configuration of a 20-MB Conner Peripherals hard disk drive, floppy disk drive, and 2 MB of RAM lists for $5499—more than any other notebook computer except the Compaq LTE 386s/20 ($6499). It also has a relatively short battery life.

The keyboard console is not suitable for long sessions, but it’s no worse than that of any other notebook machine. The sidelit screen, one of the better displays, features VGA graphics with 32 levels of gray. The monitor controls, although flush on the display panel, are easy to manipulate. The case seems a bit flimsy, but it held up fine during testing.

Unquestionably, the TravelMate 3000 is a technological showpiece and a performance leader. Given its price, I question how many business travelers will be throwing a TravelMate into their briefcase; it does, however, make an ideal traveling companion.

Toshiba T2000SX

Toshiba has once again come through with a winner. The T2000SX outperformed most of the other 16-MHz machines in this review, and its unique nickel-hydride battery outlasted those of every SX notebook machine BYTE has tested, including that of Compaq’s LTE 386s/20 ($6499). It also has a relatively short battery life.

The base machine isn’t cheap, however. Configured with 1 MB of RAM and a 20-MB hard disk drive, it lists for $4999. The T2000SX also holds up to 9 MB of RAM.

Better battery technology is just one reason to go with the T2000SX. The machine’s power management software is top-notch, and Toshiba’s unique Resume feature lets you turn the machine off while running an application. When you power the machine up again, your application begins running where it left off. Even if the battery runs out while you’re working, you don’t have to worry about losing data.

The keyboard is also first rate. The nearly full-size (86-key) layout features good key placements, and using it is almost like typing on a full-size keyboard. I also preferred the system’s fluorescent sidelit display, which stands out even against those of the TI and Everex systems.

Like any other computer, the Toshiba T2000SX has its share of troubles. Some of the port covers detach completely from the system. They are difficult to fasten securely, and they seem almost custom-made to get lost. But these are minor points. If I were going to go out and buy a 386SX laptop computer, I would spend the extra money and get the T2000SX. It’s not perfect, but it’s close enough.

Steven J. Vaughan-Nichols is a freelance writer based in Lanham, Maryland. You can reach him on BIX as "sjvn."
COREL announces the finest in data security and mass storage for Novell networks. As the world’s leading developer of optical interface software for IBM and Macintosh computers, COREL brings you its award-winning line of optical disk sub-systems, the most powerful NetWare compatible optical drives on the market today. Whether you need the permanence of WORM storage, the convenience of erasable optical or the power and flexibility of our new multi-function drive and CD-ROM drives, COREL offers you the most flexible and effective storage solutions anywhere, providing massive archiving capabilities and exceptionally high security options.

COREL software is completely compatible with Novell NetWare utilities, security levels, and all existing applications. The world’s leading developer of optical disk interface software invites you to make the networking breakthrough. For details, contact COREL Systems today!

Corel Systems Corporation: the universal choice for optical innovation.

Circle 80 on Inquiry Card (RESELLERS: 81).
NCR's WaveLAN seems like the perfect solution to many of the problems associated with installing a LAN. You get fast, reliable connectivity without the wires. And unlike some other systems that include their own network operating system, WaveLAN supports NetWare. There are, however, a few problems in paradise.

WaveLAN replaces network cabling with high-frequency radio signals and uses spread-spectrum techniques to reduce interference. Nodes can transmit at up to 2 megabits per second over distances of 800 feet (unobstructed). Like a standard Ethernet LAN, WaveLAN uses CSMA protocols. But where Ethernet adds collision detection, WaveLAN uses collision avoidance techniques.

Because WaveLAN uses radio signals instead of transmitting data through a cable, collision detection would be difficult to arrange. Instead, WaveLAN listens before transmitting in an attempt to avoid collisions. When simultaneous transmissions do occur, WaveLAN depends on NetWare to detect garbled packets and request a retransmission.

WaveLAN currently works only with versions of NetWare 286 between 2.1 and 2.15C. NCR claims that WaveLAN will support NetWare 386 by the time you read this review, and it's working on drivers for Banyan's Vines and Microsoft's LAN Manager.

The Basic Package

NCR includes everything you need to set up a WaveLAN workstation or server with each network interface card. The package includes a full-length 16-bit AT-bus or 32-bit MCA-bus NIC, an antenna that's slightly larger than a 3½-inch disk, mounting hardware, two installation and setup disks, and an installation guide for $1390. A metal enclosure that houses the RF circuitry takes up approximately half the space on the network card. The back of the card holds a bank of four DIP switches and an F connector for the antenna. (The F connector looks like the threaded jack that your cable TV company installs in your house.)

You select from four available I/O addresses by setting two of the DIP switch-
WAVELAN

LIKES
No cabling needed; NetWare-compatible; high reliability; performance acceptable for most applications.

DISLIKES
Poor documentation makes installation irritating; noticeably slower than Ethernet for large file transfers, particularly with competing network traffic.

RECOMMENDATIONS
Worth consideration in offices with frequent moves and changes, or where running cable is difficult.

REQUIREMENTS
An AT- or MCA-bus PC and NetWare 2.1x

COST
$1390 per workstation or server; $90 for Data Encryption Standard chip

FOR MORE INFORMATION
NCR Corp.
1700 S. Patterson Blvd.
Dayton, OH 45479
(800) 225-5627
(513) 445-5000
fax: (513) 445-3842
Circle 1205 on Inquiry Card.

WaveLAN vs. Ethernet
Once you get through the installation, WaveLAN workstations work just like any other NetWare 286 workstations. WaveLAN's 2-Mbps speed rating is only 20 percent of Ethernet's theoretical 10-Mbps potential, but the difference isn't noticeable for most applications. There is an obvious difference if you have to perform transfers of large files, however.

In an effort to measure WaveLAN's
ability to deal with large files, I transferred a 1.2-megabyte file 10 times (5 times in each direction) between my Samsung/Novell 386AE file server and a Unisys PW2 486/25 client. I compared this with the same operation over conventional thin-wire Ethernet using a 3Com 3C503 card in the Unisys client and a Novell NE2000 in the Samsung/Novell file server. The 1.2-MB transfer averaged 1 minute, 36 seconds over standard thin-wire Ethernet versus 2 minutes, 41 seconds over WaveLAN. (Note that these numbers reflect relative performance; they do not reflect the speed of the network medium. Other factors affecting throughput include the speed of the hard disk drives, available memory, and the size of any disk cache on the workstation and client machines.)

Since WaveLAN depends on NetWare to catch transmission errors, I tried the same test while generating traffic from another workstation (a Zenith Z-248 in another room) to create interference. The effect was clear: The transfer still occurred without errors, but the average file transfer time increased to 3 minutes, 38 seconds—almost a minute longer.

WaveLAN uses spread-spectrum transmission in the 902- to 928-MHz range, so it’s unlikely that it will interfere with anything you’re likely to have around your office, although NCR warns that any machinery that generates radio noise, such as microwave ovens and copiers, could meet with interference that affects performance. One unexpected office appliance that WaveLAN interfered with was my multifrequency monitor. If you set the antenna next to a VGA color monitor as I did, your screen will look like it’s under water. Moving it away from the machine solved the problem.

Do You Want One?

Compared with the cost of standard Ethernet NICs, the WaveLAN’s $1390 list price sounds high, but you don’t have to pay for workstation cable drops with WaveLAN. A typical Ethernet installation that includes new cabling and adapter cards typically costs between $500 and $1000 per node, depending on the cable used. WaveLAN makes sense in areas where moves and changes happen frequently, or in open areas where it’s difficult to run cabling.

WaveLAN will never completely eliminate the need for cabling. While it can transmit up to 800 feet under ideal conditions, realistically you’ll be confined to a single floor of a high-rise building. You will still have to connect multiple servers with a backbone cable, and you may find that cable is required in some locations with high levels of electrical noise.

WaveLAN is clearly not going to keep up with Ethernet for CAD users wanting to transfer large files—particularly when many nodes are contending for transmission time. But for most typical LAN applications, WaveLAN is plenty fast.

Wayne Rash Jr. is a contributing editor for BYTE and a principal and technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He consults with federal and private sector clients on microcomputers and communications, and he is co-author of two books for business network users: The Executive Guide to Local Area Networks and The Novell Connection. You can contact him on BIX as "waynerash," or in the to:wayne conference.
ZEOS. Simply the best notebook you can buy.

Take it from the experts:
A few expert opinions:

"There's a new king of the hill—the ZEOS Notebook..." — PC Magazine

"This notebook is a steal." — InfoWorld

"In this category I'm most impressed with the ZEOS Notebook...it has to be the number one contender." — John C. Dvorak

"The best price performer in its category." — Mobile Office

"An outstanding value." — PC Week

"Impressive" — PC Sources

Impressive Indeed!
And The Price?
The ZEOS Guide to the Perfect Notebook:

**PROCESSOR:** PC Magazine recommends a '286 or '386SX processor pointing out that "8086- and 8088-based portables have only half to a third of the computing power of a 286." That’s why ZEOS offers you your choice, '286 or '386SX! More power for you. After all it’s just like a 6.5 pound desktop!

**SYSTEMS STATUS AT A GLANCE:** Yes, monitor eight key system components at a glance! We’ve equipped your new notebook with eight LED indicators which monitor disk access, keyboard functions and power status. There is even an audible alarm which may be programmed to inform you of a low battery condition and to let you know if the cover is closed with the power on. Now that’s one smart notebook!

**CHECK IT OUT!**

Now, you can take desktop computing power anywhere! Your ZEOS notebook has many features of obvious importance. Also, there are a number of features that are subtle yet critical to your ultimate satisfaction. We’ll go over them here one by one. We think you’ll agree your new ZEOS Notebook is the one for you!

**CONNECTIVITY AND I/O:** Keeping in touch is easy when you order our internal 2400 baud MNP Class 5 modem. Simply plug in the phone line and dial away. How about I/O ports? Many notebooks don’t have them and if they do they’re often non-standard. But your ZEOS notebook has industry standard I/O—serial, parallel and VGA. Just like your desktop!

**VIDEO:** ZEOS raises the ante to VGA! We’re talking about bright and crisp VGA displayed on one of the largest notebook screens in the industry. The display also features advanced fluorescent backlighting, 32 grey scales and 640 x 480 resolution. Plus, it can be adjusted to any position over a 135° angle and features easily adjustable brightness and contrast controls. Easy viewing under virtually any lighting conditions. You can connect to an external VGA color monitor too!

**GREAT BATTERY FEATURES:** Every battery feature you want. You can plug your notebook in and “quick charge” the battery in less than one hour or you can “trickle charge” while in use. Plus, your battery easily snaps out allowing the quick installation of an optional replacement battery. It’s great to be able to carry a light weight spare for those especially long trips. An optional battery charger stand is available as well.

**INTELLIGENT POWER MANAGEMENT:** Your new ZEOS notebook features an intelligent programmable power management system if you wish to use it. Based on the length of time since your last keystroke, you may reduce CPU speed, display screen backlighting etc. Full power is immediately restored at the stroke of any key. The system even knows not to use the power management system when you are operating on AC power!

**DESKTOP KEYBOARD FEATURES:** We’re talking 82 full size keys with full 101-key emulation. And the keyboard isn’t squeezed either. The distance between the “Q” key and the “[” (left bracket) key measures 7.5 inches, just as PC Magazine suggests. The keys are of standard size, plus touch typists will love our full 3.5mm keystroke. Type for hours and love it!

**FCC & UL APPROVALS:** Your new ZEOS notebook features both FCC Class B and UL approvals. We’ve also met CSA and VDE requirements too, just for good measure. Quality and reliability.

**WATCH THE DETAILS TOO:** Like memory expandability. One Meg comes standard, you can also order a total of 3 or 5MB as a factory option. And lots of other details. Like a recessed power-on reset button, a soft carrying handle, built in speaker and more. You’re going to love it! And there’s no reason to wait.

**CALL NOW TOLL-FREE:**

800-423-5891
Your New ZEOS Notebook.
Take your pick!

As a ’286
Only $1995!

As a ’386SX
Only $2295!

’286 or ’386SX, Hard Drive, Floppy Drive, VGA, Under 7 lbs., Beautiful!

Unbelieveable.
Believe It!

Call Now:
800.423.5891
"THERE'S A NEW KING OF THE HILL"
—PC MAGAZINE

"King of the Hill . . . Impressive . . . The best price-performer . . . An outstanding value . . . A steal . . . The number one contender . . . " We couldn't have said it better ourselves. The experts love the new ZEOS Notebook. And you will too. At only $1995 for our '286 version and $2295 for our new 386SX, you simply can't find a better notebook anywhere!

As PC Magazine said, the ZEOS Notebook “offers a top notch combination of power, weight, features and price . . . " And you can pick your power! Choose our '286 version or go for the incredible new ZEOS '386SX. Combine either with our high speed hard disk, built in 1.44MB floppy drive, VGA and more—you've got the greatest notebook going at any price!

INCREDIBLE DESKTOP FEATURES IN A NOTEBOOK.

In fact, it's really like owning a 6.5 pound desktop that you can take with you anywhere! Look closely at the details. Like our crisp 10'' VGA display. The ultimate in sparkling clarity, it features advanced fluorescent backlighting for vivid VGA graphics. Then, the drives.

Two drives are better than one! First, your notebook will include our whisper quiet high speed, high capacity hard disk. It will read and write your data so fast chances are you'll hardly know it's there. Then we're building in an industry standard 1.44 Megabyte 3.5 inch floppy as well.

While most notebooks don't include a floppy drive at all, you're really going to appreciate your ZEOS notebook's industry standard 3.5'' floppy. It makes loading software and transferring files a breeze. Simply toss in your 1.44 and it's done. Anyway, can you imagine a desktop system without a floppy? We couldn't either. That's why your ZEOS notebook has one. It's great!

But the features of your incredible new ZEOS Notebook don't just stop there. Detail after detail we're giving you more than anyone else. Much more, for much less. Take a closer look.

DETAILS MAKE THE DIFFERENCE!

For instance, the battery system of your new notebook is the most advanced on the market. You can quick charge, or trickle charge, any time your system is plugged in. You can also take the battery out and use the optional charging stand if you wish.

Either way, you're sure to appreciate
our light weight snap-in, snap-out battery packs. They're so light and easy to use, you can easily take an extra one with you on those really long trips. You can get even more life out of a single charge by using our programmable power management system. Hour upon hour of Notebook computing power!

**CONNECTIVITY TOO!**

Your new ZEOS notebook is a great connectivity tool. Utilizing our optional built-in 2400 baud MNP Class 5 modem, connectivity buffs will find themselves logging on at every turn. And speaking of connectivity, we've kept the I/O easy to use too. Because unlike many of the others, your new ZEOS notebook has the same industry standard port connectors you'll find on your larger desktop system. Completely compatible! Serial and Parallel ports; even an external VGA connector. All industry standard and ready to go the minute you receive your system.

It's attention to detail that makes the difference. Tens of thousands of hours of development time have been invested. We've been thinking and re-thinking exactly what you want in a notebook, and now we're building it for you. We think you'll agree, it's an incredible product. Plus, your new notebook is backed by the best support in the industry, 24 Hours a Day.

**ZEOS 24 HOUR A DAY SUPPORT.**

After all, it was ZEOS that invented 24 Hour a Day Toll Free Sales and Technical Support. We're always here to help. Any time you need us, your telephone is a Toll Free Hotline—direct to your own personal Technician. 24 Hours a Day, 365 Days a Year. Now that's ZEOS value. But we don't stop there either.

Your new notebook is also backed by our 30 Day Absolute Satisfaction Money Back Guarantee and One Full Year Limited Warranty. You're going to be very satisfied. We don't just say it. We Guarantee It.

**ORDER YOUR OWN ZEOS NOTEBOOK NOW!**

You can order your new ZEOS notebook right now. Simply pick up the phone and give us a call now at 800-423-5891. At last, a full featured notebook that lets you compute anywhere. You're going to love it. That's a guarantee!

**ORDER NOW TOLL FREE:**

800-423-5891
Reason #1
"Overall Excellence"
As PC Magazine said
"Price is always a consideration. So are benchmark test results. But both factors can be deceiving, which is why we consider them in the context of other aspects that will make the difference between a real system and a paper one."
These are the attributes which PC Magazine used in awarding ZEOS the coveted Editor's Choice, not once, but seven times. And "Overall Excellence" are the very words used in describing ZEOS systems comparing them to all others.

Reason #2
Dazzling Performance.
In one recent "386 review, PC Magazine awarded ZEOS Editor's Choice. "The ZEOS '386 blows away every other computer... a smart choice" is what they said. And in another recent review, Government Computer News said the ZEOS 33MHz '386 is "arguably the fastest MS-DOS and OS/2 micro in the world."
Dazzling Performance is built into every ZEOS system. It's a key component of ZEOS Overall Excellence.

Reason #3
Exceptional Quality.
PC Resource Magazine put it this way. "ZEOS... provides the quality comparable with IBM and Compaq and does so for about 70% of the price." ZEOS uses only the very best components. And every system is fully tested and burned-in right in our own labs.

Reason #4
Value.
InfoWorld says, "We find the ZEOS '386 an excellent value. Speed: Excellent. Compatibility: Excellent."

Reason #5
Warranties and Guarantees.
ZEOS believes in its products. That's why we offer each and every customer our 30 Day Absolute Satisfaction Money Back Guarantee. No questions asked. Plus, our One Full Year Limited Warranty and Express Parts Replacement Policy. Optional On Site Service is available too. Call for details.

Reason #6
24 Hour Toll Free Technical and Sales Support.
At ZEOS, the customer is #1. That's why we invented 24 Hour A Day Tech Support. For your convenience, you can now buy a product from us we feel we should be there to help, any time of the day or night. Give us a call Toll Free 800-423-5891. Anytime!

Reason #7
Experience.
Almost unique in the mail order computer industry, ZEOS maintains its own chip level Research and Development staff. In addition to systems Manufacturing, we also operate our own Board Level Manufacturing facility. ZEOS has been involved in Research and Development since our incorporation back in 1981. Our strong and experienced Research, Manufacturing and Technical Staff translates into superior factory direct computer systems for you.

Reason #8
A Sterling Reputation.
In magazine after magazine and review after review ZEOS systems are cited for Overall Excellence, for Excellent Value, as the Right Choice and so on. All of this is flattering but the most important thing is this: What do our customers think? Frankly, they love us. The systems and the support. That means more to us than anything.

Reason #9
Easy to Buy.
ZEOS systems are easy to buy. You can pick up the phone any time of the day or night and order your new ZEOS computer. And we accept MasterCard, Visa, Discover, American Express, and Corporate Purchase Orders from Fortune 1000 Companies, Colleges, Universities and Governments. Complete Leasing Programs are available as well.
And now the Z-CARD! It's your very own ZEOS Credit Card and you can apply today. With the Z-CARD you can charge your ZEOS purchases and pay in easy monthly installments. It's just like a Bank Card. Why not apply for your Z-CARD now?

Reason #10
You're Going to be Very Satisfied.
When it comes right down to it, you're going to be very satisfied with your new ZEOS system. Our goal is your complete satisfaction. And that's our commitment to you. To quality. To performance. To reliability and support. To Value. We don't just say it, we Guarantee it!

Order Now Toll Free
800-423-5891

ZEOS International Ltd.
The Nextstation: A High-Performance Graphical Workstation with a PC Price Tag

STEVE CARPENTER

There's no question that Next makes an avant-garde machine. The original Nextcube had a unique set of features that made it "one of the most eagerly anticipated machines in recent memory." (See "The NeXT Computer," November 1986 BYTE.)

But there were some serious problems with the original Nextcube. First, the $10,000-plus price tag put the first Next system beyond the reach of many budgets. Then, the features that made the original Nextcube so attractive slowed down the 25-MHz 68030 and optical drive combination to the point that some people were disappointed with its performance. Finally, although the Nextcube had some fantastic native applications, there weren't enough third-party applications available to justify many end-user purchases. (See "Sizing Up the Cube," January 1990 BYTE.)

But that was then. Now, the new Nextstation leaves the original Nextcube's problems in the dust. And if Next overcomes its marketing and distribution problems before Apple, PC vendors, or workstation vendors field a competitive model, the competition could be in for a big surprise.

The Reality Zone
The lessons Next learned about the impact of pricing have certainly come home to roost. An entry-level Nextstation with 8 megabytes of memory, a 2.88-MB floppy disk drive, and a 105-MB hard disk drive (the interesting but pricey optical drive is gone) lists for an affordable $4995. This configuration is competitive with other vendors' entry-level diskless machines. But although this configuration is usable, for the kind of work this machine was meant to do, more is better. I reviewed a system with 16 MB of RAM and a 406-MB hard disk drive. The cost of that configuration is still very aggressive at $7275.

The 17-inch, 1120- by 832-pixel MegaPixel display is almost the same as the one shipped with the old Nextcube, but the Nextstation's CPU housing has shrunk from a 1-foot square to a 2½-inch-high pizza-box shape. This has the effect of reducing the awe-inspiring black cube to a (more functional) monitor stand. Despite this diminished profile, Next promises at least three times the performance of the Nextcube, thanks to a powerful combination of 68040 CPU, cache, integrated channel processor, 56001 digital signal processor, and a fast hard disk drive instead of the optical drive. I figured I was in for a treat.

The other issue for Next was stimulating application development. Next has been aggressive here, too. All the workstation vendors advertise thousands of applications, but only a fraction of the applications actually take full advantage of a graphical environment.

Next takes a different approach to applications, one that reflects its avant-garde focus. First, it developed NextStep, its acclaimed visual object-oriented programming environment (see "The Next Step," March 1989 BYTE). Second, all applications in Next's catalog use NextStep. As of March, according to Next, 43 third-party NextStep applications, including Lotus's revolutionary Improv spreadsheet, are shipping (see "What's NeXT After 1-2-3?," October 1990 BYTE, for details on Improv).

Also, Next bundles another eight major integrated applications packages,
The Nextstation

including the multimedia Nextheme, and at least a dozen more useful demonstration (unsupported) packages that you have to see to believe. With all this taken together, the Nextstation is probably a more useful machine out of the box than any other workstation on the market, and quite possibly any system in its price range, including PCs and Macs.

Close Encounters

I dove right in to get some first impressions. My first excursion involved logging on as the supervisory user “root.” This brought up the familiar Next workspace screen: a menu bar to the left, a file browser in the center, and, to the right, a set of applications icons “docked” along the side of the display. But no terminal window was visible; as a longtime Unix user, I felt a little out of place.

A quick tour through the documentation was helpful, but it seemed to consist mostly of guide rather than reference materials. This is documentation that you must read completely to find the information you might need, not something to breeze through. It’s not a chore, though, because the documentation is well organized. For avid bookhaters, Next has an on-line librarian that helps you find what you need, and includes a nice multimedia tour conducted by the pleasant-voiced Ms. Cathy.

I got my terminal window running and started poking around. A quick tour told me that this was indeed a Berkeley Unix system. I became a little distressed when I couldn’t find the vertical bar (pipe symbol) key. I finally found it on top of the right key cluster—not a good place if you want to use the Unix system interface. Surprisingly, Next moved the key from the more reasonable position on the original Nextcube’s keyboard.

I then set up the original Nextcube beside the Nextstation. Whereas the Nextcube takes several seconds to build the workspace, the Nextstation, with 16 MB of RAM and a fast 406-MB hard disk drive, starts up almost immediately.

Opening an application window was a slow process on the Nextcube, but windows pop up quickly on the Nextstation. Running in this environment with several open applications seemed to have no noticeable effect on graphics performance. In contrast, just moving one window on the Nextcube completely stopped a file scrolling in another window. Checking the BYTE benchmark results at right confirms that feeling.

From this user’s perspective, the Nextstation lives up to the workstation performance I’ve come to expect. So it’s safe to say that Next kept its promise of exceptional system throughput and performance and laid to rest the performance problems of the original Nextcube. Expanding on this good news, Next recently announced a family of Next systems, as well as a 68040 upgrade board for the original Nextcube (see “Fast New Systems from NeXT,” November 1990 BYTE).

Stacking It Up

In doing a review, it’s ideal to compare the reviewed system with like systems from other vendors, but it’s hard to come up with competing systems that have much in common with the Nextstation. The Nextstation has the competition beat right now in price and standard features. However, that set of features will become commonplace in the coming years, and you can configure competing systems now with third-party products that offer similar capabilities. So to get a rough idea whether the Nextstation is indeed a price/performance bargain in its class, I compared a Nextstation with systems that
I thought would have most of the performance and a similar configuration and be in the under-$10,000 price class. On that basis, a high-end Macintosh, a high-end 486-based system, and a low-end workstation should all be candidates. I was in for some more surprises.

The Mac IIfx running A/UX version 2.0, although beating the original Nextcube soundly in the BYTE benchmarks, clocked in at 50 percent to 60 percent of the Nextstation's performance. One IIfx configuration with 8 MB of RAM, a keyboard, a 210-MB Quantum drive, and a 19-inch display lists for $12,125. Of course, some dealers have packages of configuration with 8 MB of RAM, a key-
clock in at 50 percent to 60 percent of 2.0, although beating the original Nextstation's performance. One IIfx that basis, a high-end Macintosh, a high-end board, a 210-MB Quantum drive, and a be in the under-$10,000 price class. On

<table>
<thead>
<tr>
<th>UNIX BENCHMARKS</th>
<th>PERFORMANCE SUMMARY</th>
<th>Better</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nextstation</strong></td>
<td>1.0</td>
<td>11.5*</td>
</tr>
<tr>
<td>AST 486/33</td>
<td>2.7</td>
<td>9.8</td>
</tr>
<tr>
<td>Sun IPC</td>
<td>1.3</td>
<td>9.4</td>
</tr>
<tr>
<td>Everex Step 386/33</td>
<td>1.3</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.4</td>
<td></td>
</tr>
</tbody>
</table>

- C Compiler
- DC Arithmetic
- Tower of Hanoi
- System Loading
- Dhryatone 2
- Floating Point

**HIGH-LEVEL PERFORMANCE**

<table>
<thead>
<tr>
<th>Time</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>* C Compiler</td>
<td>2.15 0.97</td>
</tr>
<tr>
<td>* DC Arithmetic</td>
<td>0.23 2.74</td>
</tr>
<tr>
<td>* Tower of Hanoi</td>
<td>0.42 1.33</td>
</tr>
<tr>
<td>System Loading 3</td>
<td>3.53 1.15</td>
</tr>
<tr>
<td>1 background process</td>
<td>4.80 1.21</td>
</tr>
<tr>
<td>2 concurrent background processes</td>
<td>3.57 1.27</td>
</tr>
<tr>
<td>4 concurrent background processes</td>
<td>13.23 1.31</td>
</tr>
</tbody>
</table>

**LOW-LEVEL PERFORMANCE**

<table>
<thead>
<tr>
<th>Time</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Dhryatone 2 (without registers; Dhry./sec.)</td>
<td>23850 1.72</td>
</tr>
<tr>
<td>Arithmetic (10,000 iterations)</td>
<td>0.21 3.43</td>
</tr>
<tr>
<td>Register</td>
<td>3.22 0.91</td>
</tr>
<tr>
<td>Short</td>
<td>2.90 1.21</td>
</tr>
<tr>
<td>Integer</td>
<td>3.20 0.98</td>
</tr>
<tr>
<td>Long</td>
<td>3.20 0.98</td>
</tr>
<tr>
<td>* Floating Point</td>
<td>3.52 3.39</td>
</tr>
<tr>
<td>Double</td>
<td>3.52 3.76</td>
</tr>
</tbody>
</table>

- Cumulative index is formed by summing the indexed performance results for C Compiler, DC Arithmetic, Tower of Hanoi, System Loading (with 8 concurrent processes), Dhryatone 2, and Floating Point tests.

Note: All times are in seconds unless otherwise specified. Figures were generated using the BYTE Unix benchmarks version 2.6. Indexes show relative performance; for all indexes, an E486/33 running Xenix 2.3.1 = 1, N/A = Not applicable. For a description of the benchmarks, see "The BYTE Unix Benchmarks." March 1990 BYTE.

I would rate the Nextstation as its main competitor in the commercial workstation market. In that comparison, Sun's low-end systems (including the $9995 color IPC with a 207-MB hard disk drive) fare relatively well, performing only slightly worse than the Nextsta-
tion. But Sun systems lack the bundled applications and general ease of use of the Nextstation. It will be interesting to see if Next's 68040-based systems can take any steam out of SPARC's commanding lead.

The Next to the Last

Despite my obvious affection for the Nextstation, it isn't perfect. Steve Jobs' vision of the needs of the commercial workstation user didn't have room for either the X Window System or System V Unix, both of which are becoming increasingly important. Users expect to be able to connect their various workstations, and the Nextstation, with its unique Mach/ Berkeley Unix and proprietary windowing system, has a little trouble fitting in with non-Next hardware. Next, along with its third-party software vendors, has plans to address this (including a commercial version of X Win-
dow that runs under NextStep).

Next excels in providing excellent value for the money. A first-time computer buyer would be well advised to consider the Nextstation, because even a fast PC can't equal the Nextstation's bundled applications and point-and-click simplicity. Insignia's SoftPC product adds DOS application compatibility. Mac users will feel very much at home in NextStep, and the crisp gray-scale monitor is perfect for technical publishing. Those who have al-
ready invested in Unix workstations should perhaps tread a little more carefully, but with X Window added, the Nextstation could be a cost-effective and valuable addition to an existing network.

In many ways, Next has redeemed itself by finally releasing a system equal to the task of running its demanding operating-system and graphical-environment software. The Nextstation, along with its array of standard software, is wholly impressive.

Steve Carpenter is an independent consultant specializing in event-driven software and open systems technology. He can be reached on BIX as "scarpentcr."

---

JUNE 1991 • BYTE 299
Objective dBASE programmers try C++

Use CodeBase++ with C++ to build multi-user, dBASE compatible programs. Take advantage of object orientated programming to quickly create maintainable, readable software.

**dBASE Compatible**

Use CodeBase++ classes to access and change the data, index and memo files of dBASE IV and III. Use other classes to manipulate strings, sort at high speed, perform date arithmetic, evaluate dBASE expressions, manipulate linked lists and manage memory.

**Portable**

Port your programs between DOS, Microsoft Windows, and OS/2. Keep all the profits as you distribute your programs royalty free.

**Fast**

Watch as your C++ programs execute much faster than corresponding dBASE, Clipper or FoxPro programs. Be surprised at the small executables and low memory requirements. Examine the C++ source code, which is completely included, to learn good object orientated programming techniques.

**Order Today**

Order today at $295 and discover why Sequiter Software Inc. and most dealers offer a 60-day money back guarantee.

Call (403) 448-0313
Fax (403) 448-0315

SEQUITER SOFTWARE INC.

P.O. Box 5659, Station L, Edmonton, Alberta, Canada T6C 4G1

Circle 280 on Inquiry Card.
Borland C++ 2.0 is a major upgrade of Borland's integrated environment for C++ programming. I found the previous version (called Turbo C++ 1.0) to be disappointing, because it could compile only small, non-Windows applications, and it had some code-generation bugs. The new version solves these problems and introduces important new features.

One major feature of 2.0 is the use of extended memory. There are now versions of each tool (compiler, linker, and so on) that use extended memory. You no longer have to worry about running out of memory during a compile or link.

The other major feature of version 2.0 is support for Windows programming. When you buy other C++ development systems, you also have to purchase the Microsoft Windows Software Development Kit (SDK). Borland C++ eliminates this hassle and expense, providing everything you need to create a Windows application in one package. And a large package it is: Borland C++ weighs in at nine manuals and 15 megabytes of program and code.

Getting to the Window
Borland C++ can generate Windows applications and dynamic link libraries (DLLs) in addition to DOS applications. Also, the project manager part of the integrated environment can now handle the.DEF and .RES files that are part of a Windows application.

You can also run Borland C++ from Windows 3.0, but the extended-memory version runs only in standard mode (not in 386 enhanced mode), and it is still a DOS application with a text-mode interface.

The disadvantages of Windows' standard mode include the lack of virtual memory and longer pauses when switching between programs. Also, any extended memory you allocate to Borland C++ reduces the memory available to Windows. My machine has 4 MB of memory, which is barely sufficient for Windows development.

An important element in the creation of a Windows application is creating resources, which describe the appearance and behavior of dialog boxes and other graphical objects. Borland C++ includes a resource compiler, which generates resources from a textual description. However, writing down the coordinates of each object in a dialog box is cumbersome. Fortunately, Borland C++ also includes the WhiteWater Resource Toolkit. This is a Windows program for graphically designing most types of resources, including dialog boxes, controls, menus, icons, and cursors.

Resources can be contained in special files or DLLs, or bound into .EXE files. The Resource Toolkit lets you modify resources wherever they're found, and even copy them from one type of file to another. While the program feels cumbersome, it has some nice features, such as displaying resource IDs using symbolic names taken from a header file. The Resource Toolkit is easier to use than the analogous set of tools in the Microsoft Windows SDK, but the latter includes a font editor that the former does not.

Standard Extras
Most DOS debuggers cannot be used to debug Windows programs, but Borland C++ includes a version of Turbo Debugger especially for this purpose. It runs as a text application while Windows is active, and it automatically switches to the graphical Windows screen when necessary.

Some excellent additions to Turbo Debugger simplify Windows debugging. You can stop execution when your program receives a specific message or class of messages, and you can log the important communications between your program and Windows. These features are welcome, because Windows' event-driven control structure horribly complicates debugging.

An extensive hypertext help facility is part of Borland C++ 2.0. It documents everything from options of the integrated environment to details of the Windows application programming interface. Although not as pretty as the help file that comes with the Microsoft SDK (which uses the Windows 3.0 help system), it is just as functional.

There is one component missing from Borland C++ that would make it much easier to create Windows applications: an object-oriented user-interface toolkit. Without such a library, Windows programming can be tedious, error-prone, and time-consuming. I used C++/Views from CNS in conjunction with Borland C++ to create, in record time, a Windows application complete with menus and dialog boxes. Other third-party Windows-interface toolkits have been announced for Borland C++.

The Proving Ground
In order to test Borland C++, I ran the extended version of the integrated environment from within Windows 3.0 (in standard mode) to compile and link a program; from there, I transferred to Epsilon for major editing, to Turbo
Good news from the BIX community:
You can read and talk with Jerry Poumelle about the unedited text of his *Computing At Chaos Manor* column—weeks before BYTE hits the newstands—on your computer. (Why settle for writing letters to him after the fact, when you have a shot at influencing his thinking—and maybe the content of the column itself?) You can also take part in a variety of other discussions with Jerry—on such subjects as computers, science, space exploration and habitation, cognitive psychology, natural and man-made disasters, education, and mathematics. Any of which discussions could work its way into his next column or book. You can even cast your vote with Jerry for the best and worst products of the year.

And download 147 programs—free. All it takes is a subscription to BIX. Call our special Customer Service number for more information: 1-800-227-2983 (in NH, call 603-924-7681).

---

BORLAND C++

Debugger for debugging, and to Windows to test my application and to use the Resource Toolkit and the C++/Views class browser. The combination was very productive.

An exciting new feature of Borland C++ is “precompiled headers.” It has been observed that C++ compilers spend most of their time processing include files, which rarely change. Borland C++ automatically notices if it is parsing a sequence of headers it has seen before and, if so, loads precompiled versions. This can dramatically boost compilation speed.

Unfortunately, this feature requires some refining. If a header file contains in-line functions that the compiler refuses to generate in-line, or if a header file contains a definition of a variable, Borland C++ refuses to precompile that file and any following. For example, one of the most common header files to include is `iostream.h`, which defines some variables and thus inhibits precompilation. The most common header file in Windows programming is `windows.h`. Fortunately, it can be precompiled.

Other random features include an integrated assembler and faster huge arithmetic. In addition, compilation speed has been boosted back to the responsive level you’ve come to expect from Turbo products. Turbo C++ 1.0 was surprisingly slow. Apparently, the Turbo C++ version will now be aimed at educational markets, while Borland C++ will be for professional programmers. Fortunately, dropping the “Turbo” moniker caused no decrease in program speed!

Borland C++ 2.0 is too finicky about in-line functions. For instance, it refuses to generate in-line functions that call a destructor on a local or temporary variable. This can slow your program down and interacts badly with the precompiled header feature, although in most programs it should have little effect.

I found only four bugs during a week’s worth of extensive testing. When I converted a mass of code to Borland C++, the only major stumbling block involved bit fields: Borland supports a maximum bit-field size of 16, unlike other compilers, which support sizes up to 32.

Overall, I judge the robustness of the compiler and environment to be the best of any C++ programming system I have used. Still, it typically takes a month or two before all the major bugs are evident. Technical support was reasonably knowledgeable and friendly, but I waited on hold for 15 minutes before a representative answered.

Borland C++ provides almost everything you need to create a Windows application in C++. Of course, there are always improvements to look forward to, such as a Windows interface for the integrated environment that can run in 386 enhanced mode, improved generation of in-line functions, smarter header precompilation, and a built-in object-oriented toolkit for Windows applications.

With Borland’s aggressive pricing, commitment to improvement, and outstanding range of features, Borland C++ represents an exceptional value that I can recommend without hesitation.

---

Steven Kearns received a Ph.D. in computer science from Columbia University. He is president of Software Truth, developing the next generation of programming environments. He can be reached on BIX c/o “editors.”

---

BYTE ACTION SUMMARY

- WHAT BORLAND C++ 2.0 IS
  A native-code C++ compiler for producing DOS and Windows programs. Windows applications can be created without the Microsoft Windows SDK.

- LIKES
  The aggressive price, compilation speed, and debugger enhancements for testing Windows applications.

- DISLIKES
  The integrated environment is still a DOS text application; developers must switch between Windows and DOS during development.

- RECOMMENDATIONS
  The Borland C++ compiler is one of the least expensive ways to get started with Windows applications development.

- COST
  $49.95; owners of existing Turbo C and Turbo C++ can upgrade for either $99.95 or $149.95.

- FOR MORE INFORMATION
  Borland International, Inc.
  1800 Green Hills Rd.
  Scotts Valley, CA 95066
  (408) 438-8400
  fax: (408) 438-8696
  Circle 1206 on Inquiry Card.
SmartLink

DOES IT MAKE SENSE TO USE A COMPILER WITHOUT IT?
NOT ANY MORE.

INTRODUCING TOPSPEED C++, C, PASCAL AND MODULA-2

Smartlinking is only one of the many unique and critically-acclaimed features in JPI's line of open-architecture, multilanguage/multiframework compilers.

Whether your working in C, C++, Pascal or Modula-2, TopSpeed compilers will cut development time and give you the excellent code quality other TopSpeed users have come to expect.

"TopSpeed is Tops in Programming"
– Peter Coffee, PC Week, January 1991

TOPSPEED CODE GENERATION TECHNOLOGY All four TopSpeed languages share a common optimizing code generator. As a result, you can produce the same high quality, optimized code with any language you choose. And, unlike any other compiler vendor, JPI offers total compatibility between languages and the ability to reuse existing code.

WRITE DOS PROGRAMS AS LARGE AS 16MB If your program requires more than 640K, TopSpeed's powerful Code and Data Overlay Management System provides code and data overlays automatically to run your large applications.

MULTIPLE MEMORY MODELS All TopSpeed languages support five distinct memory models which allow you to adapt your program to make optimal use of the 80x86 family of processors. Additionally, TopSpeed provides a re-entrant library for multitasking projects (even under DOS).

PICK YOUR PLATFORM All TopSpeed compilers are available for DOS, Windows 3 and OS/2 development.

To order:
In USA: (415) 967-3200
In Europe: +44 (0) 234 267500

© TopSpeed is a registered trademark of Jervis & Partners International Inc
1051 San Antonio Rd, Suite 201 Mountain View, CA 94043
Other brand and product names are trademarks or registered trademarks of their respective holders.
Circle 167 on Inquiry Card.

[smart-link] vt. linking 1 Feature in all TopSpeed compilers which eliminates redundant procedures, methods and data. 2 Technology not available in other vendors' compilers.
In 1972, Summagraphics introduced the first affordable desktop tablet. Eighteen years and more than 40 patents later, our SummaSketch™ II is the industry standard in graphics tablets.

Our unsurpassed technology and proven reliability have made SummaSketch the best selling tablet in the world—with over 500,000 sold to date. More than any other manufacturer.

SummaSketch has also won every major editorial accolade, including PC Magazine Editors' Choice, PC Week Corporate Satisfaction Poll, CADENCE's Blue Ribbon Best of 1989, and CADalyst's Dream Systems and Highly Recommended rating.

SummaSketch II. The people's choice. The critics' choice. And the easiest choice you have to make. For literature and the name of your local dealer call 1-800-888-2028, Ext. 304 or in Canada call 1-800-729-7866. For technical information call 203-881-5400.
What-If CAD: Parametric Math Migrates to Windows

DON BISSELL

At first glance, Computervision's DesignView 2.0 and MCAE Technologies' Cedar 1.07 look like noteworthy additions to the arsenals of PC-based mechanical engineers and CAD designers. The packages are among the first CAD products to support and capitalize on Microsoft Windows 3.0. Also, their dimension-driven drawing approach may well convince designers to abandon the hand-held calculator, thanks to the variational geometry that lets engineers explore and resolve design alternatives while bypassing some customary recalculations.

But don't confuse these packages with production-drafting software like AutoCAD: DesignView and Cedar (for conceptional engineering design and reporting) are primarily design, analysis, and presentation tools. And while the two packages promise similar results, DesignView ranks as the far superior implementation of Windows-based parametric mathematics.

Why Windows?

Thanks to Windows 3.0 to cut and paste text and graphical information effortlessly to various windows operating within the drawing environment. However, the packages can access only textual information from other programs via the Windows Clipboard. Design View makers promise that the next release will ingest a bit map and let you draw on top of it. But for now, if you want to transfer graphics information between applications, you must choose the tedious DXF or Initial Graphics Exchange Specification (IGES) translation route.

The report on translations, however, is mixed. Using DesignView's DXF Translator and Cedar's Smart 2-Way DXF Translator (a $100 option), I decoded moderate-size AutoCAD, DesignView, and Cedar drawings and successfully ported them into and out of all three packages. Since Cedar doesn't support polylines or layering, the program would not convert drawings containing these.
entities. Large 600K-byte to 1-MB AutoCAD drawings did not cross over into Cedar or DesignView despite the amount of hard-disk space I freed up.

Another Windows-related feature, Dynamic Data Exchange links, allows mathematical links to remote Windows applications like Excel; for example, you can start DesignView from within Excel and load values back and forth. (Cedar's current version does not support DDE.)

As a CAD designer and AutoCAD user, I initially questioned the value of Windows-based CAD. Why hand over to Windows computing power that my RAM-hungry application requires? But working engineers who deal with medium-size drawings and who spend more time analyzing than drafting can benefit from the environment. Windows exploits DOS and gives engineers time-saving access to a variety of applications besides CAD drafting. Engineers can always pass their completed designs into production CAD applications by way of a DXF or IGES translation.

I tested DesignView and Cedar under Windows 3.0 on a Compaq Deskpro 386/20e Model 40 with 6 MB of RAM and Intel's 386 cache-memory controller and 80387 coprocessor. Compaq's Advanced Graphics board and 16-inch monitor provided a 1024- by 768-pixel resolution and 16 colors. I freed up 10 MB of hard disk space and operated Windows 3.0 in 386 enhanced mode, which lets those 10 MB act as RAM. This feature, of course, is one of the main reasons to choose Windows. I also tested the two packages on my NEC PowerMate 1 Plus with 2 MB of RAM on an Intel AboveBoard Plus, an Intel 80287 coprocessor, a Paradise 16-bit video card, and an Imtek 800- by 600-pixel color monitor. Perhaps because I only worked with the modest sample drawings on this system, the results compared favorably with those of the 386 machine.

**DesignView Run-Through**

DesignView's setup routine quickly loads about 3 MB of data onto your hard disk drive. The program includes drivers for most monitors, digitizers, printers, and plotters. The software also provides spooler and setup utilities for most popular memory boards.

DesignView is easy to learn, thanks in part to a tutorial that delivers a fine overview of dimension-driven CAD. I passed a pleasant Saturday working the three-tiered tutorial and absorbing the well-written manual. By evening, I felt comfortable merely referring to a quick-start reference card.

DesignView taught me the practicality of dimension-driven CAD, and I was delighted to have discovered a new analysis tool. When I did encounter problems, I found Computervision's technical-support staff to be informed and willing to provide detailed explanations.

I had little difficulty in creating an original drawing with DesignView (see screen 1). The software makes masterful use of construction lines set in the ortho mode. Although orthographic projection is not supported, you can link a side view to the plan view. Polyline creation and editing is quite sophisticated, and there is a noteworthy dynamic control of dimensioning. Via menus and keyboard macros, you can access the usual CAD commands, which both DesignView and Cedar call tools.

But DesignView's limitations are apparent when compared to a feature-laden production CAD package; for example, DesignView's undo facility only allows one step back, and you can't add user-defined macros to the menu. Text will not resize, and it blocks automatically whenever you rescale the drawing to a smaller-than-normal size. Mostly, I missed a built-in text editor, an omission that severely limits any attempt at productive CAD drafting. Working in the reverse of typical CAD packages, DesignView and Cedar require you to select an entity before you can act on it. This, and the requirement to adjust constraints, makes any drafting process laborious.

**Sorting Out Cedar**

Cedar's installation instructions direct you to copy its 600K bytes' worth of data into the Windows directory. Cedar uses the drivers supplied with Windows 3.0. But because I prefer to keep my hard disk organized, I moved the Cedar files into Cedar's own subdirectory, where the program behaved without problems.

Some of Cedar's drawing commands, such as Pan, Zoom Window, and Delete, surpass DesignView's. Undo will retreat 25 steps, and there's a Redo facility. However, Cedar's spline or polyline requires concatenation of miscellaneous arc and line segments, which cannot be constrained and will not respond as variational geometry. As with DesignView, you must select each entity before acting on it. Although the reference manual provides 11 pages of instruction, the arc command remains confusing.

---

**BYTE ACTION SUMMARY**

**WHAT DESIGNVIEW AND CEDAR DO**

They operate under Windows 3.0 and let mechanical engineers explore designs through what-if scenarios that bypass many engineering recalculation.

**LIKES**

Equations and formulas control key elements within a drawing. In DesignView, Dynamic Data Exchange allows mathematical links to remote Windows applications like Excel.

**DISLIKES**

Although the packages provide basic CAD functionality, they lack the sophistication of CAD packages. Also, the respective DXF translators work successfully only with moderate-size drawings.

**RECOMMENDATIONS**

Choose DesignView as an engineering design, analysis, and presentation tool that can augment your production CAD application.

**PRICE**

DesignView 2.0: $895, as tested; Cedar 1.07: $995 (as tested; includes $100 Smart 2-Way DXF Translator software)

**FOR MORE INFORMATION**

Computervision
55 Wheeler St.
Cambridge, MA 02138
(617) 888-4556
fax: (617) 888-4658
Circle 976 on Inquiry Card.

MCAE Technologies, Inc.
3160 De La Cruz Blvd.,
Suite 201
Santa Clara, CA 95054
(800) 258-6223
(408) 748-0334
fax: (408) 748-1915
Circle 977 on Inquiry Card.
You've just finished The Big Meeting and you head out of the building, a dozen ideas filling your mind. Budgets, forecasts, letters and directives to members of your team all appear on your mental list of things to do. You hop a cab for the airport, wishing you could get your hands on a PC. Unfortunately, yours is holding down a corner of your desk back at the office.

**Wish no more.**

Next trip you can tuck away all the computer power you need in the bottom section of your briefcase. Right now, take a few minutes to imagine how it's going to be when you're out there with that list of tasks, several sheets full of notes and your Texas Instruments TravelMate™ 2000 in hand.

The first thing you like about the TM 2000 is its scant 4.4 lbs. — a six-pack of soft drinks weighs a lot more. With many of the common notebook computers tipping the scales at around 7 lbs., you might think we left something out. Not much. Your bantam-weight includes a bulit-in 20MB hard drive, 286™ processor, 10" diagonal VGA screen, AT*-style keyboard, up to two-hour rechargeable battery and standard 1MB RAM. Yes, all that.

At 8.5" x 11", your TM 2000 could almost be lost under a sheet of letterhead. Most threatening binders are thicker than its 1.4", so you might wonder why it's called a "notebook." You switch on your new TM 2000 to see what you can do with 286 power. You find it already supplied with an array of free extra-value software — standard, not optional: MS-DOS® 4.01, Battery Watch*, LapLink™, Laptop File Manager and a set of special utilities that do things like extend battery charge life and customize the TM 2000 display. What's more, your TM 2000 swallows up huge chunks of software quicker than you can say "twelve megahertz clock speed."

Once on board, you'll like how fast your programs run. They seem to go quicker than those at your desk. As for take-it-with-you capacity, you have all you need with the 20MB hard disk drive.

**Small outside, enormous inside.**

You can boot up popular software with room to spare on 1MB RAM, or take on the latest colossus with optional expansion up to 3MB RAM.

Small, yes, but this is no scaled-down compact, robbed of the features you're used to in the office. Take the keyboard, for example. You recognize its AT-enhanced configuration with a full 79-key inventory of the alphaneumerics you know and need. What the skeptics don't expect, however, is the full size and solid feel of the keys. They're all arranged in less than 11 inches, side to side. Put a ruler to the AT keyboard in your office and you'll wonder how it's possible!

Well, here's part of the secret. You can get an optional outboard numeric keypad. You plug it in when you do heavy number crunching. The rest of the time you don't need it, so it's not there just taking up space. Makes sense.

**Easy on the eyes.**

As for the display, you're looking at serious high-resolution technology: a 640 x 480 VGA 10" diagonal, sidelite, reversible black-on-white, picture-perfect, triplesupertwist LCD screen that makes complex graphics and windowing applications show up like ink on paper. With 16 gray scales, visibility is magnitudes better than just about any lighting condition. Check it out!

**Major league interface.**

The TM 2000 wasn't built to be a minor player, so it can support all the interface capability you need. Its serial (RS-232-C) nine-pin interface is standard. There's also a parallel (Centronics) port for your printer. You can drive your VGA color monitor with a CRT interface option. Or you can plug in an optional 2400 bps modem with send/receive capability. An optional multitask expansion station for one full-size and one half-size IBM PC/ XT/AT-compatible cards rounds out your flexible interface array.

That's not to say you won't have to sacrifice.

To keep you light on your feet, something had to give. So we took the 3,5" floppy disk drive out and made it optional. Now you only carry it with you when you need it. Besides, you can transfer files between your TM 2000 and a desktop PC fast and easy with LapLink.

**Awards winner.**

When you add it all up, you'll understand why BYTE magazine said, "The TravelMate is as close as you can get to the ultimate portable." In fact, BYTE gave the TM 2000 its 1990 Award of Excellence, acclaiming its exceptional value for the money and smart design. Not only that, PC World named it their 1990 Best

---

Buy for its premium power and portability. And PC Magazine was so impressed that its editors gave the TM 2000 their most prestigious awards: the Editor's Choice Award — for two consecutive years — and the 1990 Award for Technical Excellence.

Yes, awards are great. But what we really aim to win is your vote. So we built this new look of power to be one you can count on. After all, Texas Instruments has more than two decades of experience in portable computing under its belt. That's why we're able to support the TM 2000 with a worldwide network of authorized service representatives.

**Turn your "things-to-do" into "all done."**

Now, about those budgets, forecasts, letters and directives. No problem. You finished them all before your plane touched the ground.

**Seeing is believing!**

Dial our toll-free number. We'll tell you where to see the TravelMate 2000 for yourself.

**A lot more speed and power. Just a little more weight.**

The Texas Instruments TravelMate™ 3000. Only 5.7 lbs. including 20 MHz 386™ SX CPU, 20-3040-60MB hard disk, built-in 3.5" floppy drive and internal rechargeable battery that works up to three hours. It's a mere 1.3 lbs. more than the TM 2000, but magnitudes beyond in capacity. Compare them here or at your

---

**Call now... 1-800-527-3500**

---

Circle 313 on Inquiry Card.
I proceeded to work through Cedar's tutorials, but I discovered that even basic commands, such as Text and Cell, which allow display of dimensional values and calculation results, did not work consistently. I created a rudimentary drawing (see screen 2) and found that although I could constrain horizontal lines, I could specify only one of two contiguous vertical dimensions. My attempts at an area computation were unsuccessful.

When I called MCAE Technologies' technical-support staff, they identified my problem immediately: an Epson 24-pin dot-matrix printer configured in Windows 3.0. They suggested that I reconfigure Windows for a Hewlett-Packard LaserJet Series II printer, even though I didn't have one. This would possibly solve my text, cell, and dimension-display problems, but it would also leave me without a printer or plotter.

I also learned that unlike horizontal lines, vertical lines needed their lengths specified by the program before I could constrain them. And an area calculation, like all equations in Cedar, requires careful preparation, especially if you prefer inches and feet to metric units, the default. Although you can select feet from the units file, you have to define square feet ($\text{ft}^2:=\text{ft}^2$) as a new unit. My test volume calculation also required a new $\text{ft}^3:=\text{ft}^3$ unit.

MCAE recommended that I use the software primarily for analysis and that I turn to my regular high-end drafting program for general drawing. But the software's problems, coupled with documentation that lacks information and a lengthy learning curve, make me question the product's usefulness as an analysis or even as a basic drafting tool.

The company promises that Cedar's next version, which was slated for release after press time, will offer an enhanced user interface, better documentation, and expanded graphics, equation, and spreadsheet functions.

CAD Pick

By contrast, DesignView 2.0 performed as advertised as a dynamic analysis tool for moderate-size databases. If you attempt to constrain a large database containing thousands of construction elements, be prepared to summon Herculean computing power. DesignView also delivers the look and feel I've come to expect from quality CAD software. But at $895, it's priced substantially below high-end production CAD software.

Because of its ease of use, short learning curve, well-written documentation, enthusiastic technical support, and relative sophistication, I can recommend DesignView as an engineering design, analysis, and presentation tool.

Don Bissell is a CAD designer and technical writer based in Wells, Maine. You can contact him on BIX c/o "editors."
WHAT MAKES A BEST SELLER
A BEST SELLER?

A great plot begins with a great idea, easily translated through every phase of design with Generic CADD 5.0.

Deadline pressure is a thing of the past. Designs can be quickly edited and annotated to produce final working drawings.

No matter the complexity, symbols keep your work flowing uninterrupted. Tap our professional libraries or create your own symbols.

Need to fit a conventional design in a nonconventional space? Revise and improve in less time with Generic CADD's one-stop convenience.

A GREAT PLOT.

Ask any of over 250,000 users of Generic CADD. They've discovered CADD that's powerful without being complicated. And professional without being pricey.

Our latest version, Generic CADD 5.0, is just $495. It's a complete design and drafting program backed by a support team that's drawing rave reviews.

Call us at 1-800-228-3601 for our free full-color CADDalog and portfolio of CADD drawings.

You'll see every plot has a great ending.

©1990 Generic Software, Inc., 11911 North Creek Parkway South, Bothell, WA 98011, FAX 206-483-6969. Generic CADD is a trademark and CADDalog a registered trademark of Generic Software, Inc.

Circle 123 on Inquiry Card.
"Wacom tablets are the top choice for artists."*

Wacom's acclaimed SD-Series graphic tablets and pens bring the new dimension of pressure input to creative computer graphics.

With Wacom's state-of-the-art systems, you can see and feel the difference. First, there's no cord so there's never the frustration of untangling wires. Second, the stylus is ultralight (just 1/3 ounce) and extremely natural and responsive to use since it has no batteries or magnets. Best of all is its widely praised pressure-sensitive input. Now the harder you press, the thicker a line becomes. Or you can control the color, density, or whatever else the software can be set to do.

Moreover, you don't need to have pressure to benefit from using the Wacom Tablet. Numerous artists are discovering they can draw faster and more naturally with vector programs such as CorelDRAW! and Arts & Letters as well as FreeHand and Illustrator. Case in point: the Monarch butterfly above, by Dan Gray, author of Inside CorelDRAW!.

See for yourself how well the Wacom Tablet works with your Mac or IBM (DOS/Windows 3.0) system. Specifications? Also superb, as you would expect from the company that invented the world's first cordless, high resolution digitizer.

Specializing since 1983 in the world's finest cordless digitizers.

Wacom Inc.
West 115 Century Road, Paramus, NJ 07652
Tel: (1) 201-265-4226, (1) 800-922-6613

All rights reserved. CorelDRAW is a registered trademark of Corel Systems Corporation. Arts & Letters is a registered trademark of Computer Support Corporation. FreeHand is a trademark of Adobe Corporation. Adobe Illustrator 3.0 is a trademark of Adobe Systems, Inc. Mac is a trademark of Apple Computer, Inc. IBM is a registered trademark of International Business Machines Corporation.

Circle 358 on Inquiry Card.
When you switch to a Microsoft Windows environment, you gain both multitasking ability and the promise of true WYSIWYG on-screen. Unfortunately, the standard Windows font management fails to deliver on that promise.

Adobe Type Manager (ATM), Bitstream’s FaceLift, and Hewlett-Packard’s Intellifont-for-Windows font managers bypass the standard Windows font display and replace it with true WYSIWYG. In a stock Windows installation, you decide which fonts you’ll need on-screen and pregenerate bit maps for all the sizes you expect to use. When your application calls for a screen font, Windows first looks for an exact match for size and typeface. If it finds one, great. If not, Windows tries to scale one of the existing sizes to fill your request. Windows font managers don’t pre-generate any fonts. Rather, they place a mathematical representation of the typeface on your hard disk drive. The font management software patches itself directly into Windows and begins to perpe-trate a lie—it agrees to any font request your application makes. When it comes time to display the font on-screen, the font manager takes control, calculates the correct bit map from the description, and renders it at your display’s best resolution. The same principle applies to your printer. Even though you may not have a printer with a page-description language, a font manager can use your printer’s graphics printing capability to print any installed font in any size at full printer resolution.

These three font managers have much in common. The Windows SYSTEM.INI file determines which device drivers control the environment. ATM replaces the standard SYSTEM.DRV file with its own, and then it points back to SYSTEM.DRV with an extra entry in the file. By making this one patch, ATM takes control of all display and printing functions. FaceLift and Intellifont both patch out the DISPLAY.DRV entry to gain control over the screen. To get control of the printer, FaceLift provides its own generic print driver, SHELLPRT.DRV, which then chains to the original printer-specific driver. It’s all rather confusing, but take heart: The installation routines handle everything for you.

These products make a standard Windows installation look positively lame. I tested all three with a variety of software, including PageMaker 4.0, Ami Pro, and WingZ. Any installed font, at any size, looks clear and sharp. Without a font manager, large characters display with distinct jaggies or get converted to
an anemic vector representation. Font managers also give you a performance improvement. After a short delay to build the font in memory, they update the screen faster than Windows can normally display its scruffy fonts.

### Adobe Type Manager

ATM uses Adobe's Type 1 PostScript fonts as its font representation. While it supports any standard Windows printer, the PostScript base makes ATM ideally suited to installations that have a PostScript printer and a selection of PostScript fonts.

In addition, folks who prepare documents for final printing on PostScript typesetting equipment should consider that ATM will assure compatibility between the screen and their final output.

### FaceLift

Bitstream's FaceLift is a serious competitor to ATM and offers you more control over nonlaser printing devices. Selectable print resolution and density control let you adjust its output for the best appearance. FaceLift's font source is the Bitstream Speedo format, a proprietary format that is sadly incompatible with the existing Fontware format. Folks with a collection of Fontware can upgrade their fonts to Speedo format.

My only problem with FaceLift during testing was a driver incompatibility with the Radius TPD/PC dual-page monitor. Using FaceLift 1.2, I connected an HP LaserJet Plus to a 386 machine running Windows on the Radius in 1280- by 960-pixel mode. While the display looked perfect, the printed page came out scrambled. Switching the display to standard VGA mode corrected the printout. Bitstream was still looking into the problem as we went to press.

### HP Intellifont-for-Windows

HP's Intellifont is more of a special-purpose font manager than ATM or FaceLift. It uses HP's scalable-font format for the Series III printers as its base and renders only to the screen. Printing from an Intellifont installation requires an HP Series III printer into which to download the font outline.

The big advantage for Series III owners is that Intellifont is free. To get screen fonts, you simply buy an HP font cartridge or disk for your Series III printer. If you're looking at third-party fonts, be sure to ask if the package includes the Intellifont font outlines.

### Putting Your Best Face Forward

If you have a Series III printer and work with the HP scalable fonts, Intellifont is your obvious choice. It's free, and it supports all of HP's scalable fonts.

Some people accumulate PostScript fonts like dust bunnies under a sofa. For them, ATM seems the natural choice. It handles the Type 1 format directly and guarantees that your screen will look exactly like PostScript output. On non-PostScript devices, it does a superb job as well, although it provides just the fonts and not the PostScript emulation.

Many people don't have PostScript printers and don't prepare work for typesetters. For them, FaceLift is ATM's equal. Its adjustable density control is particularly handy for printing on dot-matrix printers.

Your final call should be based on the font technology you already own. Fonts are expensive, and switching formats can be costly. If you've already invested in fonts, stick with the offerings from that vendor. If not, and you don't have a Series III printer, it's almost a coin flip. I prefer ATM because of its clean installation and the better guarantee of WYSIWYG when working on PostScript devices. Either way, a font manager is a must-have item when you're buying or upgrading a Windows machine.

Howard Eglowstein is a testing editor in the BYTE Lab. He has a B.S. in architecture and design from MIT and is a desktop publishing systems consultant. You can reach him on BIX as "heglowstein."

---

### FONT MANAGER FEATURES

All three type managers share the same system requirements but support different font formats. If you've already invested in a font library, stick with a package that supports it. Likewise, Intellifont should satisfy LaserJet Series III owners. It's bundled with the LaserJet III.

<table>
<thead>
<tr>
<th>Font Manager Features</th>
<th>Adobe Type Manager</th>
<th>Bitstream FaceLift 1.2</th>
<th>HP Intellifont-for-Windows</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System requirements</strong></td>
<td>Windows 3.0 or higher, MS-DOS 3.1 or higher, 286 or 386 PC with 1 MB of RAM, Windows-compatible display</td>
<td>Windows 2.03 or higher, MS-DOS 3.1 or higher, 286 or 386 PC with 640K bytes of RAM and EMS or extended memory, Windows-compatible display</td>
<td>Windows 3.0 or higher, MS-DOS 3.1 or higher, 286 or 386 PC with 1 MB of RAM, Windows-compatible display</td>
</tr>
<tr>
<td><strong>Printers supported</strong></td>
<td>Most laser and impact graphics printers with Windows drivers</td>
<td>Most laser and impact graphics printers with Windows drivers</td>
<td>HP LaserJet III</td>
</tr>
<tr>
<td><strong>Font format</strong></td>
<td>Adobe Type 1</td>
<td>Dutch (like Times Roman), Swiss (like Helvetica), Park Avenue, Cooper Black, Brush Script, Formal Script, Monospace</td>
<td>Agfa Compugraphic FAIS Scalable format</td>
</tr>
<tr>
<td><strong>Included fonts</strong></td>
<td>Times Roman, Helvetica, Courier</td>
<td>FaceLift Companion Pack for PostScript (adds remaining 35 typefaces): $179</td>
<td>CG Times and Univers</td>
</tr>
<tr>
<td><strong>Optional fonts</strong></td>
<td>Adobe Plus Pack (adds remaining 35 PostScript fonts): $198</td>
<td>FaceLift Companion Pack for the HP LaserJet III (12 resident typefaces): $99</td>
<td>Included with font cartridges</td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td>$99</td>
<td>Other fonts available $99</td>
<td>Bundled with printer</td>
</tr>
</tbody>
</table>

---

1 Product did not work with Radius TPD/PC display in high-resolution mode.
2 Upgrade available for existing Fontware fonts.
I thought this was quality software—now my system's just hanging!

Don't leave your customers hanging...

Before you ship any program, check it with

BOUNDS-CHECKER™

FINDS OUT-OF-BOUNDS MEMORY ACCESSES AUTOMATICALLY

Your program may have 10,000 to a million lines of code. It may occasionally hang mysteriously or it may appear to run flawlessly every time. But under DOS, how can you ever be sure that your program is not corrupting memory it does not own? The only way to be 100% sure is to BOUNDS-CHECK before you ship.

To use BOUNDS-CHECKER you build your program with debugging information (we support most compilers including Microsoft, Borland & JPI). Then you just type <BC file-name>. BOUNDS-CHECKER sets up the 386™/486 for protection and lets your program fly. If your program accesses memory it does not own or overwrites its own code, BOUNDS-CHECKER pops up displaying the offending SOURCE-LINE or instruction.

Programming under DOS is a gamble, so why not stack the odds in your favor—CALL TODAY.

(603) 888-2386

Dual-ICE Features:
• Break out of a hung program
• Real time Break-Points
• Back-Trace history
• Works with other debuggers

If you are debugging an application, Soft-ICE is seamlessly integrated with BOUNDS-CHECKER so you can easily go back and forth between BOUNDS-CHECKing and debugging:

The ultimate systems debugger.

Soft-ICE

Run CODEVIEW for Windows on a single monitor
CV/1 $129

• Runs in a window • No annoying flash •
• Runs on any display that supports windows •

Other fine Nu-Mega products.

Call by 4:00 PM EST TODAY and ask us to EXPRESS you an Info packet. In most cases you will receive it by 10:30 AM tomorrow. (USA only)

All Nu-Mega products require a 386, 386SX or 486. MS-DOS and Codeview are trademarks of Microsoft Corp. 386 is a registered trademark of Intel Corp. Nu-Mega, BOUNDS-CHECKER, Soft-ICE and CV/1 are trademarks of Nu-Mega Technologies, Inc.

Nu-Mega TECHNOLOGIES INC
P.O. Box 7780 • Nashua, NH • 03060-7780 U.S.A.
(603) 888-2386 • Fax (603) 888-2465

Money Back Guarantee

Buy BC & S-ICE $386

Special Offer

Save $100

30 Day

BOUND-CHECKER $249

Soft-ICE $386

Circle 223 on Inquiry Card.
An Out-of-Towner's Introduction
to the BIX Community

BIX is for people who use microcomputers for business, finance, research, and career and personal development. There's always something interesting happening here. No matter what you're into. The latest industry news. Top-notch software libraries. Private electronic mail. Real-time chatting. And every month, the complete text of *BYTE* magazine. (Read more about BIX, and how to join, on adjacent page.)

From Artificial Intelligence to Zenith Laptops...

Whatever your interest, BIX has a conference for you. Here's our latest list.

(In each Exchange, Conference name appears on left, description on right.)

### Amiga Exchange

**Joanne Dow, Exchange Editor**

*amiga.user* Exchange ideas, solve problems, compare notes

*amiga.sw* Amiga programming and developer issues

*amiga.hw* Amiga hardware design, use, and hookup

*amiga.arts* Artistry using the Amiga

*amiga.int* Developing for the International Amiga

*amiga.special* Special guests and events

*amiga.dev* Commodore's conference for developers

### IBM Exchange

**Barry Nance, Exchange Editor**

*ibm.pc* The venerable PC

*ibm.at* The AT series and workalikes

*ibm.ps* The PS/2 series

*ibm.os2* OS/2 operating system

*ibm.dos* PC/DOS & MS/DOS operating systems

*ibm.os.386* Alternative 386 operating systems

*ibm.utils* Utility software for IBM computers

### Writers' Exchange

**Wayne Rash, Jr., Exchange Editor**

*desktop.pub* Using microcomputers for publishing

*elfquest* Find out about things elven with Richard Pini

*journalism* Reporting and writing news

*journalism.pro* Interaction for working press only

*lexicon* About words

*marketing* Promos, sales, public relations and high tech

*newwriters* Getting started in the writing business

*poetry.prose* Writing both types of English

*sf* Science Fiction, Star Trek, and fantasy fans

*sfwa* Science Fiction Writers of America

*tech.news* Discuss Microbytes, product reports, items

*word.processor* Word-processing programs

### Macintosh Exchange

**Dr. Larry Loeb, Exchange Editor**

*mac.apple* The word from Cupertino

*mac.business* Macs in the office

*mac.desktop* Publishing with a Mac

*mac.external* Information from all over

*mac.hack* Technical information about the Mac

*mac.hypercard* Using the HyperCard programming environment

*mac.news* Up-to-the-minute information

*mac.novice* For beginners

*mac.products* Listings of new hardware and software

*mac.sandbox* For off-hours fun

### Tojerry Exchange

**Jerry Pournelle, Exchange Editor**

*tojerry* Messages for and from Jerry Pournelle

*chaos.manor* Computing at Chaos Manor

*astronomy* A star party for amateur astronomers

*contact* Science fiction meets science

*disasters* Natural and man-made disasters

*education* Computers in American classrooms

*mathematics* Talk about high-level mathematics

*sciences* Scientific programs

*space* Space exploration and development

*technology* New technologies and their impact

*Please Note: Membership in this conference is limited to pre-screened specialists only.*

---

Circle 450 on Inquiry Card.
Imagine a setting in which communal wisdom is on tap. A place that has the fit and feel of a small, friendly town, yet the sophistication and resources of a global community. One which you can visit electronically—to increase your knowledge of computers and their applications, hone your skills, share insights with thousands of other computer pros, and have fun. Such a community would be called BIX.

Subscribe to BIX, the flat-fee, on-line information service.
BIX is your access to industry news. And to many special interest Exchanges—such as our Amiga, IBM, Mac, Writers’, and Interactive Games Exchanges—which include thousands of free, downloadable programs. All for just $39 per quarter.*

Subscribe via your computer...
Set your program for full duplex, 7 bits, even parity, 1 stop bit. Call BIX on our registration-only number: 800-225-4129. In MA: call 617-861-9767. International: call NU1310690157800. Then hit the return key, and respond:

Prompt: You Enter:
login bix
Name? bix.ville
You may buy off-peak access via Tymnet at $20 per month or $3 per hour, or you may buy peak access at $6 per hour.**

*Based on a $156 annual fee, billed quarterly. Telecommunications charges are extra. You may cancel at any time without future charges.

**Available only in contiguous 48 states. Tymnet rates subject to change.

800-227-2983 • In NH 603-924-7681
Solved.

End of Problem.

New Mathcad 3.0.

When number-crunching time comes, does work grind to a screeching halt? Want a better way to do technical calculations than a spreadsheet or calculator—an obstacle clear instead of an obstacle creator? You need new Mathcad 3.0, the crunch-those-numbers, and deliver-results-in-a-second calculation software. As in-depth as you want, as routine as you need. Mathcad 3.0 does everything from averages to FFTs, from percentages to matrices. Almost every function you’ll ever need is built in for rapid, effortless calculations.

New Electronic Handbooks make it easy to click-n-paste hundreds of standard formulas, useful data, even entire calculations into your documents. And a full range of add-on Applications Packs help you solve problems specific to your profession.

Mathcad’s new easy to learn and use Windows 3.0 interface has you up and running in hours—not days. Best of all, Mathcad is just plain fast. Simply plug in data and you’re done—Mathcad does all the work for you. It does the calculations. Automatically updates results when you change a variable in the live document. It graphs in 2-D or 3-D. And prints results in presentation-quality documents, complete with equations in real math notation. In the blink of an eye—numbers crunched—and you’re back to work.

Meet the Mathcad 3.0 power list:
• New easy to learn and use Microsoft Windows 3.0 interface
• New Electronic Handbooks and Applications Packs provide solutions for Electrical, Mechanical, Civil and Chemical Engineering, Statistics, Advanced Math, and Numerical Methods
• New symbolic calculations performed easier than with any other product
• Does exponentials, integrals, matrices, and more

• 2-D and 3-D graphics
• Prints high-quality documentation
• PC DOS, Macintosh, and Unix versions also available

For a free Mathcad 3.0 demo disk, or upgrade information, call 1-800-MATHCAD (or 617-577-1017, Fax 617-577-8829). Or see your software dealer.

Available for IBM® compatibles, Macintosh computers, and UNIX workstations.

The answer is Mathcad®

MathSoft, Inc.
201 Broadway, Cambridge, MA 02139 USA

1-800-MATHCAD

* Free upgrades available for those who purchase Mathcad 2.5 for DOS from 5/9-6/30/90. Call for details.
Things tend to disappear from my Macintosh hard disk. The disk isn't defective—the files just seem to get lost in the clutter of hundreds of other files in hundreds of subdirectories. When I try to look for the files that I need, the names provide only a clue to their contents; this means that if I'm looking for a particular passage, I must endlessly open and close files until I find the keywords. Some programs automate this search, but they still take too long, because the disk is too big.

The best of all possible disks would have an index that knew where to find every word. In the discussion that follows, I'll consider the details of how to create a program that automatically maintains such an index to all the files on a disk. Once the program has constructed the database, you can find the files you want instantaneously.

Design for Size and Speed

A good index is nothing more than a set of pointers between keywords and the file blocks that contain those words. A set of pointers takes space, though. The trick is to design a network of pointers large enough for quick searches but small enough to avoid overwhelming the disk. An index must also be easy to update when files are added, deleted, or modified.

A null index is one extreme of the trade-off between space and search time. It doesn't take up any space, but searching every file for keywords is slow. Luckily, the other extreme is a complete index of all the data, which usually consumes no more than 5 percent of the entire disk, because an amazing amount of data is redundant. Many keywords occur numerous times in a file, but the index needs only one entry. The worst case would be a disk that was filled with a spelling dictionary of unique words; the index would carry one entry for each of those words and a pointer to that one file. In this case, the index would actually be larger than the data it was mapping. But on the other extreme, if the disk contained text from simple children's books, the index would contain only its limited vocabulary—maybe a hundred items.

My hard disk contains plenty of programming code filled with funny variable names like PQincrement and PMincrement. The index is somewhere between the extremes, but because the words go beyond the English language, it is actually a little larger than simple text.

The system I describe can convert a normal array of data into a decent-size index. My almost-full 40-megabyte hard disk drive generates an index that is about 1800K bytes. This index system includes the ability to make a few simple trade-offs between completeness and index size by providing some indexing options, but

Create an efficient keyword index for all the files on your disk by combining tree, trie, and linked-list data structures.
the default should be efficient enough that you won't need to use these options except in pathological cases of very low disk redundancy. On the other hand, I haven't cut every bit of fat from the system. The structure of the index is rich with pointers that are not explicitly necessary but that make the system run much faster. The index files are not as small as they could be, but they are manageable on a system with a 40-MB hard disk drive. Even though the examples and code have been implemented using Pascal on a Mac, the concepts are easily transportable to other languages and operating systems. The listings are written in pseudocode. Listing 1 is composed of global definitions for the examples.

### The Structural Outline

This indexing scheme uses three main structures: a list of the filenames on the disk, a list of the keywords in the files, and a set of pointers between the keywords and the filenames. The list of filenames has one entry for each filename on the disk. The list of keywords has one entry for each unique word on the disk. The glue between these two lists is the set of pointers between each word and the file (or files) that contains an instance of that word. Each of these structures is stored in memory in a unique format, tuned to balance access speed, modification ease, and small size.

As an example of how this design works, let's say that your disk contains three letters of complaint to Getta Lottagrief, the director of customer service at a company. The names of the three files, MadLet, Really Mad Let, and Extremely Mad Let, are included in the list of filenames. Her last name, the word Lottagrief, would have a list of pointers joining it (as a keyword) to the entries for the three filenames. The keyword upset would have pointers to the latter two letter files as well as other files on the disk that contain that word.

### The Filename Tree

In the filename structure, each file has a unique ID number. The structure that matches the number with the file has two parts, which saves space and allows safe modification. The first part of the structure holds the filenames in a tree-like network that mimics their positions on the disk, and the second part holds a list of file numbers and their position in the tree. By shaping the first structure like a tree, you use far less space than you would if you used the complete path name for each file, because each directory name appears only once in the tree. The second list allows you to manage file numbers.

Each file tree node contains the name of a directory, a file, and three pointers to other nodes (see figure 1). The first pointer points up to the parent directory that contains the name of a particular node. For example, if the file Lambada is in the directory Waltzes, the first pointer for the node Lambada will point to the node Waltzes. The second pointer of the Lambada node will point to the next entry in the same directory—say, a file called Bartman. The third pointer does one of two things: If the node represents a directory, the third pointer points down to the list of filenames and subdirectories contained within it (e.g., the third pointer of Waltzes points to Lambada). If the node represents a file, though, the third pointer contains a unique number assigned to that filename.

The complete file path can be constructed by tracing the first pointers of each node from the leaf entry to the root. In connecting a keyword and a file that contains it, the indexing program converts the unique file number into the full path; the first pointers make this easy to do. Adding new nodes in the correct place and moving pointers makes it easy to add and delete filenames. The function AddFileName in the pseudocode of listing 2 describes the basic recursive structure of a function that adds a filename to a tree. The indexing program uses a function similar to AddFileName.

---

**Figure 1:** Each file tree node contains the name of a directory or a file and three pointers to other nodes. The first pointer points up to the parent directory. The second pointer is directed to the next entry in the same directory. If the node is for a directory, the third pointer points down to the list of names of files and subdirectories contained within the directory. If the node represents a file, though, the third pointer contains the unique number assigned to that filename. (A slash means empty.)
Power C combines a high-performance C compiler with superb documentation, at a price that brings chuckles from over 50,000 satisfied customers. That’s because Power C performs favorably against compilers costing 10 times as much. And you can’t buy a compiler that’s more reliable or easier to use - at any price. Perhaps that’s why Power C has won Computer Shopper’s Best Buy award for three years running.

- compatible with ANSI C standard
- integrated Make utility
- library of over 450 functions
- IEEE software floating point
- supports 8088/286/386/486 CPU
- memory resident program support
- supports 8087/287/387 math chips
- small/medium/large memory models
- mixed model with near/far/huge
- allows arrays larger than 64K
- CGA, EGA, VGA & Hercules graphics
- 630 page manual with tutorial

Power C Library Source includes our Power C assembler, plus the C and assembly language source code to over 450 functions in the Power C library. Unlike our competitors, who charge $150.00 or more for library source code, we’ve made ours very affordable.

Power C BCD Business Math includes binary coded decimal floating point routines and financial functions to calculate interest, depreciation, etc. BCD routines are used for dollars and cents calculations to eliminate inaccuracies caused by rounding.

Power Ctrace combines state-of-the-art technology with a friendly interface, making it very easy to find and correct your programming mistakes. No time consuming edit/compile cycles are needed to crack down bugs. Simply compile your program once with the trace option, and Power Ctrace does the rest. Multiple windows display your C source code, the values of all your program variables, program output, watch points, and assembly instructions. Put Power Ctrace to work for you, and we guarantee that you’ll be a more productive C programmer.

Order line:
1-800-333-0330
Technical Support:
1-214-783-6001
Fax: 1-214-783-1404
Mix Software, 1132 Commerce Drive, Richardson, TX 75081

$19.95
60 day money back guarantee

Circle 201 on Inquiry Card.
Listing 2: The basic recursive design for adding a filename to the filename/number tree.

Function AddFileName(p:array[1..n] of file or directory names) :FileNamePointer;
  [This function adds a path of n-1 directory names and one filename to
   the file structure.]
var
  CurrentNode:FileNamePointer;
  CurrentLevel:integer;
begin
  Set CurrentNode to FileStructureRoot. [This assumes one root directory.]
  CurrentLevel:=2;
  StillSearching:=true;
  [We are now at a list of the branches at CurrentLevel.]
  while p[CurrentLevel] is not past the end of the path do begin
    Scan along this list started by CurrentNode until the name
    corresponding to p[CurrentLevel] is found.
    If the file/directory name is found, then set CurrentNode to the
    down pointer here. Increment CurrentLevel.
    Otherwise, add the new name and the rest of the path. Do this by
    creating a node. Set the first pointer to point to previous
    directory. Set the second one to point to the next file/directory
    at this level, and fill the third with the pointer to the next
    level.
  end;
  when the loop exits because it finds (or adds) the node of the last
  filename, return this leaf. Set the number stored at this leaf (in
  the third pointer) to the value of PopUnique#.
end;

to search a directory for new files added since the last time the index was updated.

The filename section must also keep track of the numbers that have been allocated as unique file numbers. It is not enough to simply increment a counter to get a unique number for the next file added to the index because the continual updating of the index will soon exhaust the list. The system recycles file numbers by maintaining a list of unallocated numbers. When a new number is needed, it is taken from the front of this list; when a number is retired, it too is added to the front.

For reasons that will become clear, this index program (in its current form) is limited to 8192 files (i.e., 13 bits of information). The list of unallocated numbers is set up as an array of 8192 pointers, with each array entry pointing to the next. When a file number is needed, the program pops it off the top of the list, and the pointer to the next element is replaced by a pointer to the leaf of the tree in the first part of the structure. This makes it easy to convert a unique file number into a position in the filename tree and, consequently, into a complete file access path.

When a file number, say i, is retired, it is recycled by setting its pointer to the current first value in the list and setting i to be the first value in the list. Before the list has been used, it looks like the following: 1,2,3,4,…,8192. After three files have been indexed and three numbers have been popped off the top of the list, it becomes 4,5,6,7,…,8192. If file number 2 is erased from the disk, its number is recycled by placing it at the front of the list, which would then appear as 2,4,5,6,…,8192. The next new file will have the number 2 assigned to it.

T
he structure is an alphabetically sorted tree, referred to as a trie.

The Alphabet Tree
When I scanned my disk, I found about 35,000 words on it. This is probably a higher number than an average disk would contain because of the non-English variable names in the large amount of program source code and the 25,000-word English spelling dictionary. In all, my index is probably larger than one containing just word processing files. I've tried the program on disks that have up to 50,000 words.

The index needs to link each keyword with a list of the file numbers for every file that contains that word. The list of file numbers is stored in a separate structure (for the purposes of conceptual clarity and space). For now, assume that each keyword comes with a pointer that leads to this list. The problem is finding an easy way to store these keywords and their single pointer. The structure should be as small as possible, easily accessible, and mutable when files are added or deleted from the index. It should also be a structure that makes adding and deleting words fast. There are several possibilities. Some are compact but slow, and others are large but faster. I use the faster, larger version in this index, but I'll look at two other designs first.

The first scheme is a simple list of words. Each word and its pointer would be placed in one long list. Assuming that the average word length is six characters, it follows that at 1 byte per character, 3 bytes per pointer, and one extra stop byte, each word would take 10 bytes to store. That means it would take 350,000 bytes to hold my list of 35,000 words. (Data compression could make it somewhat smaller.)

With this scheme, adding new words to the list looks deceptively simple—they could simply be plunked on the end. The problem is that this method does not check for duplicate entries, an obvious requirement. Checking for words that are already in the list would take a scan of the whole list—a list that would eventually grow to 35,000 words. This just isn't efficient.

The second scheme is to build a hashing table. The big list could be split into a set of n lists using a function that parcels out words evenly to each of the n lists. If the function did a good job distributing the words to the n lists, the average list would be 1/nth the size, and the algorithm would run n times faster. But getting hashing functions that distribute words equally can be difficult.

The structure used in this program is an alphabetically sorted tree, sometimes referred to as a trie. In this structure, there are 26 roots that correspond to the first letters of the words. At each node, there is a letter, and the letters in the nodes along paths from the roots to the leaves are guaranteed to form words. This saves a great deal of space, because
IDEK's MULTIFLAT Series of 17-Inch Color Monitors

IDEK's MULTIFLAT Series of 17-inch Color Monitors take full advantage of the remarkable properties of their Flat Square Tubes (FST) to deliver superior resolution and a sharper image that is easier on your eyes. A glimpse at our 17" Color Monitors reveals their matchless over-scanning capability that delivers a crisp, distortion-free display across the entire screen.

In addition, Automatic Frequency Scanning realizes outstanding performance for business graphics, CAD/CAM applications as well as desktop publishing on your Mac or IBM compatible system.

As you can see below, whether your requirements are simple or complex, IDEK has the Flat Screen Color Monitor that's just right for you. And priced right, too! See for yourself what a difference a Flat Screen Monitor from IDEK can make.

MULTIFLAT Series (17" Flat CRT Monitors)

<table>
<thead>
<tr>
<th>Model</th>
<th>H. Frequency</th>
<th>Dot</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>MF-5117</td>
<td>20 to 50kHz</td>
<td>0.28</td>
<td>1024 × 768</td>
</tr>
<tr>
<td>MF-5217</td>
<td>30 to 57kHz</td>
<td>0.28</td>
<td>1024 × 768</td>
</tr>
<tr>
<td>MF-5317</td>
<td>30 to 80kHz</td>
<td>0.28</td>
<td>1280 × 1280</td>
</tr>
</tbody>
</table>

MULTIFLAT Series (21" Flat CRT Monitors)

<table>
<thead>
<tr>
<th>Model</th>
<th>H. Frequency</th>
<th>Dot</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>MF-5021</td>
<td>15 to 38kHz</td>
<td>0.31</td>
<td>1024 × 768</td>
</tr>
<tr>
<td>MF-5121</td>
<td>21 to 50kHz</td>
<td>0.31</td>
<td>1024 × 768</td>
</tr>
<tr>
<td>MF-5221</td>
<td>30 to 80kHz</td>
<td>0.31</td>
<td>1280 × 1280</td>
</tr>
<tr>
<td>MF-5321 (A.R.Panel)</td>
<td>30 to 80kHz</td>
<td>0.31</td>
<td>1280 × 1280</td>
</tr>
<tr>
<td>MF-5421 (A.R.Panel)</td>
<td>30 to 80kHz</td>
<td>0.26</td>
<td>1600 × 1280</td>
</tr>
</tbody>
</table>

IDEK also offers its MULTIFLAT Series of 21-inch Flat Screen Color Monitors that deliver the same superior resolution and performance as the other members of the IDEK lineup.

IYAMA ELECTRIC CO., LTD.
Overseas Division
7th Fl., US Hanzomon Bldg., 2-13, Hayabusa-cho, Chiyoda-ku
Tokyo 102, Japan
Phone: (81) 3-3265-6081 Fax: (81) 3-3265-6083

IDEK Europe (Germany)
Neumannstrasse 38, 6000 Frankfurt a.M. 50, Germany
Phone: (49) 69-521 922 Fax: (49) 69-521 927

IYAMA North America Inc
650 Louis Drive, Suite 120, Warminster, PA 18974 U.S.A.
Phone: (1) 215-957-6543 Fax: (1) 215-957-6551
Figure 2: (a) A trie—26 trees, one for each letter of the alphabet, and each node containing a single letter. The path from the root defines a word. Each node that represents an indexed word contains a pointer to a list of file numbers. (b) The pointer structure of the trie. (The asterisks stand for pointers to a list of file numbers; the empty boxes could be pointers to other nodes; the dashed lines indicate the omission of a few nodes for clarity.)

many words share the same beginnings. Figure 2 illustrates a simple trie. Words like share and ship have the same first two letters, so there is a fork after sh. One path leads to a, r, e, and the other path leads to i and p. The first two letters are not duplicated, thereby saving space. The function AddWord in listing 3 shows how to do this. Packing the data into 8 bytes makes it the size of two 4-byte integers, a great advantage on some processors. For example, the 68030 fetches 4-byte integers at locations evenly divisible by 4 much faster than it fetches integers at other locations. Some RISC processors don’t allow access at locations that aren’t evenly divisible by 4.

The Web of Connections
The objective of this index system is to connect keywords to the files that contain them. Three parts make up this system. So far, I have discussed only two: the file list and the keyword list. The third part is the connection between these two. The connection begins with the second (down) pointer in the leaf nodes of the word list tree, and for leaf nodes, this points to the beginning of the word list.

There must be a separate list for each unique word—some 25,000 to 100,000 (or more) separate lists. When there are so many lists, a structure needs to be simple to conserve space, so I chose to use a simple linked-list structure and pack each node into 4 bytes of data. In this tree, every node contains a number corresponding to a filename and a pointer to the next node in the list. The lists are kept in sorted order so that finding duplicates will, on the average, take half as much time. (The function AddValue in listing 4 shows how to add a value to a sorted linked list.)

Thirteen bits are allocated to the file number, which means there are $2^{13} = 8192$ file numbers allowed (remember the limitation I stated earlier?). The other 19 bits are allocated to the pointers. This means that a block of lists can contain 512K-byte nodes. The bits can be split differently between the file numbers and pointers, but this division should be adequate for now. In the future, when files contain terabytes of information, these 4 bytes will be inadequate.

It is tempting to pack these lists even tighter. With the pointers taking up 19 bits per node, this takes up plenty of space when the list looks like this example:

value1 pointer value2 pointer
... valueN null-pointer

It is possible to just place the numbers end on end and designate a stop value, similar to a null-terminated character string. In this case, the list becomes like this example:

continued on page 412
Mylex has the best EISA solution. At least that’s what people tell us.

“The Mylex MAE486 with its 32-bit EISA SCSI controller kills the competition for reading large sequential files in the IOBench 2 tests under UNIX.”  Personal Workstation, June 1990

“If I wanted to replace my entire system for optimum all-around performance, I’d build it from Mylex EISA-based boards.”  Personal Workstation, June 1990

“The GXE020A TIGA board ...scored as much as 45 percent higher on our low-level benchmark tests than any other TIGA board evaluated.”  BYTE, April 1990

“Mylex has done a lot of work with EISA, and we plan to use its motherboard and adapters in a LAN Labs ‘super-AT’ server.”  PC Magazine, May 1990

Of course, we’ve tested our EISA peripherals for compatibility with major EISA systems. To see what our high-performance EISA solutions can do for your system, call us at 1-800-446-9539, or fax us at 1-415-683-4662. In California, call 1-415-683-4600.

486 is a registered trademark of Intel Corporation. T134020 is a registered trademark of Texas Instruments. Mylex is a registered trademark of Mylex Corporation. © Mylex Corporation, 1990

Circle 204 on Inquiry Card (RESELLERS: 205).
The joy of C-scape

Elegant graphics and text

The C-scape™ Interface

Management System is a flexible library of C functions for data entry and validation, menus, text editing, context-sensitive help, and windowing. C-scape’s powerful Look & Feel™ Screen Designer lets you create full-featured screens and automatically generates complete C source code.

C-scape includes easily modifiable high-level functions as well as primitives to construct new functions. Its object-oriented design helps you build more functional, more flexible, more portable, and more unique applications—and you’ll have more fun doing it.

The industry standout. Many thousands of software developers worldwide have turned to the pleasure of C-scape. The press agrees: “C-scape is by far the best. . . A joy to use,” wrote IEEE Computer. Major companies have selected C-scape as a standard for software development.

C-scape’s open architecture lets you use it with database, graphics, or other C and C++ libraries. C-scape runs in text or graphics mode, so you can display text and graphics simultaneously. To port from DOS or OS/2 to UNIX, AIX, QNX, or VMS, just recompile. C-scape also supports Phar Lap and Rational DOS extenders.

Trial with a smile. C-scape is powerful, flexible, portable, and easy to try. Test C-scape for 30 days. It offers a thorough manual and function reference, sample programs with source code, and an optional screen designer and source code generator. Oakland provides access to a 24-hour BBS, telephone services, and an international network of companies providing international support. No royalties, runtime licenses, runtime modules. After you register, you get complete library source code at no extra cost.

Call 800-233-3733 (617-491-7311 in Massachusetts, 206-746-8767 in Washington; see below for International). After the joy of C-scape, programming will never be the same.

DOS, OS/2 (Borland and Microsoft support): with Look & Feel, $499; library only, $399; UNIX, etc. start at $999; prices include library source. Training in Cambridge and Seattle each month. Mastercard and Visa accepted.

Oakland Group, Inc. 675 Massachusetts Ave., Cambridge, MA 02139 USA. FAX: 617-586-4440. Oakland Group, GmbH. Alt Moabit 91-B, D-1000 Berlin 21, F.R.G. (030) 381 5045, FAX: (030) 393 4349. Oakland International Technical Network (training, support, consulting): Australia Noble Systems (02) 584-1200; Benelux TM Data (02156) 46814; Denmark Ravenholm (642) 887248; Austria-Germany-Switzerland ESM 07127/5314; Norway Ravenholm (02) 448855; Sweden Linsoft (013) 111588; U.K. Systemstar (0992) 306919. Photo by Jessica A. Boyatt; Kanji by Kaji Aso. Picture shows a C-scape program combining data entry with video images loaded from PCX files. C-scape and Look & Feel are trademarks of Oakland Group, Inc.; other trademarks belong to their respective companies. Copyright © 1990, by Oakland Group, Inc. Features, prices, and terms subject to change.

Circle 224 on Inquiry Card.
Laser printers have become the office workhorse because they can produce fast, high-quality graphics output at a reasonable price. Among their most important features has been support for multiple character-font types and sizes, useful in desktop publishing and other document preparation applications. Printer-resident page-description languages define the command set used to tell the laser printer what to do, in much the same way that a BASIC interpreter or Pascal compiler determines the instructions that can be used to tell a computer what to do. And just as BASIC programs and Pascal programs use different instructions to accomplish the same task (e.g., drawing a line on your video screen), different PDLs require different commands to accomplish the same print function (e.g., printing a line on the paper).

As its name implies, a PDL is page oriented; all the commands that describe the format of the printed page go to the printer before it actually prints the page. This contrasts with conventional dot-matrix “pin-head” printers, which print each text or graphics line as the computer receives it. Two PDLs in particular have become standard in personal computer laser printers: Adobe Systems’ PostScript and Hewlett-Packard’s Printer Command Language. A lot has been written about the powerful PostScript PDL and its many features. Its support for scalable fonts and vector graphics has made it overwhelmingly the PDL of choice in desktop publishing applications. In this article, I’ll take a look at the evolution of HP’s popular PCL, concentrating on the latest version, PCL 5, and how it is encroaching on PostScript’s turf.

A note on terminology: HP makes a point to clarify that a typeface is a set of characters and symbols with a unique look, whereas a font is a typeface of a specific size. Thus, it would be appropriate to refer to scalable typefaces, not scalable fonts. Nevertheless, the term scalable fonts seems to have become the vernacular, and I’ll use it here. Nonscalable fonts are commonly referred to as bit-mapped fonts, since they are simply made up of fixed, prearranged dot (bit) patterns.

The Five Stages of PCL
Because HP is the dominant supplier of laser printers in the personal computer industry, its PCL has become the most commonly used PDL. Most non-HP laser printers, for example, tout “HP LaserJet Series II compatibility,” which they achieve by mimicking HP’s fourth-generation PCL, as implemented in the company’s LaserJet Series II printer. With the introduction of the HP LaserJet III and PCL 5, HP has raised its PDL to new heights.

In the early 1980s, HP was using a loosely defined Version 5 of Hewlett-Packard's page-description language may be the cure for "PostScript envy"
Virtually all applications are disk bound. Today's PCs have over 60 times the power of their ancestors of just ten years ago, while hard disk performance has only just tripled. This makes mass storage the PC's worst bottleneck. PSI has eliminated this bottleneck with the hyperSTORE Caching Disk Controller, a sort of mass storage co-processor. The hyperSTORE does for disk-intensive programs what a math co-processor does for number-crunching software. Databases, file servers, multiuser systems, and other disk-hungry applications start screaming... frustrated users stop screaming! Call (800) 486-FAST now to find out more about PSI's line of intelligent controllers. All you have to gain is time.

hyperSTORE FEATURE HIGHLIGHTS
• Data access in 0.28ms or less, at 3-4MB/sec
• Works in any 286, 386, or i486 system
• Simultaneously control any drive interface: MFM, RLL, ESDI, SCSI, or AT/IDE
• Controls up to 28 physical disk drives
• 0KB to 20MB of SIMM-based cache memory
• Supports all PC-based operating systems: DOS, Windows, UNIX/Xenix, Netware, etc.
• Data mirroring option for fault tolerance
• NO DEVICE DRIVERS REQUIRED

"Normally, it's a bit hard to pick the most impressive item at Comdex [Spring 1990],... This time it was easy,... the hyperSTORE/1600."
-Dr. Jerry Pournelle, Byte Magazine, September 1990

"The real-world result will be blazing record handling from within a data file as well as unstoppable fast program loads."
-Bill O'Brien, PC Magazine, February 13, 1990

"PSI has created the power user's ultimate Lego set for disk controllers: the hyperSTORE/1600" 
-Alfred Poor, PC Magazine, June 12, 1990

"Not only is it the fastest controller available, it's the most flexible, too."
-Byte Awards, Byte Magazine, January 1991
PCL in its line printers. In 1982, realizing the need for improved definition and varying levels of functionality, HP's Vancouver, BC, division formed a PCL committee to develop a PCL for the company's ThinkJet (ink-jet) and LaserJet printers. The ThinkJet, which was introduced in 1984, incorporated the company's basic-level PCL I. This language had only "print and space" functionality for basic printer operation, including basic control codes (e.g., carriage return, linefeed, and page eject), printer reset, character-set selection, and basic raster-graphics support.

Today, HP's PCL committee consists of representatives from many of the company's divisions, to ensure that each progressive enhancement to the language fits within the scope of overall product goals and integrates properly with other company products. HP's stated goal with PCL is to meet the functional requirements of its broad customer base in a way that offers an acceptable trade-off between cost and performance.

Aside from the basic printer control codes, all the PCL commands consist of an escape character (ASCII 27) followed by a sequence of characters that specifies the operation to take place; thus, the commands are often referred to as escape sequences. From the outset, PCL was designed to be expandable, enabling future versions to add additional commands and capabilities; each successive version becomes a functional superset of the previous version. If a PCL printer receives an escape sequence it does not recognize, it simply ignores it, assuming that it is targeted for a higher version of PCL.

Each new version represents a new, substantially enhanced level of functionality. Within a given version, however, there can be variations in the commands that different printer models support. The LaserJet IIP, for example, incorporates PCL 4 like its LaserJet II big brother, but the IIP includes a few enhancements not found in the LaserJet II, such as the ability to rotate fonts 90 degrees.

PCL 2 and PCL 3 were also introduced in 1984. PCL 2 was used on some HP line printers, and it achieved what HP refers to as "electronic data and transaction processing" functionality. Cursor, margin, and line-spacing control functions were added to the PCL command set.

PCL 3 made its debut with the original HP LaserJet—the printer that solidly established laser-printer technology in the personal computer marketplace. PCL 3 attained a level of functionality referred to as "office word processing," which included support for plug-in font cartridges.

The next generation, PCL 4, was introduced with the HP LaserJet Plus in 1986, although it was popularized by the now-ubiquitous LaserJet II, introduced in 1987. PCL 4, with its page-formatting level of functionality, added support for downloadable soft fonts, macros, and improved graphics capabilities. The LaserJet II's implementation of PCL 4—with several enhancements over the LaserJet Plus implementation—has become the de facto industry-standard PDL. A majority of competing laser-printer manufacturers have cloned this version of PCL.

While the LaserJet II was successful, it lacked some of the features that the ever-expanding number of desktop publishing and high-end word processing users increasingly demanded. The limited number of built-in character fonts, combined with the lack of scalable-font
The Debut of PCL 5
Not being a company to rest on its laurels, even in the midst of the LaserJet II’s enviable market success, HP became acutely aware of the LaserJet II’s limitations and worked to alleviate them. The culmination of this effort was last year’s introduction of the greatly enhanced LaserJet III.

The HP LaserJet III’s PCL 5 lives up to the company’s office-publishing functionality designation, offering scalable-font capability, a full-featured vector-graphics command set (HPGL/2), and the ability to change the printing direction (to any angle); it can perform reverse (white on black) printing, and gray-shade and pattern fills. In addition, the LaserJet III includes eight scalable fonts (two sets each of normal, bold, italic, and bold italic) and 11 bit-mapped fonts built in, as well as HP’s proprietary Resolution Enhancement Technology for smoother curves. Note that RET is a feature of the LaserJet III printer, not a PCL 5 feature. In short, PCL 5 offers a quantum leap in capability over the previous generation.

For its scalable-font capability, HP enlisted the help of Agfa Compugraphic. That company’s Intellifont scaling technology lets you scale HP’s typefaces from 0.25 to 999.75 points without distortion; since there are 72 points per inch, that means characters can range from microscopic to nearly 14 inches tall. An algorithm known as hinting is
SELECT 3 BOOKS for only $4.95

The two most comprehensive computer book clubs have joined forces to bring you the largest selection of business and personal computing references available...at savings up to 50% off publishers' prices!

The Computer Book ClubSM with the BYTE Book Club®

Membership Benefits

The Computer Book Club and the BYTE Book Club have joined forces to bring you the largest selection of business and personal computing titles available today.

- **Big Savings** In addition to this introductory offer, you keep saving substantially with members' prices of up to 50% off the publishers' prices.
- **Bonus Books** Starting immediately, you will be eligible for our Bonus Book Plan, with savings of up to 80% off publishers' prices.
- **Club News Bulletins** 15 times per year you will receive the Book Club News, describing all the current selections—main, alternates, extras—plus bonus offers and special sales, with scores of titles to choose from.
- **Automatic Order** If you want the Main Selection, do nothing and it will be sent to you automatically. If you prefer another selection, or no book at all, simply indicate your choice on the reply form provided. You will have at least 10 days to decide. As a member, you agree to purchase at least 3 books within the next 2 years and may resign at any time thereafter.
- **Ironclad No-Risk Guarantee** If not satisfied with your books, return them within 10 days without obligation!
- **Exceptional Quality** All books are quality publishers' editions especially selected by our Editorial Board.

All books are hardcover unless number is followed by a "P" for paperback.

A shipping/handling charge and sales tax will be added to all orders.

If card is missing, use this address to join:

©1991 The Computer Book Club with the BYTE Book Club, Blue Ridge Summit, PA 17294-0820
used to ensure proper character formation regardless of size. Of course, scalable-font cartridges (and downloadable soft fonts) available from HP and other vendors let you add additional scalable fonts to the printer; scalable-font developers can obtain technical details from Agfa Compugraphic on how to engineer the scalable fonts to take advantage of hinting and the Intelligent technology.

Printing Pictures

With the font-scaling problem resolved, HP's next major obstacle was vector-graphics capability. HP has been an industry leader in vector-oriented pen plotters for years, so it was only natural to port the company's industry-standard Hewlett-Packard Graphics Language vector-graphics language used on its plotters to the PCL 5 for use in its laser printers. In addition to providing vector-graphics capability to PCL 5, the powerful, full-featured HPGL also provides compatibility with the myriad software packages that are already capable of generating HPGL output. The HPGL/2 implementation in PCL 5 includes some additional commands that are required for residing happily inside a laser printer (e.g., "Select Primary Font ID" and "Enter PCL Mode").

PCL 5's vector-graphics support has numerous benefits. Most notably, system software can be simplified, and substantially faster print operations can now take place by using vector-graphics commands instead of generating the traditional raster graphics. For example, a single HPGL/2 command consisting of a few characters can tell the laser printer to draw a diagonal line across the paper; it would take many lines of PCL raster-graphics data to accomplish the same task. As you'll see shortly, HPGL/2 is also capable of many more complex operations (e.g., drawing circles, arcs, polygons, wedges, and other complex images), all from a few simple commands.

While PCL 5 has filled the major voids that until now have separated PCL 4 and PostScript so noticeably in desktop publishing applications, HP claims that its goal is not to incorporate all of PostScript's capabilities into PCL. Indeed, HP sells an Adobe PostScript cartridge for its LaserJet III series of printers, and the new IIIi offers an optional integrated PostScript.

HP recognizes that PostScript offers powerful features and functions that are not implemented even in PCL 5, such as support for multiple colors, and drawing support for Béziers and conic lines. Moreover, for professional publishing
We can save you from one of them.

Sorry. Death we can’t do anything about. As for taxes, when you use our product you’ll probably wind up paying more. But software piracy: there we offer some help. Our family of software protection devices (dongles) have improved unit sales for over 2,000 companies around the world. Our products can be used in the MS-DOS, OS/2 and Macintosh environments.

Build Your Own Custom Protection Environment

Use our patented “dual-locking” ASIC chip as the basic building platform. Next, add options like: on-the-fly read/write memory, write-once or multiple-write locking codes, and encryption shells. Then add your own programming creativity to build a protection environment best suited to your product.

Users attach the device to their parallel port, and programs won’t run without it. Back-up copies, hard disk and LAN operation are not interfered with.

Your Intellectual Property Belongs To You

And if you don’t protect it, who will? Our products offer the most equitable way to protect your interests without sacrificing the rights of your customers. Call us today for information and demonstration units.

Software Security

1011 High Ridge Road
Stamford, CT 06905
203-329-8870

Fax 203-329-7428
BBS 203-329-7253
AppleLink™ D2379

1-800-333-0407 ext. 102

Macintosh is a trade mark of Apple Computer Inc.
Activator, Macintosh are trade marks of Software Security, Inc. Illustration: detail from Michelangelo’s Last Judgement.
tasks, with PostScript's hardware-independent design, PostScript-formatted documents are more easily transferred to other, higher-density printing devices, such as Linotronic printers. Nevertheless, PCL 5 has addressed many of the deficiencies that hindered many PCL 4 users, narrowing the gap between PCL and PostScript.

Command-Language Basics

The primary reference for PCL 5 is HP's PCL 5 Printer Language Technical Reference Manual. I'll provide an overview of the language to give you a taste of its features and power. I'll also introduce some of the concepts and terminology associated with PCL 5.

In describing the PCL command escape sequences, I'll use Esc to represent an escape character (ASCII 27); this character could be sent to the printer from, for example, a BASIC program using the statement

```
PRINT CHR$(27) ;
```

Some PCL commands are two-character escape sequences, while most are multiple-character parameterized escape sequences. Two-character commands include Printer Reset (EscE), Clear Horizontal Margins (Esc9), and Half-Line Feed (Esc=). Notice how the character following the escape character is printable. All the PCL escape sequences use printable characters, making it easier to generate and debug PCL commands.

Figure 1 illustrates the general, five-part format for parameterized PCL commands. An escape character is always the first character of the sequence, informing the printer that the characters to follow are part of a PCL command. It's followed first by a parameterized character with a value between 33 and 47 (ASCII ! to /), which tells the printer this is a parameterized command (as opposed to a two-character command).

The next character, the group character, has a value between 96 and 126 (ASCII ` to `). This, in conjunction with the parameterized character, determines the function group or type of function to be performed.

The value field consists of one or more numeric digits, specifying a value required by the command. Depending on the command, the value may be one of a few specific choices available for the command, or it may be a variable. It may even be a signed value—possibly floating-point. If a value is not specified, it is assumed to be zero.

The last character, the termination character, is a value between 64 and 94 or between 97 and 122 (ASCII @ to a). It identifies the command parameter to which the value applies, and it signals the end of the escape sequence. Note that some commands, such as the Transfer Raster Data command (for generating raster graphics), require data after the command escape sequence.

Some of the font-selection commands differ from the general command format outlined above in that they lack a group character. For example, the Symbol Set (primary) command format is

```
Esc(ID)
```

where ID is the symbol set identification number. The command to select the HP Roman-8 symbol set (ID = 8U) would be

```
Esc(8U)
```

In some cases, you can combine PCL commands, eliminating certain character redundancies. Basically, if the parameterized and group characters of multiple commands are identical, the commands can be combined. In that case, only the first command in the sequence requires the escape, parameterized, and group characters. In addition, only the termination character of the last command in the sequence is in lowercase; all other termination characters in the sequence must be in lowercase.

For example, to rotate the printing direction 90 degrees, the escape sequence
Who Works When® is a PC software package that helps you create employee schedules better and faster than you can with pencil and paper. Why not use the power of your PC to make your tedious scheduling chores easier?

**Time-Saving Features:**

- Create 20 departments and 26 shifts to schedule up to 200 employees per file.
- Select from Job Code, Station and Team parameters to define your staffing needs.
- Manually edit the on-screen schedule to "fine tune" your assignments.
- Design Work Patterns up to 16 weeks long to track rotating shift and/or station assignments.
- Produce 1- to 6-week schedules and carry them forward indefinitely.
- Print 11 different schedules, reports and lists to keep you informed and your employees up to date.

Harvey discovered what over a thousand hospitals, universities, businesses, and government agencies already know: Who Works When helps you better manage your most valuable resource - your employees.

Skeptical? Then try before you buy! Order Who Works When on a 30-day trial basis for only $30.00. If you like it, we'll bill you for $895.00 + shipping at the end of the trial period. If you don't, your month trial will cost you just $30.00.

Call, fax, or write today and we'll send you a free demo disk and information packet.

**30 DAYS FOR $30**

Just because it's powerful doesn't mean it's complicated. Move between easy-to-use screens with just one keystroke. On-line help too.

**FREE INFO DISK**

**TO ORDER CALL TOLL FREE**

1-800-782-1233

**GET YOUR BUSINESS IN ORDER...CALL TODAY!**

Circle 215 on Inquiry Card.
is sent to the printer. To set the left margin to the eighth column, you would send the escape sequence

```
Esc&a90P
```

Similarly, to set the right margin to the seventy-second column, you would send the escape sequence

```
Esc&a72M
```

Since the parameterized and group characters (&a) are the same for these three commands, the commands can be combined as

```
Esc&a90P8L72M
```

**PCL Concepts and Terminology**

To use the PCL 5 command set effectively, you need to understand how the printer views the page (see figure 2). The physical page is the actual piece of paper, extending beyond the logical page on the sides, and the logical page extends beyond the printable area at the top and bottom. With the introduction of HPGL/2 vector-graphics support to PCL, the concept of the picture frame is also important. The picture frame is an area within which HPGL/2 vector graphics can be placed. The size and location of the picture frame within the boundaries of the logical page depend on the location of the anchor point of the picture frame. HPGL/2 employs its own coordinate system within the picture frame. The PCL coordinate system is defined using Cartesian coordinates. The (0,0) point is at the intersection of the left logical page boundary and the current top margin. The positive x direction is then to the right, and the positive y direction is down. Depending on what you are doing, units can be rows, columns, dots, or decipoints. Since the printer prints at 300 dots per inch, a dot equals 1/300 inch. Following the standard in the typesetting/printing industry, a PCL point is 1/720 inch; a decipoint, then, is 1/42 point, or 1/720 inch. The column width is determined by the current horizontal motion index. Similarly, the distance between rows is defined by the current vertical motion index or the current lines-per-inch setting. In all cases, the units are internally converted to *internal units; one of these equals 1/7200 inch (which, of course, is divisible by both 1/300 inch and 1/720 inch).*

**A Sampler of PCL 5 Commands**

PCL 5 has a robust command set, accounting for its high level of functionality and versatility. The PCL commands are broken down into several functional categories, shown in table 1. Table 2 lists the many HPGL/2 commands available for vector-graphics operations. I’ll present examples of how some of the commands are used.

The job control commands include Printer Reset and other functions that are used for selecting the number of copies to print, controlling duplex (two-sided)
Hold Everything... on the fastest, most reliable, highest capacity floppy drive available... Brier Technology's 25 Megabyte Flextra™ Drive.

Hold Everything... with an average seek access time of 35 milliseconds. The 25 megabyte Flextra drive is 77% to 100% faster than any other high capacity floppy drive.

Hold Everything... with confidence. Data integrity is insured on each diskette with Flextra's extensive error code detection and correction process. Brier backs its technology with a lifetime warranty on each 25 megabyte diskette it ships with the Flextra drive.

Hold Everything... on the only high capacity floppy with enough formatted storage space—21.4 megabytes—to back up an entire 20 megabyte standard hard drive.

Hold Everything... by your fingertips. Storage capacities of 25 megabytes, 50 megabytes and 100 megabytes on a single, standard, barium ferrite 35° diskette are supported by Brier's Twin Tier Tracking (T²) technology. By submerging the read/write head positioning information on thousands of invisible buried tracks, the entire surface of the diskette is available for data storage.

Hold Everything... Until now, no one has been able to put 25 megabytes in their pocket. With Brier Technology's Flextra 25 drive, over 27,000 business letters, a mailing list with 250,000 names, or twenty years of financial statements will fit on a single diskette... and fit in your pocket!

Can You Find The 25 Megabytes Hidden On This Page?

BRIER TECHNOLOGY
SALES & MARKETING GROUP
25 Meca Drive, Norcross, GA 30093 • 404/564-5550 • 404/381-2808 FAX
Circle 262 on Inquiry Card (RESELLERS: 263).
operation, and performing job separation. Only certain printer models can handle duplex printing (e.g., the LaserJet IIIID) and job separation (e.g., the LaserJet IIIIs). Job separation involves displacing one printed document slightly from the previous one in the output tray to simplify the separation of multiple documents in the tray. HP recommends sending the Printer Reset command (EScE) to the printer at the beginning and end of each print job, to ensure that the printer settings are at a known (default) state at the start of each print job.

The page control commands permit the setting of parameters related to positioning characters and symbols on the page. These commands select the page size, orientation, margins, print direction, text spacing, and paper source (for printers with multiple input trays, such as the LaserJet IIIIs). The Print Direction command is particularly interesting; it allows printing to occur at any 90-degree angle. PCL 5 printers can print text at any angle using HPGL/2 commands.

The cursor can be positioned at any absolute location on the page (with the coordinate units specified in dots, decipoints, or rows/columns), or it can be moved relative to its current position. You accomplish relative moves with the Half-Line Feed command or common printer control codes: carriage return, space, backspace, linefeed, formfeed, and horizontal tab. This command group includes a special command, Push/Pop Cursor Position, which permits some powerful operations. It allows the current cursor position to be saved and then restored later (with up to 20 nested levels). The BASIC program in listing 1 uses this command to anchor angled text.

The font-selection commands permit the selection of the symbol set, typeface, character pitch, height, style, weight, orientation, and other characteristics of the next font the printer is to use. The program in listing 1 uses the Typeface Selection, Spacing, Stroke Weight, and Height commands to specify a bold scalable font with a large (18-point) size. The font management commands are useful for deleting, saving, copying, and assigning font numbers to soft (downloadable) fonts. The font creation commands
There are plenty of places to get information in this industry. Too many. But if you want the best quality information, there's only one that rises to the top: BYTEWEEK.

BYTEWEEK is a weekly newsletter from the same professionals who produce BYTE Magazine. Each week, the most important news and information from the previous week is presented in a readable and concise manner. BYTEWEEK offers you what no other publication can: timely news on the rapidly-evolving computer industry as it happens with the interpretation and evaluation that only BYTE's experienced editorial staff can provide.

Subscribe now and take advantage of a special subscription rate of $395 ($495 outside the U.S. and Canada). Your subscription to BYTEWEEK also includes a free subscription to BIX, BYTE's exclusive on-line conferencing system. Don't miss this opportunity!

For fastest service, call toll-free 1-800-258-5485 (in N.H., call 603-924-9281) and charge to a major credit card or we'll bill you.

BYTESWEEK
One Phoenix Mill Lane, Peterborough, NH 03458.

BYTESWEEK offers a money-back guarantee if you are not completely satisfied.

YES! Sign me up as a subscriber to the Cream of the Crop, BYTEWEEK at the special subscription rate of $395 a year for 50 issues ($495 a year outside the U.S. and Canada).

Name _____________________________________________
Title ______________________________________________
Company __________________________________________
Mail Address ________________________________________
City/State/Zip ______________________________________
Business Phone __________________________

☐ MasterCard ☐ Visa
☐ Check enclosed ☐ Bill me
Card #: ________________________________
Exp. _________________________________
Signature __________________________________

BYTESWEEK
One Phoenix Mill Lane, Peterborough, NH 03458
create soft fonts in the printer. PCL 5 supports user macros; that is, you can assign a series of PCL commands to a single macro ID and store it in the printer. By merely telling the printer to execute the macro, you execute the entire series of commands. Macro definition and execution are handled by the macro commands.

The print model commands provide another method for doing complex image generation on the LaserJet. You can select a shade of gray (including black or white) or one of six patterns for printing subsequent text and raster images. For even greater flexibility, the pattern can be projected onto a destination image after being masked by a source image; special transparency modes provide an even wider variety of printed outputs.

The rectangular-area-fill graphics commands, as you might guess, let you define rectangles and fill them in with a gray shade or a pattern. Similarly, the raster-graphics commands are responsible for the generation of raster graphics on the printer. With these commands, several controlling parameters can be set for the raster-graphics operation, including the raster print area, orientation, resolution, and compression mode. There is also provision for downloading raster-graphics pixel images. The resolution setting determines the size of the raster pixel or "dot," and it can be set to 75, 100, 150, or 300 dpi. Each dot for the lower resolutions consists of an array of the printer's standard 1/300-inch dot.

PCL 5 supports three data compression formats: run-length encoding, TIFF revision 4.0, and delta row compression. Using compressed data can noticeably reduce the download time for graphics images, but HP points out that it doesn't reduce printer memory use. TIFF is a popular graphics file format that Aldus and its PageMaker software have made famous. It is also now used by many scanners and paint programs. The other formats are described in HP's PCL documentation.

Realizing that not all programmers write perfect code the first time through (I must be the rare exception), HP has included some troubleshooting commands in PCL 5 to help debug printing problems. The End-of-Line Wrap command can tell the printer to wrap characters around to the beginning of the next line if they go past the right margin (where they would otherwise normally be clipped, or cut off). The Display Functions Mode command forces all escape sequences and control codes to be printed instead of executed, letting you verify what PCL commands are getting to the printer, and in what order. There are two exceptions: A carriage-return control code causes the printer to generate a carriage return and linefeed, and the Printer Reset command (EscE) is still executed (exiting the display functions mode).

A whole book could be written on the HPGL/2 functions alone. This vector-graphics command set has many advanced functions, and using the HPGL/2 commands in a LaserJet can dramatically reduce the graphics-image download time over comparable PCL raster-image downloading.

HPGL/2 commands let you generate a wide variety of shapes, such as circles, arcs, rectangles, wedges, and other polygons. HPGL/2 also allows versatile line drawing, with varying angles and line widths, and it even lets you print text at any angle. It's a powerful command language in its own right—the predominant vector-graphics language of choice in the plotter world—and its adoption into the PCL 5 definition makes an already-capable PDL all the more powerful.

The commands in HPGL/2 don't have the same escape-sequence format as the standard PCL commands. Once HPGL/2 mode is entered, the printer interprets incoming commands as HPGL/2 commands and cannot interpret PCL commands (except Printer Reset). After you return to PCL mode, the incoming commands are again interpreted as standard PCL escape sequences.

Beefing Up the Standard Office Printer
HP's PCL has come a long way since its formal debut in 1984. With the addition of scalable, rotatable font technology, the ability to change print direction, and the incorporation of the robust HPGL/2 vector-graphics command set, PCL 5 has seen vast improvements over industry-standard PCL 4, established by the LaserJet II. Now that it contains much of the functionality primarily sought after in PostScript, PCL 5 has become a powerful contender for use in desktop publishing applications. When combined with HP's RET, PCL 5's scalable fonts and graphics images print with unprecedented sharpness on a conventional 300-dpi printer.

Since HP is a trendsetter in the laser-printer industry, it shouldn't be long before most applications support the expanded capabilities of this enhanced language. Thanks in part to PCL 5, the workhorse office printer is becoming a much more capable beast.

ACKNOWLEDGMENT
I would like to thank Clay Young and Kurt Rockenhous, both of Hewlett-Packard, for their generous help during the preparation of this article.

Roger C. Alford is president of Programmable Designs, a Michigan-based consulting firm specializing in electronics design. He can be reached on BIX c/o "editors."
Use KnowledgePro to build fast, complete, royalty-free Windows applications in record time. Get started quickly with interactive design tools and easy-to-learn commands.

Use KnowledgePro's rich, object-oriented (OOP) language for rapid development capability and low-level control.

Give your applications depth with hypertext and hypermedia. Take advantage of built-in expert systems technology to create smart, easy-to-use, state-of-the-art solutions.

Use KnowledgePro's simple DDE commands to write intelligent front-ends for Windows programs like Excel, Word and Superbase.

Write your own DLL extensions to KnowledgePro in low-level languages like C or C++.

Shorten your development cycle, whether you use the SDK or not.

Work smart. Ask your dealer for:

KnowledgePro®

...your door into Windows 3.0

Circle 171 on Inquiry Card.


KnowledgePro is a trademark of Knowledge Garden Inc. Microsoft, Windows, Excel and Word are trademarks of Microsoft Corp. Superbase is a trademark of Precision Inc. Image by Robert Tinney.
The Ultimate in Hardware Based Copy Protection

Compatible
Hardlock is designed for the "real world". Side effects from printers, laptops and technical issues such as static and true IBM printer port compatibility are virtually non-existent.

Flexible
Field programmability is now possible. Additionally our optional Crypto Programmer board permits the Hardlock to be uniquely programmed for your company.

Reliable
Our unique ASIC (Application Specific Integrated Circuit) extends the Hardlock's operating range below 2 volts. Since no idle current is required, there is no additional loading on the printer. Electronically erasable memory requires no battery.

Space-Saving
Hardlock measures only 1.75". Three of our units fit in approximately the same space as only two others. Hardlock with Memory may also be purchased on the smallest PC board you've ever seen. Perfect for those who don't want the device on the exterior of the computer.

Hardlock
Hardlock with (128 bytes) Memory
Hardlock with Memory on a Board
The Security System You've Asked For.
SOFTWARE CORNER

BARRY NANCE

JUST FOR CHECKING UP

This is the first installment of a new column in which we will present useful programs and utilities at no charge (or as shareware) for PC-compatible, Macintosh, and Unix systems. Source code and executable versions (when offered) of Software Corner programs are available in a variety of formats. See page 5 for details.

If you agree that the Novell _USER-LIST_ command is a little dry at times, you'll like NETMAP. NETMAP draws a colorful map of your NetWare LAN. Each user is represented by a push button on your screen. You can use a mouse to click a push button and reveal the user's log-in date and time, along with some simple traffic counts for that user's workstation: "Lost Packets" (the number of times IPX received a packet it didn't know what to do with); "Postponed AES" (the times IPX could not process a rescheduled packet event on time); "Listen ECBs" (the number of event control blocks given to IPX, usually by NET3, for receiving packets); "Packets Sent" and "Inbound Pkts" (the total counts of network message activity); and "Can't Route" (the times IPX couldn't find a route across the network to deliver a packet).

NETMAP requires a PC-compatible computer with EGA or VGA display, and it uses a mouse if you have one. This software shows up to 100 connections (users) on a VGA screen, but it has room for only about 70 on an EGA screen.

If you don't have a NetWare LAN, you can still run NETMAP. If no network is present, the program randomly creates pretend users it can display.

NETMAP polls the network every 2 seconds, looking to see who might have logged on or off. You'll see new push buttons appear for the new users. People who have logged off are represented by bright blue, empty push buttons on the screen. (Ask a friend to temporarily log off the network while you watch the screen.) Users show up as white push buttons; your file servers are cyan and are in the center of the display. If you use the Tab key, the currently highlighted user is bright white and the current server is red.

Three free programs that monitor NetWare LANs, Mac memory, and UUCP connections

Programming Techniques

I used version 2.0 of the Turbo C compiler to develop NETMAP. In the source code, you'll find lots of techniques and coding strategies you can explore. The management of the graphics display is pretty simple; I draw push buttons—using the Borland Graphical Interface—in a pattern that starts near the center of the screen. I reserved the center itself for servers. The x,y coordinates of each push button are saved in an array so I can do mouse hit-tests.

The network aspects of NETMAP are a little more complicated. Every 2 seconds, the program gathers data on all the current workstations and servers. It uses the GetConnectionInformation() NetWare function call to do this, and it compares the data with what it saved from the previous calls. NETMAP shows the differences as either new users or logged-out users (the blue, empty push buttons). When you click on a push button, the program establishes an SPX connection with the other workstation and issues a series of diagnostic requests. NETMAP asks for only a small amount of the diagnostic data that's available. If you have the NetWare technical references handy, you can turn NETMAP into a full-fledged diagnostic tool.

MAC/ Tom Thompson

Swatch Watches Your Memory

S

watch 1.1 (short for "system watch") is an INIT/application combo that monitors Macintosh memory usage. Scliced bars represent the amount of memory each application uses; the system heap is also shown. Colors within each bar indicate that memory blocks are either locked, relocatable, purgeable, or free. The display is updated automatically as applications launch, quit, and run. A magnifying glass function lets you zoom in to examine a particular memory block, or zoom out to see the big picture on memory use. Holding down the Option key while clicking on a block gives its memory address.

These capabilities make Swatch a handy developer's tool. If you're tangling your heap because you're forgetting to dispose of memory you allocated, it'll show up on Swatch's display quickly. This little jewel could have spared me a lot of grief with heap management on an earlier Mac development project. Swatch was written by Joe Holt.

UNIX/ Ben Smith

UUSTATUS Checks Connections

The freely available Unix utility uustatus uses the Curses visual library routines to display the current status of active UUCP connections. When a system spoofs files up for transfer, uustatus displays the number of files and number of tries. When a connection becomes active, the display changes to show what state it is in, and the log file for UUCP connections to that site scrolls in at the bottom of the window. Here's a sample screen dump from uustatus:

```
   SYSTEM  RETRY  IO  FIL  LAST  TRY  NEXT  TRY  STATUS
       3/03/01 14:51

    uunet       0   1   03/01 05:56   03/01 16:56  SUCCESSFUL
    maxx       0   2   03/01 13:58   03/01 15:58  WRONG TIME TO CALL
    enetpro    1   3   03/01 14:50   03/01 14:50  TALKING
    ronin       0   2   03/01 13:34   03/01 16:34  CALLER SCRIPT FAILED
    tideast    0   2   03/01 12:12   03/01 18:12  SUCCESSFUL
    csfid       0   3   03/01 07:31   03/01 20:31  SUCCESSFUL
```

Editor's note: We solicit your contributions. If you've written a program or utility that you think others might find useful, let us know. We'll pay $50 for any program we use. Write to Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

JUNE 1991 • BYTE 341
It wasn't easy. But we did it. Made the long-time best-selling IBM* PC-based interactive CAE tool even better.

Take modeling power. We've significantly expanded math expression capabilities to permit comprehensive analog behavioral modeling. And, beyond Gummel Poon BJT and Level 3 MOS, you're now ready for nonlinear magnetics modeling. Even MESFET modeling.

Analysis and simulation is faster, too. Because the program's now in "C" and assembly language. That also means more capacity — for simulating even larger circuits.

As always, count on fast circuit creation, thanks to window-based operation and a schematic editor. Rapid, right-from-schematics analysis — AC, DC, fourier and transient — via SPICE-like routines. The ability to combine digital/analog circuit simulations using integrated switch models and parameterized macros. And stepped component values that streamline multiple-plot generation.

And don't forget MICRO-CAP III's extended routine list — from impedance, Nyquist diagrams and BH plots to Monte Carlo for statistical analysis of production yield. The algebraic formula parsers for plotting virtually any function. The support for Hercules, CGA, MCGA, EGA and VGA displays. Output for plotters and laser printers.

Cost? Still only $1495. Evaluation versions still only $150. Brochure and demo disk still free for the asking. Call or write for yours today. And see how easily you can get ideas up and flying.
Last month, I discussed Wausau Insurance's decision to hire my company to rework our DOS-based insurance-rating application. Wausau wanted it to run as an AIX-based client/server application on IBM RISC System/6000 file servers, with DOS clients and perhaps some Unix clients. I immediately began a search for the right network-support software and narrowed the choice down to two products from IBM: its version of Sun Microsystems' Network File System (NFS) and AIX Access for DOS Users (AADU), which is its version of Locus Computing's PC Interface.

NFS took an early lead in the competition, but I discovered several problems with it, as I detailed last month. Specifically, NFS's extra overhead makes it slow, the IBM version lacks the lockd daemon for file and record locking, and there's no mechanism for mapping user names and permissions across the network.

This month, I'll talk about AADU, and I'll let you know which product got the nod and why. I'll also discuss a special Oracle interface we constructed that saves both memory and money.

How AADU Works
AADU, like NFS, runs on top of TCP/IP. On a Token Ring LAN, it consists of two DOS device drivers. One implements TCP/IP; the other establishes a new letter for the network drive. You don't designate the network-drive letter for each workstation as you would with NetWare's Map command, however. DOS and AADU assign the next available letter.

The network drive encompasses the top-level directory structure of the Unix host, including all its file systems: You'll see typical Unix directories such as \USR, \TMP, and \LOST'UND.

The last one is AADU's way of representing the ubiquitous Unix "lost+found" directory in terms of the more restrictive DOS rules for filenames. The udir utility in AADU lets you see both the full AIX name and the mapped DOS name.

To accomplish file redirection, AADU uses the Internet Protocol and User Datagram Protocol for LAN communications. IP routes the packets; UDP provides simple process-to-process data-gram services on top of IP.

When an application (even COMMAND.COM) issues a DOS request for file or disk services, AADU snatches the request away from DOS and shunts it across the LAN to the Unix host. A background process (daemon) on the host fills the request by issuing the corresponding Unix system call and sends the response back to the workstation.

These AADU packets, like other Token Ring frames, have specific source and destination network addresses. NetWare, LAN Server, and NFS/AADU can coexist on the same physical LAN, but a workstation can see only one type of server at a time. (I boot my own workstation with one of three CONFIG.SYS files that load DOS and NetWare, OS/2, and DOS and AADU.)

Actually, two Unix daemons (pcimapsvr.ip and pciconsrvr.ip) run on the host, and these daemons spawn a third daemon (pcidossvr.ip) for each workstation that performs the AADU log-in sequence. The pcimapsvr.ip daemon maintains site maps that identify all the AADU servers on the LAN; the AADU log-in program uses the information to list these servers so you can pick one. You identify servers by host name and by Internet address in the /etc/hosts AIX file.

The pciconsrvr.ip daemon periodically broadcasts <host name> HERE messages to let all pcimapsvr.ip daemons know to include the host name in their site maps. The pcidossvr.ip daemon maintains a dialogue with the workstation and executes Unix system calls on behalf of that workstation. The host transmits the results from these system calls back to the AADU workstation, but it appears to the workstation as though DOS has performed the request. As you would expect, AADU supports both printer and file redirection.

This structure of Unix daemons and DOS device drivers works well until a DOS user forgets to use the AADU log-out program to end a session. If the DOS machine reboots during a session (or if it suffers a power failure or lockup), pcidossvr.ip remains running as a "zombie" Unix process. Only a supervisor-level (root) Unix log-in can kill it.

A software developer chooses between NFS and AADU network-support software
Each Unix file system, like each DOS drive letter, has its own space-available and space-used statistics. Since AADU maps the entire Unix host as a single DOS drive, you can get confusing and conflicting reports from even a simple DOS DIR command. In the E: \TMP subdirectory, for example, you might see the following message:

8,000,000 bytes free

But in the E: \USR subdirectory, you'll see a different report. This is disconcerting, but if AADU were to map each Unix file system as a separate network drive, the result might be even more confusing and difficult to follow.

Locks Supported
AADU supports DOS file and record locking—something that’s lacking in IBM’s NFS. This was a sore point for me when evaluating NFS, and I was prepared to add my own record-locking scheme on top of NFS by writing a custom Unix daemon.

With AADU, I wouldn’t have to, although there are administrative headaches associated with record locking. The pctlodsvr . ip daemon uses Unix shared memory to keep track of record locks, and a DOS workstation that reboots or crashes with outstanding locks leaves those shared-memory entries intact. To free the locks, all AADU users have to log off and the supervisor has to use the AADU sharectl utility to clean up shared memory. I would face this
Printer Sharing Solutions

5 or 10 Ports

- Reliable Automatic Switching
- Easy to Install and Use
- No PC RAM Memory Required
- Toll-Free Technical Support
- 45-Day Money-Back Guarantee

HWP 5 Ports

HWP-256 with 256KB $325
HWP-512 with 512KB $375
HWP-1000 with 1MB $425

User Upgradable Memory:
From 256KB to 16MB buffer

Input/Output Settings - 4/1 or 3/2:
All parallel ports; user configurable as either three inputs to two outputs, or four inputs to one output, buffered auto-switch

Rapid Data Transfer - 100,000 cps:
The HWP uses Direct Memory Access (DMA) for data transfers into the buffer, making the HWP hardware capable of receiving parallel data at the high rate of 100,000 characters per second.

Pop-up Menu or Front Panel Buttons:
Use either the pop-up menu or the front panel switches to select printers, select the next available printer, send multiple copies, clear data, and other functions.

AS-41 5 Ports $200

Smart Switch - No Pop-up or Buffer:
Four parallel inputs to one parallel output, electronic automatic switch with no buffer

SPPS (not shown) $100

Interface Converter - No Buffer
Combination serial-to-parallel, or parallel-to-serial interface converter in a single unit; low-power CMOS design derives power from serial connection, no power supply needed; supports 9,600 to 115,200 bps, DIP switch configurable

HWP-512 with 512KB $375

Save Money by Sharing Office Resources:
The SL is the peripheral sharing solution which enables everyone to share lasers, printers, plotters, and modems. The HWP is ideally suited for sending large graphics files, but is economical enough for any kind of printing within a small workgroup.

Greater access by more users reduces unproductive idle times and the expense of purchasing additional peripherals. With a buffer, all users can simultaneously send print data and quickly release their PCs to continue working.

We are the world's largest manufacturer of buffered data switches for PCs which assures your getting the best value and highest performance from our products.

Call For More Information
(800) 345-2356
Fax (503) 585-4505

SL or SLP 10 Ports

SL or SLP-256 with 256KB $495
SL or SLP-512 with 512KB $575
SL or SLP-1000 with 1MB $675

Two Configurations - Ten Ports Each:
SL - four parallel and six serial ports
SLP - eight parallel and two serial ports
Both include 15 ft. serial null-modem cable

User Upgradable Memory:
From 256KB to 4MB buffer

Any Combination of Printers or PCs:
All ten SL or SLP ports can be software configured as either input or output.

Automatically Routes and Buffers Data:
Automatic switching and queuing of jobs; automatically converts data from parallel-to-serial or serial-to-parallel

115,200 bps PC-to-PC File Transfers:
Transfer files serially between PCs up to 115,200 bps; buffer serial data to the SL several times faster than normal 9,600 bps

Pop-up Menu via Hotkeys or Mouse:
Keyboard selection of printers and many other control functions; pop-up is for convenience, but is not required

Simple Installation:
Plug in your cables; if desired, run the installation software for the pop-up menu

Circle 399 on Inquiry Card.
HANDS ON NETWORKS

AADU Measures Up

Memory usage and performance are always big concerns on a network, and AADU did well in both of these areas. The AADU device drivers use about 60K bytes of RAM, compared to about 90K bytes for NFS. Our application runs as quickly using AADU on a RISC System/6000 PowerServer 320 as it does same situation as a design issue if I decided to write a record-locking daemon for NFS.

To my surprise, I also found that AADU doesn't support Machine Name, a common feature of most networks. Machine Name is supposed to be available through a standard DOS call, function 5E00 hexadecimal. Because our application uses the first two characters of Machine Name to uniquely identify each user, I had to write a small (800-byte) TSR program to add this support to AADU. This was annoying, but certainly not fatal. IBM or Locus should correct this oversight.

For security, AADU relies on standard Unix protections. You use the AADU log-in program, which prompts you for a Unix account ID and password, to gain access to the network drive. (The supervisor must add each AADU user to the Unix system.) The supervisor can deny any user read or write access to files and directories on the Unix host through the standard Unix permission masks.

Speaking of security, be aware that each AADU DOS device driver contains a serial number and is therefore copy protected. Don't take the first disk and make copies for all the users, as I did. You'll have to recall all the disks and make new ones, one at a time, from each individual distribution disk.

Be aware that each AADU DOS device driver contains a serial number and is copy protected.

- No external power
- "One-Touch" selection
- Mix PC, PC/XT, PC/AT and PS/2
- "AutoBoot" Feature boots attached computers without operator intervention after power failure
- Shows PC power status
- Mouse support available
- TTL (MDA, CGA, EGA) up to 600 feet away
- VGA up to 400 feet
- Each unit accommodates from 2 to 8 PCs
- Up to 12 units can be cascaded
- Mounting kit available for 19” rack installation

Dealer Program Available
Cybex Corporation
2800-H Bob Wallace Ave., Huntsville, AL 35805
(205) 534-0011 • FAX (205) 534-0010

346 BYTE • JUNE 1991
SmartCache™ Plus: the grow-as-you-go approach to SCSI controllers

START WITH THE BEST...
DPT's entry-level SmartCache Plus board offers unrivaled price/performance for single-user systems. It features ISA or EISA bus mastering, and universal SCSI disk compatibility for all PC operating systems. SmartDriver software supports SCSI-2 peripherals like tape and optical drives.

NOW ADD CACHING!
Get DPT's award-winning caching technology in a plug-in module! Move up to disk caching speed without investing in a new controller. With an integral 512K cache, the module provides up to 5X performance gains for workstations, power users, and small multiuser systems.

ADD MORE USERS, ADD MORE CACHE!
Plug in a 2 MB or 4 MB memory module and accommodate up to 18 users from a single card slot. Ideal for medium-sized networks or multiuser systems.

HOW ABOUT DISK MIRRORING?
DPT's SmartCache mirroring module provides 100% disk fault tolerance by simultaneously writing all data to a second "mirrored" drive. No more data loss or costly system down-time due to disk failures. And unlike software mirroring schemes, fault tolerance is achieved with no performance penalties.

PLUS STILL MORE CACHE, AND THEN SOME...
Cable over to DPT's 4 MB Cache Expansion Card, then grow your system to 16 MB by adding more plug-in memory modules—enough power for 64-plus users!

DPT has your solution—no matter how you grow. Performance, compatibility and upgradability make SmartCache Plus the only SCSI controller you'll ever need. For details, contact Distributed Processing Technology, 140 Candace Drive, Maitland, FL 32751. Phone (407) 830-6522; FAX (407) 260-5366. In Europe (UK) phone 44 04 884 718 FAX 44 04 884 8892.

SEE DPT AT COMDEX SPRING BOOTH #2046
Circle 98 on Inquiry Card (RESELLERS: 99).
using NetWare on a 33-MHz 386 server. This tipped the scales between NFS and AADU, and, if you haven't guessed by now, we chose AADU over NFS.

A few other features helped to make AADU the favorite. The software includes a set of utilities for starting and monitoring Unix software from the DOS environment. It even comes with a C programming interface that lets you embed host-control functions in your software. You can manipulate AADU, execute Unix programs, and perform DOS/Unix interprocess communications involving message queues and semaphores.

What if you want users to be able to run Unix software and DOS software? No problem; AADU provides two terminal emulators (i.e., VT100 and VT220) that work across the LAN through a virtual serial link. You can easily hop back and forth between a DOS prompt and a Unix prompt. However, you can't hot-key between the two.

Oracle Innovations
We're using Oracle 6.0 on the RISC System/6000 to store much of our data in relational form. The front-end application (a DOS program that resides on each workstation) issues Structured Query Language statements to retrieve the data; a series of DOS programs on the workstation then do the processing and issue SQL statements to store the results.

One way to get the SQL statements and data across the LAN to Oracle on the RISC System/6000 is to use Oracle's SQL*Net software on each workstation. SQL*Net makes it look as if Oracle is running on the workstation by redirecting data to and from the host. Unfortunately, SQL*Net takes up extra memory underneath the application, and Oracle's per-workstation licensing is expensive if you have many workstations.

We passed over SQL*Net and developed a homegrown link (a queue) between the DOS machine and the Unix host. Through this link we pass data records in both directions. We issue the actual SQL statements directly to Oracle with a C program on the RISC System/6000; the C program responds to entries we place in our queue. This approach leaves us with enough memory to run our application, and it saves the cost of about 100 copies of SQL*Net.

Unix and DOS Get Closer and Closer
As this column went to press, IBM announced that it has become a reseller of Novell's NetWare products, Novell has announced that it will soon have a version of NetWare that runs under AIX on the RISC System/6000, and IBM is working on a version of OS/2—as yet unannounced, but I've seen it—for the RISC System/6000. Also, Locus Computing should be shipping PC Interface for the Mac by the time you read this.

We don't think we'll change our minds about using AADU as our network support software, but it is comforting to know that LAN vendors are offering a wider and wider range of solutions for DOS/Unix connectivity.

Invisible
As it should be. A LAN's moment of truth is its ability to access data fast while remaining invisible, easy to use. And it should take up little, if any, of your DOS memory. So there'll be plenty available for processing tasks.

With speed in mind, we designed new super-swift Net/30 2.0 software. How fast is it? At least 20% faster than our nearest competitor. And about 60% faster than the rest of the pack.

To help you squeeze more from your DOS memory, we were first to introduce expanded memory support. And we're still the only network offering expanded memory managers as part of the operating system. This lets you load the network plus your TSR programs outside conventional memory. In fact, you can actually add to the 640K DOS memory capacity.

The Invisible Network™ comes complete with hardware and software. And all the tomorrow-minded features come standard. For more information, call 415-570-5967, or Fax 415-570-6017.

Oracle Innovations
Barry Nance does R&D and technical-support work for Insurance Software Systems, a software development company in Hartford, Connecticut. He is also the author of Network Programming in C (Que Publishing, 1990) and is the IBM Exchange editor on BIX, where you can reach him as "barryn."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.
The Multiuser DOS Platform
For The '90s

The 386 and now the 486 microprocessors have focused a lot of attention on the multiuser, multitasking possibilities of advanced PCs. A myriad of software and hardware manufacturers are promising a new age of multiuser options in the '90s. But when you take a closer look, only one solution focuses on the features you want and anticipates the capabilities you need to use your PCs to their greatest potential. That solution is PC-MOS™ from The Software Link, the first DOS-compatible, multiuser, multitasking operating system.

A Network Alternative
The advantage to the PC-MOS shared processing solution is its ability to maximize the available memory on your PC, taking full advantage of extended memory and sharing it with up to 25 users on inexpensive terminals or monitors. You can share data with the same speed and integrity of a network solution without the expense of network cards and the waste of under-utilized PCs. And no additional investment is required to get the multitasking capabilities inherent in PC-MOS.

A Network Enhancer
For affordable network expansion, PC-MOS servers can be connected to other servers with The Software Link’s LANLink or with the PC-MOS GATEWAY™ to Novell’s NetWare®. This connectivity lets a business configure its automation systems for departmental efficiency and expand affordably as needs grow with LANs or even WANs.

DOS Compatible
The PC-MOS alternative is clear: DOS compatibility means your users can continue to use all the popular software packages. And that means no investment loss, no retraining and no limitations in available applications.

An Unbeatable Solution
The next decade of shared processing will be clouded with choices. Only one operating system was first to offer you DOS-compatible, multiuser, multitasking solutions. Only one operating system continues to provide unbeatable multiuser solutions for over 150,000 users. PC-MOS from The Software Link. Call today and set your computing sights on a more productive horizon.
Pick Our Brains.

Product support for your IBM or compatible.

CompuServe, the world's largest network of people with personal computers, is also the world's largest network of people with answers to your hardware and software questions.

Brains abound on CompuServe. You'll find quick solutions and information from our thousands of forum members, some of whom have already had your problem, some of whom are the product developers themselves. Company decision-makers are online, too, discussing the next generation of products, and giving CompuServe members software updates before they hit the market.

Got a question? Got a problem? Get smart. And get some answers, from the many minds of CompuServe.

To join, see your computer dealer. To order direct, or for more information, call us today.

CompuServe®
800 848-8199

Circle 72 on Inquiry Card.
Windows Meets AI

Windows 3.0, Microsoft says, is revolutionary. Hype? Yes, of course. It's really an evolutionary improvement over Windows 2.0. But still, Windows 3.0 is good enough to move the graphical user interface (GUI) into the mainstream of the many- forked IBM-compatible personal computing river.

One of the striking things that Windows 3.0 has done is to open up the PC to AI applications. There are two good technical reasons why this should happen. First, Windows 3.0's protected-mode operation gives AI applications the memory they require to run efficiently. Equally important, Windows provides the GUI that AI applications need to be usable by mere mortals.

A funny thing happens to AI environments on the way to Windows: They become general-purpose development environments. They still have their expert-system heritage in there somewhere, but it gets bundled with other good stuff like object hierarchies and interprocess communication.

According to a good book on the subject, Edmund Payne and Robert McArthur's Expert Systems (John Wiley & Sons, 1990), that trend isn't unique to Windows programs. The expert-system shells of 10 years ago have grown up into hybrid systems. These days, a "real" shell is an integrated set of tools that provides facilities for building a knowledge base as well as support for various AI paradigms.

Payne and McArthur cite editors, interface-building tools, debuggers, and an open architecture as the four necessary facilities. They list rules, frames (or classes), inheritance, graphics, truth maintenance, alternative views, external language calls, and an external program interface as the usual paradigms that need support. They discuss examples using Knowledge Engineering Environment (KEE), Knowledge Base Management System (KBMS), GoldWorks, Expert, Level5, and Advanced Debugging System (ADS), along with their own software, Entrypaq.

Kappa PC
KEE is an interesting example. It runs on Lisp machines from Symbolics and Texas Instruments, Hewlett-Packard and Sun workstations, and Macs or 386 PCs with TI Explorer boards. The HP version costs about $30,000.

IntelliCorp, the maker of KEE, also has a line of C-based applications development and deployment environments: Pro-Kappa, which runs on workstations, and Kappa PC, which runs on Windows.

AI applications benefit from the memory and interface features of Windows

Kappa PC costs $3500, and run-time licenses are $450.

Several years ago, I built a prototype expert system for diagnosing the cause of failures in metals and alloys. My work was based on the Failure Analysis volume of the Metals Handbook, and I used Level5 on a PC. At that time, Level5 was purely a rule-based system; now, I understand, it has frames as well. It was a lot of work implementing my failure-analysis system using unstructured facts.

The knowledge base is full of rules that assert obvious things like the following:

RULE ferrous materials 2
IF material IS carbon steel
THEN material IS ferrous
AND material type is alloy

When I started to convert my Level5 implementation to Kappa PC, I discovered that more than half the rules could be replaced by an object hierarchy that I simply drew in Kappa PC. Instead of having to assert facts about material classification with rules, I was able to build a classification tree. The rule above was replaced by making carbon steel a child of ferrous materials and setting carbon steel's material type slot to alloy (as opposed to metal).

This technique is a major improvement. IntelliCorp says that the diagram is the program. While that is a gross exaggeration, it has more than a grain of truth.

In addition to rules, frames, and inheritance, Kappa PC supports object methods, procedural programming with the KAL language, Dynamic Data Exchange (DDE), active graphical images, and a C-language interface. The level of integration is very, very high. Rules can look at slots, which can reference objects, which can invoke methods, and the music goes round and round. My biggest problem in learning to use this package was that so many paradigms are
In the course of talking to other users, I discovered that Kappa PC was developed as a thesis research project in the MIT civil engineering department. The student who developed it (Fadi Chehayeb) went on to form his own company, MegaKnowledge, and finally sold the product to IntelliCorp, which made substantial improvements.

The MIT civil engineering department continues to use Kappa PC as well as KEE. According to Prof. Robert Logcher, the department gets far more use out of Kappa PC because it is an easier development environment than KEE—and certainly a lot less Lisp-oriented. Currently, Logcher is using Kappa PC to develop a construction manager adviser for Shimizu.

Fascinating stuff, this. Logcher's system picks up where the Program Evaluation and Review Technique and critical-path method scheduling systems leave off. Instead of telling you that delays have slipped your schedule, the system figures out how to recover from the delays and restore the original schedule most efficiently, by shifting resources and allocating overtime. The development of the system was fairly smooth with Kappa PC. Logcher's team had no trouble writing its own C programs to expand the capabilities of Kappa PC and no trouble interfacing to construction data in dBASE.

Across the Charles River, Dr. Chris Cimino at Massachusetts General Hospital has been developing a unified medical-language system—an integrated query workstation for accessing bibliographic data on MEDLINE and drug data on the Physicians' Desk Reference CD-ROM—using Kappa PC as a development environment. When MGH was looking for an environment some 18 months ago, the alternatives weren’t anywhere near as flexible as Kappa PC—and Cimino’s development group has added lots of C modules, as well as making extensive use of Kappa PC’s object hierarchy and user interface paradigms. Interestingly enough, Cimino says he has yet to write a rule in almost two years of working with Kappa PC, although he expects to use rules for parsing natural-language queries.

I can recommend Kappa PC for serious R&D projects, but I’d caution you that there’s a steep learning curve—it’s right up there with learning to read Chinese or learning to program Windows in C. (By the way, learning to read Chinese isn’t impossible—I’ve done it. It does, however, require you to learn new paradigms and acquire hundreds or thousands of characters.) On the other hand, once you understand Kappa PC, you’ll find that it’s a solid, high-level tool with more than enough depth for big projects. It is an open architecture. You won’t find any real walls.

KnowledgePro for Windows

Of course, not everybody can justify $3500 for a development environment, especially with run-time fees tacked on. IntelliCorp does have a "gateway" program that allows consultants to use Kappa PC for six months before paying for it. But for $695 (with no run-time fees), KnowledgePro Windows (KPWIN) from Knowledge Garden looks like a bargain by comparison.

While KPWIN doesn’t support all the
G.U.I. CLEARING HOUSE - PM / Windows Catalog

**G.U.I. CLEARING HOUSE**
Specializing in products for Microsoft Windows and OS/2 graphical environments

**PRODUCTS AND SERVICES**

<table>
<thead>
<tr>
<th><strong>Windows Applications</strong></th>
<th><strong>CASE:W3.0</strong></th>
<th><strong>CASE:W3.0</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design/IDEF</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DesignView</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DRAFIX Windows CAD</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Microsoft SQL Server</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Microsoft SQL Server</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Windows NT Server</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Windows NT Server</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Contact Information**

1-800-522-4624

International, call (203) 426-4624

Monday - Friday 9:00am to 8:00pm EST

GUI Clearing House is the only national reseller specializing exclusively in Windows and OS/2 Presentation Manager environments. This specialization is necessary in order to properly serve you, our customer, in this rapidly evolving market. Our goal is to provide you with the highest customer service in the industry and to ensure that the products you select are the correct ones for your application.

When you call GUI Clearing House, you will be greeted by one of our friendly, knowledgeable sales staff who will take the time to talk with you to understand your specific requirements. To further assist you, we maintain a staff of technical consultants available to answer in-depth technical questions on products; and to help customers in identifying applications to meet their needs.

Please Note: The applications listed in this ad represent only a small sample of the Windows and OS/2 Presentation Manager products available through GUI Clearing House. Call us for pricing on any Windows or OS/2 application. We'll promptly get pricing and availability for you. **CALL TODAY!**

**HARDWARE**

- **Image Scanners**
  - Logitech ScanMan 256/PC-AT
  - Microtek scanners

- **Boards**
  - ATI 851/Ultra 512K
  - ATI 851/Ultra 1MB
  - IAT 851/853/Ultra-West 512K, 1MB

- **HARDWARE, etc.**
  - NEW TERMINUS for Windows
  - Black ICE
  - Braincell
  - FileShell XSPRESS
  - Remote Possible
  - VentanaDRAW

- **Publishing/Graphics**
  - Adams Clip-Art Window Shopper
  - Adobe PageMaker
  - Archetype DESIGNER
  - CorelDRAW
  - Microsoft Office for Windows
  - Microsoft PowerPoint
  - PowerPoint for Windows
  - Publisher's Paintbrush
  - Publisher's Paintbrush

- **Multimedia Products**
  - Guide 3 (Web Int.)
  - Icon Author (WinTech)
  - Super VideoWindow
  - VideoLink/FRAMEBUFFER

- **GUI CLEARING HOUSE offers a full line of hardware items selected to augment the Windows, Presentation Manager, and Multimedia based platforms. If you don't see a particular item, just ask...we will promptly obtain pricing and availability for you. Call us TODAY!**

---

**PAYMENT - Visa, MasterCard, Diners Club and Carte Blanche accepted. Personal and company checks accepted. Please allow 2 weeks for processing. Corporate and institutional purchase orders subject to credit approval and a minimum initial purchase $500. paid via C.O.D. or in advance. B.O.D. minimum purchase is $100, minimum $1,000 payable by cash, cashier's check, or money order. T.R.T. residents add 6% sales tax.**

**Shipping/Handling Charges - 3% or $6 minimum. $5 extra for C.O.D. Larger shipments may require additional charges. Call for information for shipments to Alaska, Hawaii, and points outside the United States.**

**PRODUCTS - All products carry manufacturer's warranties only. Product warranties, guarantees, licenses, tool period privileges, or other promotional programs are handled by the manufacturer. Selective items replaced or replaced at our discretion. All returned items are accompanied by a return material authorization (RMA) number. RMA numbers are used to properly identify returned product and are required to facilitate immediate repair.**

**SOFTWARE - Software errors are not defects. Software errors are the result of typographical errors or hypothetical errors.**

**G.U.I. CLEARING HOUSE** P.O. Box 10, Sandy, Utah 84070 (801) 425-1004 Copyright © 1994, 1995 G.U.I. CLEARING HOUSE. All rights reserved. 091-040

---

**Circle 130 on Inquiry Card.**
paradigms and facilities of a full hybrid expert-system development environment such as Kappa PC, it is interesting in its own right. KPWIN is a development environment with a programming language that handles lists but has a syntax more like Pascal than Lisp. It includes a backward-chaining inference engine and rules, and it has a number of hypertext features, but it’s not a conventional expert system.

KPWIN’s building block for objects is the topic. A topic can contain procedures and daemons, as well as rules and variables, and you can organize the topics in a hierarchy. KPWIN has no frames as such, but you can get the same effect with topic hierarchies. It has a backward-chaining engine, but you can build one fairly easily with procedures acting on topics.

A lot of the applications for KPWIN seem to be in the training and intelligent assistant areas. For instance, Avis Leasing is testing a KPWIN program to automate sales proposals: Commonwealth Edison is using KPWIN to link scanned maps with geographical information about gas and electric lines. A system called HUGO, sponsored by the National Institute on Drug Abuse, helps minority students apply for grants and provides technical information on NIDA policies. These are smaller-scale applications than people are creating with Kappa PC, but they are still significant.

I came to KPWIN with the same impediment that made it difficult for me to learn Kappa PC: I already knew how to write programs and rules for a conventional expert system. According to Bill Thompson, who with his wife Bev developed KPWIN, the people who do best with the product are not necessarily the hard-core programmers or knowledge engineers. They’re more likely people who have written Excel or Lotus 1-2-3 macros.

I eventually got the hang of KPWIN, and I like it as a rapid prototyping tool for Windows. It’s quite a rush doing a whole file-selection dialog box (which is about three pages of C code) with the following:

```c
selected_file = file_menu('*.bmp','');
```

### COMPANY INFORMATION

**IntelliCorp**
1975 El Camino Real W
Mountain View, CA 94040
(415) 965-5500
fax: (415) 965-5647
Circle 1160 on Inquiry Cord.

**Knowledge Garden, Inc.**
473A Malden Bridge Rd.
Nassau, NY 12123
(518) 766-3000
fax: (518) 766-3003
Circle 1161 on Inquiry Cord.

**LaserMaster Technologies Corp.**
7156 Shady Oak Rd.
Eden Prairie, MN 55344
(612) 944-9330
fax: (612) 944-0522
Circle 1162 on Inquiry Card.

**U-lead Systems, Inc.**
680 Knox St.
Torrance, CA 90502
(213) 538-9911
Circle 1163 on Inquiry Card.
You're one of millions who started with this vision of productivity...

...and are about to discover how to actually achieve it.

Words can't capture what HP NewWave software adds to Windows. You have to experience it in motion.

Get our interactive demo disk, and you'll know why the editors of PC Magazine chose NewWave as "Environment of the Year." You'll discover:

- how much easier NewWave is to learn and use than Windows alone.
- how much simpler it is to combine information from word-processing, spreadsheet, graphics and other applications, for greater impact.
- how only NewWave can perform everyday tasks like sales reports and inventory updates automatically, even while you're home asleep.

To put it simply, people had hopes for Windows, but it's NewWave with Windows that really delivers on them. Don't take our word for it, get our interactive demo disk. (83.95 handling charge)

Call 1 800 345 9111 x23A

Act now for a $25 rebate

Buy HP NewWave between 5/1/91 and 8/30/91, then send this coupon, original product registration card, and your sales receipt to HP Program Awards Center, P.O. Box 59058, Minneapolis, MN 55459-0058. Must be postmarked by 9/6/91.*

Name & Title

Company

Phone

Street address

City, state, zip.

*Dealers of HP products and their employees not eligible. Allow 6-8 weeks for your check to arrive.
HANDS ON BEYOND DOS

That merely scratches the surface. KPWIN has several hundred functions in its language, including the ability to call functions in an external dynamic link library, to have DDE conversations, and to execute the contents of a text string (shades of Lisp!).

The Thompsons’ goal is to use the computer to communicate knowledge. They have got a great start at that in KPWIN. If you’re looking for a fairly easy development tool for small-to-middling Windows applications—especially those that could benefit from an inference engine or hypertext—KPWIN may be just what you need.

Odds and Ends
And now for something completely different.

Most of my time the last month has been spent working on my book, Advanced Windows Programming, which is to be published in the fall by John Wiley & Sons. One of my major examples is a simple image-display and processing program. I was really tuned into this project when I came across PhotoStyler, which is a new, full-blown photographic image-processing application from U-Lead Systems.

I can’t tell you how nice PhotoStyler is—you’ll have to see it for yourself, preferably on a 24-bit color display. I have “only” a 256-color Super VGA display; PhotoStyler makes me want better. It does color correction, color conversion, color separation, image editing, retouching, and composition. Also, it can run a scanner. At $795, PhotoStyler is not inexpensive, but it looks to be worth every penny.

I will be producing my own camera-ready pages once I’ve finished writing the book. The piece of hardware that makes this possible is the LX6 Professional printer enhancement board from LaserMaster Technologies. The LX6 is a PC add-in board with 6 megabytes of memory, several programmable array logic chips, and its own processor. It talks to an HP LaserJet or compatible printer through the printer’s video port.

I have it working under both Windows and Presentation Manager with 135 fonts. In low-resolution mode, I get 300 dot-per-inch pages at the full 8 pages per minute that the printer engine can handle; in high-resolution mode, I get 800-dpi pages at about 4 ppm. I didn’t deserve this kind of performance until I started the book, but printing graphics from Windows 2.0 (at 20 minutes per page) was making my beard turn gray.

There has been one drawback with the LaserMaster board besides the price (which is about as much as the HP printer it drives): The output is too nice. Not for the book: 800 dpi is at the low end of typeset quality. No, my problem is that my younger daughter is in a cooperative nursery school. And the nursery school has a newsletter, which my wife edits. I made the mistake of producing one page for them, at 800 dpi, in several sizes of Bookman, with ornamental stuff in Zapf Dingbats. I just couldn’t leave well enough alone: It showed up the rest of the newsletter. Guess who has to produce the whole newsletter now?

Martin Heller, a contributing editor for BYTE, develops software in Andover, Massachusetts, and is writing an advanced Windows programming book. He holds a Ph.D. in physics. You can reach him on BIX as “mheller.”
I have been using System 7.0 since the initial developers' beta version was sent out last year after the 1990 developers' conference. By the time you read this, Apple will have released System 7.0 at this year's developers' conference. My comments here are based on System 7.0b4, the final beta version Apple sent to developers.

Let's get one thing straight: System 7.0 is not supposed to be a niche operating system for only the highest-powered Mac iron, like OS/2 is for Intel boxes. It will run on a Mac Classic with 2 megabytes of RAM, as well as on a loaded-to-the-max Mac IIx. Because it's an evolution of the existing Mac graphical user interface, it has success designed into it right from the start. It's not like Apple tossed out everything and started over.

Because of the importance of System 7.0, it's also my software of the month.

Apple has announced that System 7.0 will not be available through the usual on-line distribution channels (e.g., CompuServe MAUG, Connect, America Online, and GEnie). You'll buy one of two upgrade kits from your local dealer. The first kit costs about $99, and it comes on 800K-byte floppy disks along with new manuals; the second kit comes on a CD-ROM and is targeted for Mac managers who must upgrade a lot of Macs across a network. Pricing for the CD-ROM kit hadn't been set at press time.

In both cases, Apple will give you 90 days of free telephone support—yes, you read that right. This is the first time Apple has done this for its Mac OS. Considering all the differences between System 7.0 and System 6.0.x, this support will be needed.

The New Finder
On the surface, not a lot seems to have changed with System 7.0's interface. What is new requires a bit of exploration and some getting used to. The first thing you'll notice about System 7.0 is that the Finder has disappeared. Well, not really, but it's gone away in terms of the Finder/MultiFinder dichotomy. Under System 7.0, the Finder is MultiFinder. In fact, MultiFinder is now built in, so you can't choose not to use it.

This new Finder has a load of improvements that show Apple listens to its customers and developers. Icons and windows now take on a three-dimensional look, much like those you see under Next and Windows 3.0 (although you'll need at least 16 colors or grays to see these differences).

Finder menus have been enhanced. If you scan the menu bar on the Desktop, you'll see the familiar Apple menu. But when you open it up, you'll see immediate differences. First, you'll see cute little icons next to each menu item. Second, you'll notice something that's likely to knock your socks off: The Apple menu is no longer just for desk accessories (DAs). In fact, you can drag (no more Font/DA Mover!) any application or document into the Apple menu (using the Menu Items Folder in your System Folder), where they are handily grabbed.

These changes are instantaneous: You don't have to restart your Mac to see the new stuff in the Apple menu. That alone makes System 7.0 about a million times more convenient for Mac power users.

Gone also is the ubiquitous (and ugly) Control Panel DA. Instead, a new menu item called Control Panels reflects the Control Panels Folder contents. Like the Menu Items Folder, the Control Panels Folder is located in the System Folder (see the screenshot). That's the metaphor Apple has chosen for all its System modifiers—separate folders within the System Folder to hold the stuff to modify and customize your system. Thus, you'll also see folders labeled Extensions (to hold INITS and cdevs), Scrapbook File, Preferences, Start-up Icons, and Clipboard, among others.

The watchword for the new Finder is customization. One such new feature, the Views Control Panel, works like the current shareware Layout Plus, in that you customize the look of windows and set defaults for information display. Other new Control Panels include Labels (a replacement for the current Color menu), Sharing Setup, User Setup, and File Sharing Monitor (these last three cdevs let you manage the new personal file-sharing capability of System 7.0—Don takes full measure of Apple's newly announced System software and finds more hits than misses
A MESSAGE 
To Our 
SUBSCRIBERS 

FROM TIME TO TIME 
we make the BYTE sub­ 
scriber list available to other 
companies who wish to send 
our subscribers material about 
their products. We take great 
care to screen these companies, 
choosing only those who are 
reputable, and whose products, 
services, or information we feel 
would be of interest to you. 
Direct mail is an efficient 
medium for presenting the larest 
personal computer goods and 
services to our subscribers. 

Many BYTE subscribers ap­ 
preciate this controlled use of 
our mailing list, and look for­ 
tward to finding information of 
interest to them in the mail. 
Used are our subscribers' names 
and addresses only (no other 
information we may have is ever 
given). 

While we believe the distribu­ 
tion of this information is of 
benefit to our subscribers, we 
firmly respect the wishes of any 
subscriber who does not want 
to receive such promotional 
literature. Should you wish to 
restrict the use of your name, 
simply send your request to the 
following address. 

BYTE Magazine 
ATTN: SUBSCRIBER SERVICE 
P.O. Box 555 
HIGHTSTOWN, NJ 08520 

HANDS ON/MACINATIONS 

sort of a personal version of Apple­ 
Share). System 7.0 makes it much easier 
to modify the way your Mac works with­ 
out going to shareware. 

Other Goodies 
Other Finder enhancements include an 
honest-to-goodness fast and powerful 
find command, file aliasing that lets you 
create filenames on your Desktop that re­ 
fer to the real files elsewhere, and new 
memory capabilities. Unlike the current 
System, which lacks virtual memory and 
limits you to a physical address space of 8 
MB, System 7.0 includes a simple vir­ 
tual memory implementation that can ad­ 
dress up to 1 gigabyte, while also sup­ 
porting up to 128 MB of real memory on 
machines with 32-bit clean ROMs, like 
the Mac IIfx and Iic. 

Don’t expect miracles with virtual 
memory, though. In my tests, if you set 
virtual memory to be anything close to 
your real single in-line memory module 
count, you can expect performance to 
take a serious nosedive. 

Keep in mind that while System 7.0’s 
virtual memory can help memory-poor 
MacFolk a little, it’s no panacea. These 
virtual memory improvements are avail­ 
able only to the 68030-based Macs and 
68020-based Macs with the external 
paged memory management unit. 

Besides these improvements, Apple 
has also added a bunch of other new fea­ 
tures. Interapplication Communications 
lets you hot-link different application 
documents. A Publish and Subscribe 
mechanism makes any document avail­ 
able to any user on a network. The Data 
Access Manager will make it easier to 
wire your Mac to applications sitting on 
other computers, while TrueType fonts 
offer sharp outline fonts on any printing 
device without the need for PostScript. 

Taken together, all the improvements 
in System 7.0 help to make up for the 
product’s overly long gestation period. 
Now, Apple, it’s time to get cranking on 
System 8.0, so we don’t have to wait two 
years for it, too. 

Tip of the Month: 
The Outbound Portable 

Ever since Apple delivered its Mac Por­ 
table, MacFolk everywhere have been 
waiting for the other shoe to drop. They 
have been waiting for Apple to get seri­ 
ous about portable Mac computing and 
produce some machines that can com­ 
pete with the likes of Toshiba, Zenith, 
Compaq, and others in the DOS world. 
Frankly, Apple has been pathetically 
slow at supplying a notebook-size Mac­ 
intosh solution for the huge pent-up de­ 
mand for portable computing—so slow, 
in fact, that many people have bought 
DOS machines and use file transfer 
products like LapLink Mac III to meld 
their DOS and Mac worlds. 

Another by-product of Apple’s porta­ 
ble recalcitrance has been the growth of 
third-party portable vendors. Colby and 
DynaMac have been around for quite a
Since Microway helped launch the 32-bit DOS Extender market in 1987, our languages have been at the heart of the 386 revolution. NDP Fortran, C, C++ and Pascal make it possible for both mainframe and PC programs to take advantage of the 4 gigabyte address space of the 386/486, plus Intel and Weitek coprocessors. They employ global optimizations and other techniques originally developed to run large applications on mainframes. The translators use dialects and extensions that simplify ports. These include a VMS compatible Fortran 77, a version 2.0 C++ and an ISO Pascal. NDP C switches dialects between UNIX V, ANSI and MSC and also contains MSC graphics extensions. NDP compilers run on the four popular 386 UNIXs, plus XENIX, Ergo and Phar Lap. For DOS users we added a library of 88 graphics and low level extensions that automatically detect and use all popular graphics adapters and modes, up to high resolution VGA.

Between the quality of the code we generate and the richness of our extensions, we thought 1991 might be a good time to examine new platforms or processors. Then along came Windows 3.0 with its 386 enhanced mode. Not happy with being able to multi-task only under UNIX or DESQview, many of our customers now wanted to run their 32-bit applications under Windows. So we visited Microsoft and followed up with NDPWIN — a Windows Extender used to create and run 32-bit applications on Windows.

One of the features of NDPWIN is that it makes possible both character and graphics based I/O. You can create a 32-bit character based application that runs in a window or an application which calls the Windows API Programs with character based I/O will run without changes and can take advantage of Windows multi-tasking, while you’re learning to deal with GUIs, APIs and SDKs. Developers who have already ported using the Windows SDK but need access to 32-bit speed or memory can simply recompile with our tools, using the NDPWIN-SDK. The NDPWIN versions of our 386 languages, including tools, are $895. The NDPWIN-SDK which interfaces the Windows SDK is $1495.

PC users have been counting on Microway since 1982, when we introduced the first 8087 development tools. In 1991 our products and technical support are the best in the industry . . . and getting better.

Call (508) 746-7341 today!
while, making overpriced and overly large portable Macs by cutting up whole Macs bought from Apple.

The only real third-party Mac Portable clone maker is Outbound Systems. Its machine, the Outbound Portable, cleverly extends the Mac Plus or Mac SE bus and stuffs it into a lunchbox-size portable Mac that's less than half the size and weight of Apple's original Mac Portable (the Mac Portable II, with backlighting, is a bit less heavy). Due to a special deal with Apple, even though the Outbound uses Mac Plus or SE ROMs, Outbound can sell these Mac clones at will.

Without mincing words, the Outbound Portable is a pretty darn good machine. I've used one since July 1990, and I've hauled it through the x-ray machines at O'Hare Airport frequently enough to ionize everything in its guts. Despite this abuse, the Outbound Portable has acquitted itself admirably. I really love this little traveling companion, so much that my Mac Portable now stands in for use around the house, on the patio, and out in the backyard.

I have stuffed my Outbound Portable with 4 MB of RAM, 16 MB of RAM disk, and a 40-MB hard disk drive. The machine also includes an antiglare-coated backlit LCD screen capable of resolutions slightly greater than that of the Mac Classic screen (560 by 384 pixels), a tiny outboard 2400-bps modem that's powered by the serial port, a small outboard Superdrive-compatible floppy disk drive, and a SCSI adapter that lets me plug in small external SCSI disks, like the IDS Wips that I'm fond of. The keyboard is detachable (infrared or corded connections) and includes a built-in Isopoint tracking device (a separate two-button Microsoft Mouse also comes standard).

Excluding the small external doodads, this Outbound Portable weighs just 8½ pounds, making it a bit large by 286- and 386SX-based notebook standards, but tiny compared with the Mac, Colby, and DynaMac behemoths.

Apple is reportedly set to announce one to three smaller Mac notebook machines later this year (using either 68020 and 68030 CMOS processors and weighing in at around 5½ to 6½ pounds). But if you need truly portable Mac computing now, the Outbound Portable works well and is reasonably priced (the street prices for a 40-MB hard disk drive model average less than $2600). —

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be contacted on BIX as "decrabb."
Up to date.
Down to earth.

changing the world. UNIX is changing the world of computers, the world of business—quite simply, changing the world. It's revolutionizing office automation. It's required for U.S. government computer contracts. It's the backbone of information strategies worldwide.

The information you need.
That's why you need *UnixWorld*—the magazine that keeps you up to date on the rapidly changing world of open systems computing. Each issue brings you the latest product trends and technical advances that can affect your business. The inside story on some of the world's biggest high-tech companies. Easy-to-understand programming tips and tutorials that can help you and your company use UNIX to its fullest. And unbiased hardware and software reviews to help you invest wisely when you buy.

The whole UNIX-verse.
*UnixWorld*'s in-depth features go beyond dry technical facts, to show how the pieces fit together—to tell you what's important about the advances and the strategies that are changing your world. And *UnixWorld* consistently offers the freshest, most down-to-earth writing you'll find in any computer publication.

Subscribe and Save. Subscribe today, and receive the next 12 issues of *UnixWorld* for just half the regular newsstand price. Save even more by ordering for two or three years. You can't lose—every subscription to *UnixWorld* comes with a no-risk guarantee.

1 year $18.00 (save 50%)
2 years $32.00 (save 55%)
3 years $42.00 (save 60%)

Subscribe now! Call toll-free: 1-800-341-1522

*UnixWorld*

If you're into UNIX, you need *UnixWorld Magazine.*
CLEO's 3780Plus* is the preferred 3780/2780 bisynchronous communications solution for applications requiring fast, efficient data transfer. It's been proven in over 50,000 worldwide installations.

With 3780Plus, you get full IBM 3780/2780 RJE emulation for IBM PCs, PS/2s, and compatibles. It also works with RS/6000, DEC VAX, HP9000, NCR Tower, Prime, Pyramid, Sequent, Alitos, and Apple Macintosh systems.

Features include forms control, auto dial/auto answer, and a communications line monitor. Our powerful Scripting Command Language and Application Program Interface make unattended operation easy.

We offer 3780Plus on high-speed modem boards, high-performance co-processor boards, and economical synchronous interface boards. Internal modems supported include 201/212, 208, 208/2400, V22 bis, V32, and others. External modem auto-dialing capabilities include UDS BSC, SADL, AT Command Set, and V25 bis.

We also offer 3780Plus through our intelligent Syncable, which allows synchronous communications activity through asynchronous ports.

AVAILABLE WORLDWIDE!
In Europe, call Sintec Peripherals Ltd. in Slough, England, at 0753-811888 (FAX: 0753-811666).

Operating Systems
- MS-DOS
- Concurrent DOS
- UNIX SystemV/386
- XENIX 286/386
- AIX
- 386/ix
- HP-UX
- Sequent Dynex
- NCR UNIX
- VMS
- Macintosh

Applications
- EDI
- Point-of-Sale
- Mainframe RJE
- Medical Claims Filing
- Check Clearing
- and Deposits
- Electronic Funds Transfer
- Credit Card Verification
- U.S. Customs Automated Broker Interface
- Electronic Tax Filing

...and More!
A typical Unix installation uses Network File System (NFS), TCP/IP, and Ethernet as the software and hardware bases for its network. In such a case, the data link layer—the next-to-lowest level of the OSI model—would be represented by the device-driver software that talks to the actual Ethernet transceiver (i.e., the card that the coaxial cable is plugged into). The physical layer is the hardware itself.

The TCP and IP packages reside in the transport and network layers, respectively. Programs on the top three layers deal with higher-level messages, and they can ignore any particular network implementation. Data transmission, reception, routing, errors, and other nasty details are handled in the lower layers.

While the software in each layer interfaces with the next one in a vertical path, it can be written as if it communicates directly with software on the same layer of a different machine (i.e., the transport layer on machine A would be talking to the transport layer on machine B). This is known as peer-to-peer communications.

I'll stress that there is more than one way to write a program properly, but a network application must be written to be as general as possible. This will let you use the finished program no matter what the eventual configuration of the network, and no matter where the system files, file systems, and devices such as printers actually reside.

**Far Out, LAN**

The TCP/IP protocols are common because, like so many other standards, they were developed for the U.S. government. They have been implemented on many operating systems besides Unix and are themselves the basis for a number of other networking innovations (e.g., NFS), which also transcend operating systems. TCP/IP is not bound to Ethernet; it can also be found on Token Ring,
StarLAN, ARCnet, and X.25 networks.

The converse is also true: A physical Ethernet is not limited to supporting TCP/IP protocols (as Novell users know well), and one Ethernet can run several compatible protocols at the same time.

But you don’t buy into TCP/IP just because you like the acronym. At the very least, most TCP/IP implementations provide a set of basic applications, including telnet, E-mail, and ftp (file transfer protocol). Telnet lets you connect to another machine on the network as if you were logged on directly. The basic concept is similar to dialing up another computer by way of ou, except that there are no modems, dialing delays, or phone charges (past whatever you’re already paying to be on the network). You’re just there.

The ftp program gives you the ability to transfer files between your local machine (the one you’re really logged onto) and a remote machine (any other one on the network). And these files transfer at very high speeds: You move megabytes in just a few seconds. With hundreds of thousands of computers on the Internet, it’s easy to see why this is a simple, yet powerful, tool. It’s even more interesting when you remember that large numbers of these machines aren’t running Unix. TCP/IP is surely the common denominator of the network world.

You’ve probably heard the term “anonymous ftp”: it’s similar to setting up a number of files in your /usr/spool/uuupload directory and letting anyone log on via UUCP to copy them. Unix systems doing the same on the Internet will put their files in the /usr/ftp/pub directory, advertise that fact and their network address, and let anyone log on under the name “anonymous.”

Unix systems running TCP/IP generally have many remote utilities, most developed at the University of California at Berkeley, that can be used only between Unix systems. For instance, rlogin lets you log onto another Unix machine, rep copies files from one system to another, and rsh lets you run programs on another machine. While these are analogous to the BNU utilities ou, uucp; and uux, don’t forget: They can execute almost instantaneously on machines thousands of miles away. Naturally, to use any of these programs, you must have the
PC Diagnostics • Preventative Maintenance • Benchmark Testing • Performance Enhancement

THE 5 MINUTE SOLUTION TO FLOPPY DRIVE FAILURE

With Align-II™ you can clean, diagnose, and align your floppy drives in minutes without a scope. Patented technology requires only a screwdriver to perform ANSI-accurate alignments (±.3 milli.).

Align-II™ is ideal for corporate users with 2 or more PCs because it includes a "GOLD STANDARD" feature so you can align all your PCs to the same in-house standard, guaranteeing that all your floppy drives are perfectly interchangeable between PCs.

80% of all floppy drive failures can be fixed with Align-II™, so don't replace your drive, save time and money instead.

Includes dual size floppy, (both high and low density) and no-mess pre-lubricated cleaning diskettes (both sizes) good for 200 uses. Replacements and single drive kits also available.

Regularly $249 (single size $149) BYT Special, SAVE $$$ CALL NOW.

“KickStart 2 system diagnostics board helps users check out virtually every aspect of a PC's hardware system... the board is a worthy investment for computer maintenance.” —David Cliburne, PC Week — December 24, 1990.

HARD CORE TESTING FOR PROFESSIONALS

Landmark/Superoft Service Diagnostics™ is ideal for professionals requiring the most exhaustive diagnostic test capabilities. Each module is CPU specific, including PC, XT, AT, 386/486, and PS/2. Since 1981 major manufacturers like Wang, Xerox, Prime, Sony, DEC, NEC, and NCR have relied on Service Diagnostics to tackle their toughest operating problems.

Intended for professional service and repair technicians, Service Diagnostics is also easy to use for the novice. Clear, concise on-line help and intuitive menus make finding system problems a breeze. Tests all CPUs, math chips, all floppy, fixed and non-standard disk drives, standard/non-standard printers, system board, video, and all keyboards. Utilities include low-level reformat, log bad sectors, edit bad sector tables; the partition editor allows you to set up multiple partitions, backup program transfers hard disk image on formatted floppy and allows for restore after reformat.

Ideal for UNIX and other operating systems, the self-booting version doesn't require DOS. The manual offers troubleshooting tips to the component level. Also available in a complete Kit including: all CPU specific software, dual size floppy alignment software (see Align-II™), and PCXT & AT ROM POSTs. Winner of the PC Magazine Editor's Choice Award in August 1990.

“SuperSoft's Service Diagnostics: The Kit is a technicians dream, with all the tools necessary to accurately analyze all phases of computer operation...it is well worth its performance potential.” —Bill O'Brien, PC Magazine — August, 1990.

CALL (800) 683-6866

International use FAX (813) 443-6603 Voice (813) 443-1331 Visa + MC + Amex + CODs Accepted • Dealer Inquiries Welcome

Circle 304 on Inquiry Card.
Imagine your bar code reader being dropped or run over by a fork-lift ... no one can afford the loss of valuable data or equipment. That is why ruggedness and durability are the most critical features when selecting a portable bar code reader.

If your bar code reader will not pass these tests, you should consider the new DuraWand. Made with a tough metal case, the portable, compact DuraWand meets the demands of any harsh environment, whether it is a manufacturing plant, warehouse or office.

The DuraWand features replaceable rechargeable AAA batteries and a protective scan tip. Special optical circuitry allows you to scan bar codes anywhere, even in direct sunlight! Add a key ring, a leather case, a sapphire scan tip or infrared optics to customize the DuraWand for your specific needs. The single or multiple Recharger/Downloader Stations can link together, supporting a number of DuraWands at one location.

To find out more about DuraWand and our complete line of bar code products call Videx today at 503-758-0521 for your free information kit.
My son just turned two, and I'll bet that he'll never know what a modem was.

appropriate permission and, generally, a log-in on the remote machine.

You can even use a standard serial port or modem to dial into many TCP/IP installations via Serial Line Internet Protocol. This gives you access to both telnet and ftp, without having to carry a coaxial cable wherever you go.

Blazing Packets
At the low end, the ubiquitous Ethernet runs at 10 megabits per second. The high-speed fiber-optic link, FDDI, is rated at up to 100 Mbps. Technology has been moving so fast that it almost doesn't pay to research new methods between these two speeds, since the object is simply to go as fast as possible.

Physically, a LAN running on Ethernet is usually implemented via coaxial cable in one of two thicknesses (the thinner one is often called Cheaperernet). Hooking up outside a single building is accomplished by coaxial cable or microwave links, and it can be done by regular radio as well. For longer distances, leased telephone lines are generally used, ranging from the well-known 9600 bps to the T1 line at 1.544 Mbps and the T3 line at 45 Mbps. It's clear that various physical constraints (not the least of which is money) can affect the speed of data transmission.

Broadband ISDN is what the future will hold. It will put everyone's communications on high-speed digital links that will carry voice, video, and data simultaneously. (see the text box "On the Threshold of a Dream" on page 234 of the June 1990 BYTE). When will this happen? Not tomorrow, but my son just turned two, and I'll bet he'll never know what a modem was.

How much data can realistically make it through all those layers of software? Using a bare Ethernet, the theoretical maximum for data throughput is about 1.2 megabytes per second. Once you start adding protocol layers and allowing for busy hosts, though, real-world performance can actually range anywhere from 30K bytes per second to 400K bytes per second. It's interesting to note that this compares favorably with many systems' hard disk drives. The inescapable conclusion is that your brand-new super-speed modem is already obsolete: At only 1000 or 2000 bytes per second, your modem is no match for even the most loaded-down LAN. The speed is available; perhaps it's time for you to join the modern world of networks after all.

David Fiedler has been a consultant and writer on Unix topics for over a decade and has started several Unix publications. His company, InfoPro Systems, produces corporate image and marketing videos for high-tech firms. You can reach him on BIX as "fiedler."
Smart LAN managers don't think about power protection

Their Smart-UPS™ do it for them. These high-performance Uninterruptible Power Systems end worries about lost data and crashed LANs so you can get on with your work. But if you ever want to know what kind of job they're doing, all you have to do is ask.

With a Smart-UPS and PowerChute® software, power quality can be monitored and analyzed. This provides graphic evidence of return on investment and tracks problems that usually require an electrician or expensive hardware to diagnose. An intelligent interface allows automatic shutdown of major networks, including Novell, LAN Manager, LAN Server, SCO Unix, AppleShare, and Banyan VINES.

And for sites prone to brownouts, SmartBoost™ automatically boosts low voltage without draining the Smart-UPS batteries. Other features include a battery replacement indicator to warn you before problems occur, load and volt meters, site wiring diagnostics, full-time line conditioning, and sine wave output.

With both 117V and 220/240V models, “the strongest support policies” (Infoworld), full safety approvals (UL, CSA and TUV), and a 2 year warranty, the Smart-UPS Series is clearly the smart choice in network protection. Call for your free 1991 LAN Protection Handbook.

The Best UPS for LANs
Smart-UPS 400 (11/20)

With PowerChute® for Smart-UPS software, you can monitor your site’s power quality, perform diagnostic tests from your keyboard, and even schedule boot-ups and shutdowns for your LAN.

LAN Server, SCO Unix, AppleShare, and Banyan VINES.

And for sites prone to brownouts, SmartBoost™ automatically boosts low voltage without draining the Smart-UPS batteries. Other features include a battery replacement indicator to warn you before problems occur, load and volt meters, site wiring diagnostics, full-time line conditioning, and sine wave output.

With both 117V and 220/240V models, “the strongest support policies” (Infoworld), full safety approvals (UL, CSA and TUV), and a 2 year warranty, the Smart-UPS Series is clearly the smart choice in network protection. Call for your free 1991 LAN Protection Handbook.

The Smart-UPS Series offers solutions for servers, hubs and inter-LAN hardware, CAD/CAM workstations, minicomputers and more.

American Power Conversion
800-541-8896, Dpt. A2
800-443-4519, Dpt. 8 in Canada
33-1-60078500 in Europe
External Floppy Disk Drives

I am presently using a desktop IBM PC compatible with a 5¼-inch 360K-byte floppy disk drive and a standard controller board. Because I am purchasing a Toshiba laptop, I am looking for a portable 5¼-inch floppy disk drive to install in this system. Unfortunately, I have had no success.

My plan is to use the old floppy disk drive as an external and portable drive. I would like to build a drive board to change the old internal floppy disk drive into a portable drive.

The old drive is a Sankyo model with a 34-pin flat cable connector for data and control and a 4-pin connector for a 5- and 12-volt power source. The Toshiba has a DB-25 parallel port.

Carlos Emilio Senna Delgado
Volta Redonda, Brazil

You did not mention the model of your Toshiba laptop, but I can give you information that should be valid for most Toshiba models. The parallel port can be configured as a standard parallel connector or as a floppy disk drive connection, and Toshiba does offer a 5¼-inch 360K-byte floppy disk drive that you simply plug into the reconfigured parallel port. This sounds like the easiest and most convenient solution for you. The suggested list price for the drive is $499, but you should be able to get a better price from a dealer or a mail-order house.

You could also purchase the Backpack from Micro Solutions Computer Products (815) 756-3411. The Backpack floppy disk drive will plug into any parallel port. If you need more space, you can also get a portable hard disk drive from Liberty Systems (120 Saratoga Ave., Suite 82, Santa Clara, CA 95051, (408) 983-1127). The Liberty drive also plugs into the parallel port, but it delivers 52 megabytes (50QC for $899) or 105 MB (105QC for $1199) of disk space.

If you're a die-hard do-it-yourselfer, Toshiba also sells a cable that maps the floppy disk drive/parallel connector to emulate a standard 34-pin controller-card edge connector. Therefore, you could plug your existing 5¼-inch floppy disk drive.

However, you would also have to build a power source for the floppy disk drive, because the drive's power is being supplied from your PC. For safety's sake, your power source should also include a fan. If you want to pursue this project, give Toshiba technical support a call at (714) 587-9476.—S. D.

Come On, Be a Good Sport

I bought a Zenith TurbosPort 386e several months ago at a good discount, gambling that there would be graphics support for the double-scan CGA display (640 by 400 pixels compared to the standard 640 by 200 pixels). I'm quite happy with the display for text-mode applications, but the CGA graphics are barely tolerable. My primary graphics applications are MathCAD, Smalltalk/V 286, and Windows 2.0. MathCAD's Toshiba DCGA driver doesn't quite work, but it comes close enough to indicate that DCGA graphics should be good enough for many applications.

I haven't found any drivers yet, and being overseas, I don't have access to the BBSes that appear to be the best source of device drivers. Have I lost my gamble, or can you direct me to a source for TurbosPort 386e DCGA display drivers? I'm especially interested in a Windows 3.0 screen driver.

Steven H. Rogers
APO San Francisco

Zenith is working furiously on a DCGA driver even as we speak. When it's ready, it will be available from local Zenith resellers. Simply walk into your neighborhood Zenith dealer and ask for a copy of VDDCGA.386. If they don't have it, they can get it from the dealer BBS.

Being overseas may present a logistical problem. Perhaps a friend can secure a copy for you.—H. E.

CD Search

I am looking for addresses of manufacturers of CD-ROM players and discs. Could you send me complete information?

Ferrer Fabienne
Paris, France

A good source of information on CD-ROM discs and drives is the Bureau of Electronic Publishing, 141 New Rd., Parsippany, NJ 07054, (201) 808-2700, fax (201) 808-2676. It publishes a large catalog and carries a wide selection of CD-ROMs, drives, and accessories for the PC and the Mac.

You can also contact CD-ROM drive manufacturers. Here is a selection of some companies:

Chinon America, Inc.
Information Equipment Division
660 Maple Ave.
Torrance, CA 90503
(213) 533-0274
fax: (213) 533-1727

Hitachi Sales Corp. of America
401 West Artesia Blvd.
Compton, CA 90220
(213) 537-8383

NEC Technologies, Inc.
1414 Massachusetts Ave.
Boxborough, MA 01719
(508) 264-8000
fax: (508) 264-8673

continued
In the BIX community we take care of people who use IBM PCs or their compatibles. For example, our IBM Exchange offers a growing list of programs which you can download for free. These 2,168 programs are the cream of the crop. All of them are tested in advance by BIX moderators so you know you’re getting top-quality, virus-free programs. Here are some of the most popular ones:

<table>
<thead>
<tr>
<th>BIX File Name</th>
<th>BIX Conference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>scars.zip</td>
<td>microsoft</td>
<td>Utility that turns your Windows desktop into a view of deep space. Choose impulse or warp speed and launch several Windows utilities from a floating pop-up menu.</td>
</tr>
<tr>
<td>e.arc</td>
<td>ibm.utils</td>
<td>Public-domain text editor, with source code.</td>
</tr>
<tr>
<td>secrets2.arc</td>
<td>ibm.dos</td>
<td>Condensed and edited messages from the ibm.dos/secrets topic. Tricks and undocumented internals of MS/DOS.</td>
</tr>
<tr>
<td>tetris2.zip</td>
<td>microsoft</td>
<td>KLOTZ, a Tetris™ clone for Microsoft Windows 3.</td>
</tr>
<tr>
<td>2zip25.zip</td>
<td>ibm.utils</td>
<td>Converts a variety of archive formats (including ARC, PAK, ZOO, LZH) to PKWare's ZIP format.</td>
</tr>
<tr>
<td>w3icons.zip</td>
<td>microsoft</td>
<td>40 new icons for the Windows 3 Program Manager.</td>
</tr>
<tr>
<td>firework.zip</td>
<td>microsoft</td>
<td>Fireworks display in a window, for Windows 3.</td>
</tr>
<tr>
<td>monitor.arc</td>
<td>ibm.os2</td>
<td>Continuous display of CPU load for OS/2 Presentation Manager.</td>
</tr>
<tr>
<td>abort.exe</td>
<td>ibm.utils</td>
<td>TSR that aborts any program when you press Alt-C.</td>
</tr>
</tbody>
</table>

Besides great free programs, the IBM Exchange offers dozens of informative and provocative conferences on OS/2, PC/DOS and MS/DOS operating systems, alternative 386 operating systems, utility software, communications programs, LANs and more. There’s even a “Repairshop” conference, and maybe as a last resort, an IBM clearing house. Beyond our IBM Exchange, we provide industry news and product information that’s essential to your performance as a microcomputer pro. All of these privileges are yours with a subscription to BIX. To find out more, call our special Customer Service number: 1-800-227-2983 (in NH call 603-924-7681).
Sony Corp. of America 
Component Peripheral Products Co. 
655 River Oaks Pkwy. 
San Jose, CA 95134 
(408) 432-0190 
fax: (408) 943-0740

Toshiba America Information Systems, Inc. 
Computer Systems Division 
9740 Irvine Blvd. 
Irvine, CA 92718 
(800) 334-3445 
(714) 583-3000

Sony has recently introduced its Data Discman CD-ROM player, but it is not yet available in the U.S.—S. W.

A Turn for the Durst

Although one of my hobbies is computers, I make my living in the field of photography. Computers have also invaded this area, and my company has three Durst 2501 enlargers. This model is fully computerized, and all the programming resides in a 2764-25 EPROM.

I have two questions: Can I duplicate those EPROMs? Can I modify their programs to adapt to our needs? I would much appreciate any advice you can give me about where to start looking into this matter.

Carlos Baranyai
Scarborough, Ontario, Canada

Duplicating the EPROM would be child's play for any EPROM programming device, but why would you need to? Each enlarger already has one, and I don't see any purpose in making duplicates—unless, of course, you want to modify them, but that also seems pointless. As you indicate, the 2501 is heavily computerized, and the EPROM contains all the programming for its many functions. To reprogram it, you would have to know all the ins and outs of the 2501's hardware design.

I spoke with Colenta America (Durst's distributor in the U.S.), and it suggested that if you have the HL2501AF model, you should order the HL2501AFN upgrade kit. It's Colenta's guess that your biggest complaint with your 2501 is the paper programming, and the upgrade is a big improvement.

Basically, it gives you simplified paper programming, Refrema roll paper easel support, expanded paper channels, added light output and on-line capabilities for the densitometer, a bar code reader, and the Durst Optoscan film scanner.

Before you attempt to modify your enlarger, I suggest you contact Colenta America (347 Evelyn St., Paramus, NJ 07652, (201) 265-5670). It's quite possible that there's some neat user tip that will make your enlarger do what you want without modification.—H. E.

I've Got the Jitters

My problem is a strange one. When my computer is on and any “visible” action (e.g., typing, mouse movement, screen updates, or hard disk drive activity)
is taking place, the screen is covered with jittery bands of light and dark areas. The actual computer screen is still there (and highly legible); it is just lighter and darker in those bands. The bands appear only in the parts of the screen that the computer is "using."

When I increase the brightness on the monitor, the portions of the screen that were black do not have the bands—only the portions that were "colored." For example, in a word processor with white letters and a black background, I can't see the bands unless I look very carefully. Only the letters are affected, not the black background. When no input is taking place, the screen has much less activity. But smaller bands still seem to creep up the screen, much like a TV that is not quite tuned.

This just started happening today, and I can't figure it out. It happens in Windows, out of Windows, with everything attached, with only the bare minimum attached, and so forth. I can't remember any significant event that triggered it, either.

Chris Hecker
New York, NY

Based on what you've described, your first step should be to isolate the problem to your video card, monitor, or cable. My guess is that the problem is in your monitor. If you have a friend with a computer whose monitor and adapter card are compatible with yours, see if you can do a quick swap for a few minutes so you can determine the culprit.

If it's your cable, get a replacement. If it's your video card, perhaps reseating any socketed chips and cleaning the edge connector might solve it. If it's your monitor, unless you're qualified to go digging around inside high-voltage electronics, I'd recommend that you take it to your nearest computer store to have it serviced.—R. G.

You're Not Alone

I write in response to Dennis C. Kornbluh's letter in the October 1990 Ask BYTE. I, too, have a Conner drive that occasionally hangs while performing I/O. It happens when reading or writing large files (e.g., loading Windows 3.0). The drive activity light stops flickering and remains solidly lit. The drive will occasionally complete its operation after several seconds, but about 75 percent of the time it remains hung. At this point, toggling the CPU speed rapidly between 12 and 25 MHz will sometimes cause the drive to continue normally.

There is never any indication of an error; either the operation completes, or it hangs longer than 3 minutes (the extent of my patience). I can duplicate this problem whether the computer is warm or cold, shadow RAM is enabled or disabled, or PCTools' Mirror and PC-Cache are loaded or not. All connections are tight.

The above suggests that Mr. Kornbluh is not alone, and that the problem is not one of the ones you suggested. I am also writing to Conner and DTK (the manufacturer of my motherboard) to see if they have any suggestions.

Bjarne Hansen
APO New York

Good luck, and keep us posted.—Staff •
Preview the latest software instantly through BYTE DEMOLINK — It's easy, all you need to access BYTE DEMOLINK is a PC, a modem and a telecommunications program and the latest demo software is at your fingertips!

Software Available on DEMOLINK:

- **ASQ**
  Memory manager freeware from Qualitas.
  Select the file ASQ.exe

- **BYTE Information Exchange**
  Sample the on-line service for people who know computers. The demo includes interaction from conferences and a sample of BIX's electronic mail system.
  Select the file blsdemo.exe

- **C++/Views**
  An object-oriented development environment for MS DOS Windows 3.0 based on C++. Includes over 75 C++ classes (with complete source) and development tools such as class browser, dialog code generator and class documenation.
  Select the file cview.exe

- **CommonView 2**
  Illustrator Diskette
  Gluck's powerful CommonView 2 + + application framework for quick development of applications portable between Microsoft Windows, Presentation Manager, OS/2 and HP New Wave.
  Select the file cvview2.exe

- **C-scape**
  C-scape is a programming tool for C programmers. It is powerful, object-oriented interface management system that includes a function library and a screen designer. The C-scape library is an extensive collection of functions for working with windows, data entry screens, input validation, menus, text editing and hypertext context-sensitive help.
  Select the file cscsape.exe

- **DR. Switch-ASE**
  Turn any dBASE program into a RAM resident dBASE program (TSRa). Works with Clipper 87/5.0, dBASE III PLuS, dBASE IV, FoxBASE and FoxPro. Gives you hot key access to any dBASE application form and graphics or text-based programs.
  Select the file switchase.exe

- **GeoWorks Ensemble**
  The PC/GEOs operating system provides a graphical user interface that runs efficiently on all levels of PCs. Features include preemptive multitasking and multithreading, the Motif compliant user interface, a single imaging model for use with WYSIWYG and superior printing, pull-down, tear-off menus, cut, copy and paste between applications, and use of expanded and extended memory.
  Select the file geodemo.exe

- **Look & FeelScreen Designer**
  An interactive screen editor that generates C source code for the screens or saves them in a file callable at runtime.
  Select the file infldem.exe

- **Lotus Magellan 2.0**
  Let you find, view, and use all the information on your PC. You can view files as they appear in your favorite program.
  Select the file magellan.exe

- **Quattro Pro 2.0**
  Borland's powerful spreadsheet with features including flexible 3D consolidation, macro building and debugging. Full mouse support, pull-down menus, 132 character-wide display, and 32-resizable windows provide modern user interface.
  Select the file quattro.exe

- **Nemesis Go Master**
  Go is an easy-to-learn strategy game which is the national game of Japan. Go is considered a philosophical and analytical tool, in addition to being an addictive game.
  Select the file gomaster.exe

- **Nemesis Go Junior**
  Ideal for novices and Go Master is intended for the serious Go student.
  Select the file gomaster.exe

- **Instant Replay Professional**
  Builds tutorials and demonstrations including graphics, animation, sound, and even interactive video. Replay sequences from application programs enhanced with pop-up notes.
  Select the file replay.exe

- **KnowledgeSEEKER**
  Combines artificial intelligence with statistical analysis techniques to link directly into dBASE, spreadsheet or ASCII files, turning data into information.
  Select the file knowledge.exe

- **Zortech C++**
  Zortech's multi-platform C++ compiler provides all the benefits of industrial strength C++ with the speed and code size you would expect from the best C compilers. Only Zortech can give you total portability to MS DOS, Windows 3.0, OS/2, DOS 386 and Macintosh.
  Select the file zortech.exe

Be the first to evaluate the latest software for just the cost of a phone call! To connect with BYTE DEMOLINK, call the office nearest you today!
SmartLynx-MC

Intelligent Eight Port RS 232 Micro Channel Adapter for PS/2 Systems and Compatibles.

Supports AIX, UNIX, XENIX, QNX PC-MOS and DOS.

Call for Special Introductory Offer
1-800-553-1170

Circle 240 on Inquiry Card.

Eight Serial Ports One Board

Quatech's ES-100 provides eight RS/232 serial ports in a single AT slot. RJ-11 modular connectors. 16450 UARTS are standard. Optional buffered 16550 UARTS, PC-AT, ISA, or EISA compatible. Priced below $500! Quantity Pricing Available!

Call for our PC Interface Handbook:
1-800-553-1170

662 Wolf Ledges Parkway
Akron, OH 44311

PC-AT is a trademark or registered trademark of IBM Corp.

Circle 241 on Inquiry Card.

RS-422/RS-485 Boards for AT, Micro Channel

RS-422/RS-485 asynchronous serial communication boards from Quatech available in 1 to 4 ports for PC-AT and compatibles and 1 to 4 ports for PS/2 Micro Channel.

Call for our free PC Interface Handbook:
1-800-553-1170

662 Wolf Ledges Parkway
Akron, OH 44311

PC-AT, Micro Channel, and PS/2 are trademarks or registered trademarks of IBM Corp.

Circle 242 on Inquiry Card.

Synchronous Communication Boards for AT

Quatech synchronous/asynchronous serial boards for PC-AT and compatibles support RS-232, RS-422, and RS-485 communication.

Call for our free PC Interface Handbook:
1-800-553-1170

662 Wolf Ledges Parkway
Akron, OH 44311

PC-AT and PC are registered trademarks of IBM Corp.

Circle 243 on Inquiry Card.

Communications Data Acquisition

"PC-AT (ISA) Interfaces"

"PS/2 Micro Channel Interfaces"

Phone: (216) 434-3154 • FAX: (216) 434-1409
TELEX: 510.MII-2726

PC-AT, PS/2 and Micro Channel are registered trademarks of IBM Corporation.

Circle 244 on Inquiry Card.

Digital I/O Board

Single-slot Quatech PXB-721 for PC-AT has 72 digital I/O lines. Connect three choices of data acquisition modules. Supports LabTech Notebook™

Call for our free PC Interface Handbook:
1-800-553-1170

662 Wolf Ledges Parkway
Akron, OH 44311

LabTech Notebook is a trademark of Laboratories Technologies Corp.

Circle 245 on Inquiry Card.

PXB-160 16-BIT TRUE PARALLEL DIGITAL I/O

- Two eight bit ports
- Latched I/O
- DMA and I/O Modes
- Handshakes for 16 Bit I/O Transfer
- Programmable timer for Interrupt or DMA Transfer
- External interrupt and data transfer request inputs
- List Price Below $400.00

Call the Order Line
1-800-553-1170

662 Wolf Ledges Parkway
Akron, OH 44311

Circle 246 on Inquiry Card.

2 parallel, 2 serial, 1 board

Quatech DSDP-402 for PC-AT has two parallel ports, and two serial ports for any combination of RS-232, 422, and 485 communication. DSDP-100, two parallel and two RS-232 ports, available at lower cost.

For order info, call:
1-800-553-1170

662 Wolf Ledges Parkway
Akron, OH 44311

Circle 247 on Inquiry Card.

Wave Form 20MHz - 32K $1290

The WSB-100 Wave Form Synthesizer Board from Quatech has the best set of numbers in the market. With speed to 20MHz and a 32K memory at $1290, it's making waves in more ways than one. The WSB-100 is also a star performer as a digital pulse/word generator with the optional digital module.

Call for our free PC Interface Handbook
1-800-553-1170

662 Wolf Ledges Parkway
Akron, OH 44311

Circle 248 on Inquiry Card.
JDR Microdevices

Experience the JDR Difference:
- 30-day Money Back Guarantee
- 1-Year Warranty on Every Product
- Toll-free Ordering and Support
JDR offers quality products at competitive prices. Our new 100-page catalog has thousands of PC products, from motherboards, monitors and cases to drives, controllers, integrated circuits, cables and connectors. Developers will find a selection of test equipment, programmers and prototyping products. Buy with confidence from JDR!

1-800-538-5000
Mention Key #1090

Annabooks

Send for Annabooks' free catalog of PC-compatible engineering products.
The newest publication, "AT Bus Design," has the official timing information for the AT bus and the 8- and 16-bit parts of the EISA bus. Over 200 pages and 100 diagrams. Author is member of IEEE 996. Available now for $69.95. VISA, MC, Amex, COD, P.O.S. OK.
Annabooks, 12145 Alta Carmel Ct. #250, San Diego CA 92128
1-800-462-1042 FAX 619-592-0061

B&B Electronics Catalog

We help you solve RS-232 problems.
Pre- and post-sale technical support. Most items shipped within 24 hours. Direct from manufacturer to you. Money-back guarantee.
Contact us for custom designs also. B & B Electronics Mfg. Co., 40301 Baker Road, PO Box 1040, Ottawa, IL 61350.
1-815-439-4091 FAX 216-439-4093

Intel Development Tools

Choosing the right architecture for your embedded design is one of the most important decisions you face today. For successful embedded microcontroller development, Intel offers you a complete line of emulators, compilers, debuggers and much more for the MCS-51, MCS-96, 1960TM, x86, Intel16TM and Intel486TM families of Intel architectures.
Call or write us for your free copy of our Development Tools Catalog.
Intel Corporation, Development Tools, 5200 N.E. Elam Young Parkway, JF1-13, Hillsboro, OR 97124.
1-800-874-6833 or FAX 503-696-4633

Specialized Products Co.

Electronic tools and test equipment
Color, illustrated 250-page catalog details comprehensive selection of tool kits, test equipment, telecom equipment and datacommunication products. Special emphasis on in-house and field service. Indexed catalog shows digital multimeters, breakout boxes, oscilloscopes, BERT testers, hand tools and extensive selection of instrument and shipping cases, plus over 50 standard tool kits. Complete specifications and prices are provided for all products.
Specialized Products Company, 3131 Premier Drive, Irving, TX 75063 USA 214-550-1923 FAX 214-550-1386

National Instruments

Free 480-page full-color catalog describing instrumentation hardware and software products for personal computers and workstations. Application software for data analysis and presentation and for collecting data using instruments and plug-in boards. Features GPIB interfaces, data acquisition and DSP boards, driver level software, signal conditioning and VXI controllers.
1-512-794-0100 Fax 512-794-8411

Best Power Technology, Inc.

FREE, money-saving literature tells you how to protect your computer from power problems such as surges, sags, spikes, noise, brownouts, blackouts and lightning. These power problems can damage delicate equipment and cause loss of valuable data. Learn how Best Power Technology's uninterruptible power systems, ranging from 300 VA to 18 KVA, can protect your computer. Contact: Best Power Technology, Inc., P.O. Box 280, Necedah, WI 54646.
1-608-565-7200, ext. 2179 Toll-free 1-800-356-5794, ext. 2179

Iotech

Free 112-page catalog features comprehensive line of IEEE 488 interfaces, data acquisition instruments, support products, analog and digital I/O converters, and software for test and measurement, research and development, quality assurance, and production applications.
To discuss your application with an engineer and receive more information on our product line, call or fax today!
216-439-4091 FAX 216-439-4093

Showcase

CALL TO ACTION

Best Power Technology, Inc.
FREE, money-saving literature tells you how to protect your computer from power problems such as surges, sags, spikes, noise, brownouts, blackouts and lightning. These power problems can damage delicate equipment and cause loss of valuable data. Learn how Best Power Technology's uninterruptible power systems, ranging from 300 VA to 18 KVA, can protect your computer. Contact: Best Power Technology, Inc., P.O. Box 280, Necedah, WI 54646.
1-608-565-7200, ext. 2179 Toll-free 1-800-356-5794, ext. 2179

Iotech

Free 112-page catalog features comprehensive line of IEEE 488 interfaces, data acquisition instruments, support products, analog and digital I/O converters, and software for test and measurement, research and development, quality assurance, and production applications.
To discuss your application with an engineer and receive more information on our product line, call or fax today!
216-439-4091 FAX 216-439-4093

Specialized Products Co.

Electronic tools and test equipment
Color, illustrated 250-page catalog details comprehensive selection of tool kits, test equipment, telecom equipment and datacommunication products. Special emphasis on in-house and field service. Indexed catalog shows digital multimeters, breakout boxes, oscilloscopes, BERT testers, hand tools and extensive selection of instrument and shipping cases, plus over 50 standard tool kits. Complete specifications and prices are provided for all products.
Specialized Products Company, 3131 Premier Drive, Irving, TX 75063 USA 214-550-1923 FAX 214-550-1386
THE BUYER'S MART

A DIRECTORY OF PRODUCTS AND SERVICES

THE BUYER’S MART is a monthly advertising section which enables readers to easily locate suppliers by product category. As a unique feature, each BUYER’S MART ad includes a Reader Service number to assist interested readers in requesting information from participating advertisers.


RATES: 1 issue—$600. 2 issues—$625. 6 issues—$600. 12 issues—$525.

Prepayment must accompany each insertion. VISA/MC Accepted.

AD FORMAT: Each ad will be designed and typeset by BYTE. Advertisers must furnish typewritten copy. Ads can include headline (23 characters maximum), descriptive text (250 characters is recommended, but up to 350 characters can be accommodated), plus company name, address and telephone number. Do not send logos or camera-ready artwork.

DEADLINE: Ad copy is due approximately 2 months prior to issue date. For example, November issue closes on September 8. Send your copy and payment to THE BUYER’S MART, BYTE Magazine, 1 Phoenix Mill Lane, Peterborough, NH 03458. For more information call Joseph Mabe at 603-924-2656. FAX: 603-924-2683.

ACADEMIC COMPUTING

Transputer Education Kit

For the student, Professional or hobbyist.

Introductory price: $346.

Includes hands-on use PC, edn. tests with 32-bit 32K-1000 transputers. Int. of Hopf, PC interface (PC, XT, 386 compatibility), and in 8-bit parallel VDU port (for optional hardware experiments). Also includes: Occam and C compilers (and assembly), forms, example, and diagnostic programs; and 1000 pages of documentation (including schematics). Can be used with other kit boards or with less expensive AI-On-Processor boards.

Computer System Architects

Inquiry 701.

Inquiry 702.

RADIOACTIVE?


Tel/Fax: (302) 655-3800

Aeware Electronics Corp.

PG. Box 4299, Wilmington, DE 19807 $149.50

LABELING SOFTWARE

On EPSON, IBM, OKI dot matrix or LaserJet. Flexible design on one easy screen. Any font size. Up to 120 fields/label. 18 text sizes to 3"/readable 100% at 100, MICRO, MINI, 2 of 5, etc. UP/DOWN, CODE 39, Rile Input & Scanned logon/username (P&X) — $279. Other programs from $49. 30-day $5 back.

Worthington Data Solutions

417A Ingalls St., Santa Cruz, CA 95060

(408) 458-9338 (800) 345-4220

BAR CODE PRINTING SOFTWARE

• MS/DOS SYSTEMS
• 9 & 24 PIN DOT MATRIX
• H-P LASER JETPLUS/SEries II
• MENU-DRIVEN OR MEMORY RESIDENT
• CODE 39, 1 2 5, UPC A/E, EAN 813
• BIG TEXT & BAR CODE SCFTTONS

AMERICAN MICROSYSTEMS

210 A Regal Parkway, Eudale, CA 91304

(800) 668-4452 (817) 571-6015 FAX (817) 685-4237

PORTABLE READER

Battery-operated, handheld reader with 84K static RAM, 32x16 LCD display, 32-key keyboard, Real-Time Clock. Wand or laser scanner. Program prompts and data checking through its own keyboard. Easy data transfer by RS-232 port or PC, PS2 keyboard. Doubles as On-Line Reader. 30-day $5 back.

Worthington Data Solutions

417A Ingalls St., Santa Cruz, CA 95060

(408) 458-9338 (800) 345-4220

PC-Wand Bar Code Solutions

Bar codes are easy using our FULL lines of readers & printers. They plug & play with your existing CUPS/terminal/terminal software systems in your office, store, truck, factory or warehouse. 105° bar code DDS programs print on matrix or laser printers. 30 day return, 1 year warranty. DATAWARE/Dealer discounts.

International Technologies & Systems Corp.

605-5 North Barry St., Brea, CA 92620-Western USA

13 Wehyn Court, Richmond, VA 23229-Eastern USA

(800)232-4447 (714)990-1880 (604)415-8733 (FAX)9900-850

5YR. WARRANTY AT PERCON

PERCON decoder are now covered by a five-year limited warranty. That means you won't spend one cent replacing your PERCON bar code decoder for five full years. That's reliability you can count on.

PERCON

1710 Willow Creek Circle, Eugene, OR 97402-9153

Phone: (503) 873-7266 FAX: (503) 344-1399

JUNE 1991 • BYTE 377
Inquiry 713.

BAR CODE

PC BAR CODE SPECIALISTS
Bar code readers designed for fast, reliable, cost-effective data entry. They emulate your keyboard, so scanned data looks just like it was typed in. Choose from stainless steel wand, laser gun, card slot reader, and magnetic stripe scanner. Also, powerful Bar Code and Test printing software. Great warranty. Generous dealer discounts.

Seagull Scientific Systems
15/17 N.E. 24th, Suite 373, Redmond, WA 98052
206-451-8956

BAR CODE READERS

Among the best and most widely used bar code decoders. Reads all major codes (93, 1/2, S, 2/5, UPC/EAN, CODABAR, MSI). Connects between keyboard and system. IBM, PS/2, Mac, DECVT compatible. CS & software independent. Same day ship. 2 Year Warranty (pen incl). Large Reseller Solutions

Large Solutions Engineering
4047 Tulip, Suite 100, McLean, VA 22101
(800) 635-6533
(301) 652-2738

DATA INPUT DEVICES

BAR CODE READERS DELIVER
WAND/LASER/MAGNETIC CARD CONNECTIVITY
- Keyboard models (w/keyboard) for IBM PC/XT/AT, PS/2 and portables.
- RS232 w/keyboard models for IBM compatible terminals.
- Bar code and label printing software.
- Full two-year warranty.
- 30-Day Money-Back Guarantee
- Extensive WAR/Del/Dealer Discount.

TPS Electronics
4047 Raphael, Suite 100, McLean, VA 22101
415-856-6833 Telex 371-9097 TPS PLA
1-800-526-5620 FAX: 415-856-3843

Inquiry 710.

VARIANT MICROSYSYTEM

BAR CODE READERS

The Global Computer Business BBS At last! Answ ers to the biggest buying & selling hitches in the computer industry. Product tech & info for buyers, sellers & users, buy & sell online, search & ask fast friendly DBA. Email, 56K X 256 telecon's, 9600, 115200 bps, SHAREWARE, & more! Call your phone # for your local TUNNET access no. or call for a brochure.

England (44) 71 224-9990 Fax (44) 71 706 0536

Inquiry 711.

BBS

CAD/CAM

STEPPER MOTOR CONTROL
FROM A PRINTER PORT!

NEW

INDEXED LPT software VERSION 2.0 $249 VISAMC

- Controls up to six motors simultaneously
- Linear and Circular interpolation
- New features include: 3D machine control,
  Easy-to-use DOS device driver. Super Manual.
- CAD/CAM interface available.

Ability Systems Corporation
W. 22nd Ave, Box 1373, Sonoma, CA 95476
(209) 657-7851

Inquiry 714.

If you've been muttering...

DXF SUX... here's the solution!
The "CAD/CAM Developer's DXF" has all the C Functions you need for programs that read and write DXF files.

CALL (617) 628-5217 FOR INFO

Building Block Software, PO Box 1373, Sonoma, CA 95476

Inquiry 715.

STOP... spending your time on math code!
The "CAD/CAM Developer's KG" series has all the 2D and 3D functions that you need for CAD/CAM applications. I... L... display... lines, arcs, ellipses, NURB splines... and much more!

CALL (617) 628-5217 FOR INFO

Building Block Software, PO Box 1373, Sonoma, CA 95476

Inquiry 716.

DRAFTeasy • ONLY $399

- Professional 3D CAD software
- "Common-sense" menus • Unmatched ease of use • Written in Assembly • Very fast and compact • Powerful features only rivaled by software costing $1000's • DXF compatible • Programmer's user interface for BASIC, Pascal and C • "TRY IT FOR ONLY $19" • Manual, tutorial, and working copy (SYS/PL0T disabled) provided

COMPUTERS ETC.

4640 Chippewa Place, Suite 204, St. Louis, MO 63118
Phone: 314-351-2513 FAX: 314-351-7256

Inquiry 717.

CD-ROM

IC ROM, Inc.

CD-ROM. VCD-ROM. VOLS. MAGNETIC OPTICAL DRIVES. CD-ROM DISKS FOR IBM AND MAC. OPTICAL CONSULTING SERVICES • PUBLISHING • DISTRIBUTION • NETWORKING QUALITY PRODUCTS AND SERVICES AT COMPETITIVE PRICES FREE CARDS

TEL. 303-231-9373
1667 COLU BLD. SUITE 400, DENVER, CO 80205
FAX: 303-231-9581, CTS: 73007,544

Inquiry 718.

NIMBUS

your complete source for CD-ROM implementation including disc replication, search and retrieval software and application design. Find out just how easy it is to put your data into the media of the '90s

Nimbus Information Systems
1-800-985-1100
Box 7427, Charleston, WV 25306

Inquiry 719.

COMMUNICATIONS

SDLC OR X.25 SUPPORT

Use Sangoma hardware and software to provide cost effective, robust and easy-to-use SDLC or X.25 links from MS-DOS, UNIX, PC-M0S, etc. All real time communication functions performed by intelligent co-processor card.

Full function SNA emulation packages also available.

Sangoma Technologies Inc.
(416) 474-1990

Inquiry 720.

COMPUTER INSURANCE

INSURES YOUR COMPUTER

SAFEWARE Computerowners coverage provides replacement of hardware, media and purchased software. As little as $49 a year covers accidents, theft, power surges and more. One call does it all. Call 9 am-10 pm ET. (Sat. 9 to 6)

TOLL FREE 1-800-848-3469
(614-262-0590)
SAFEWARE, The Insurance Agency Inc.

Inquiry 721.

CROSS ASSEMBLERS

CROSS ASSEMBLERS

Universal Linker, Librarian

Targets for 42 Microprocessors

HOSTS: MS-DOS, UNIX, VAX VMS

ENERTEC, INC.

BOX 1312, 811 W. FIEL St.
Lansdale, PA 19446
Tel: 215-362-2096 Fax: 215-362-2404

Inquiry 722.

CROSS ASSEMBLERS/SIMULATORS

New unique full-function simulators for the 6809 and 80C196 controllers, featuring ALL MODES of interrupts. Plus the HSI, 16C548, and 40 pins. Cross Assemblies and Simulators.

Lear Com Company

2440 Kings St., Ste. 206, Lakewood, CO 80215
(303) 232-2226 FAX: (303) 232-8721

Inquiry 723.

CROSS DISASSEMBLERS

PROFESSIONAL PC SOFTWARE

NEW: SPARC CROSS-DISASSEMBLER
- ANALYTIC CROSS-DISASSEMBLERS WAUTO LABEL GENERATION
- RELOCATE MACRO CROSS-DISASSEMBLERS
- SUPPORT FOR 80486, 80486EX, 80386, 80386EX, 80286, 80286EX, 8086, 8086EX, 8088, 8088EX, 8086EX, 8086EX, 8086EX, 8086EX
- SOURCE TO SOURCE TRANSLATION UTILITIES
- ORDER TODAY: (408) 773-8465

LOGISYS

PO BOX 5192, SUNNYVALE, CA 94086
FAX: (408) 837-9686

Inquiry 724.

DATA RECOVERY

CRASHED?

Keeping your business on its feet!

ONTRACK DATA RECOVERY, INC.

612-937-5161 • 1-800-872-2599

Inquiry 725.

DRASHO

Your valuable data can be recovered!
- 95% success rate • Fast turnaround
- Priority service available • Limited recovery, DOS, Macintosh, Unix, OS/2, Bernoulli and more

Inquiry 726.
**PROGRAMMERS TOOLS**

**HYPERINTERFACE™ II**
Menu Creator™ — An interactive WYSIWYG editor to generate a menu-driven user interface for your software. 
Screen Creator™ — An interactive WYSIWYG editor for quick and easy screen design and a screen database manager for your software. Advanced Library — Extended capability for data entry into your programs. FORTRAN, Pascal, C, BASIC supported.

**Avanpro Corp.**
PO Box 109, Pacific Palisades, CA 90272
(213) 454-3666

**SECURITY**

**FIGHT PIRACY!**
Since 1988, companies worldwide have been choosing Az-Tech security products. If you demand the strongest protection available, why not choose one of these leaders? 
**COMPUTER SECURITY**
- EVERTRAK Software Security
- EVERTRAK Hardware/Software Security
For IBM and Compaq, 30 day money back guarantee. Free info and demo.

Az-Tech Software, Inc. 305 East Franklin, Richmond, VA 23230
(800) 227-0644 Fax: (818) 776-8398

**SHAREWARE**

**FREE SOFTWARE FOR IBM®/clones**
Monthly, get 5 disks with 10+ latest programs plus catalog—FREE! Pay only $500 for $5.25 or $6.95 for 3.5" disks. Join today for only $19.95 membership fee and get your first volume of software—FREE!

SOFTWARE OF THE MONTH CLUB®
619-931-8111

**SOFTWARE/ACCOUNTING**

**Solomon III Software**
Integrated Accounting Software
Top rated last 6 years
No down time — No lost data
Unmatched Security System
Major Account discounts available

Can Debra J. Tucker
National Training Sol III Training
4420 Hotel Circle Dr. #30, San Diego CA 92120
(619) 224-9191 Fax: 619-229-6165

**SOFTWARE/BUSINESS**

**Network Multi User**

IDEA Computers, Inc. (Since 1982)
300 Jackson Street, Richmond, VA 23249
(703) 342-5848

**UNIX SOFTWARE**

**GNU, X Windows & More!**
Search our on-line catalog of Unix public domain software using keywords to find what you want quickly. Place your order on-line, and it is shipped to you on either Unix or DOS media—no costly downloading time. Just $2/MB for tapes ($75 minimum order) or $75/MB for floppies (minimum $65)

**SOFTPRO™ (818) 784-2070**
(500, 1200, 2400 baud; 8 bits; 1 stop bit; no parity)

**UNIX SOFTWARE**

**GNU, X Windows & More!**
Search our on-line catalog of Unix public domain software using keywords to find what you want quickly. Place your order on-line, and it is shipped to you on either Unix or DOS media—no costly downloading time. Just $2/MB for tapes ($75 minimum order) or $75/MB for floppies (minimum $65)

**SOFTPRO™ (818) 784-2070**
(500, 1200, 2400 baud; 8 bits; 1 stop bit; no parity)

**PUBLIC DOMAIN**

**FREE SOFTWARE FOR IBM®/clones**
TRY USI GET 15.25" or 60.5" Diski full of our best selling software—FREE. Great games, utilities, business, educational, and desktop publishing, plus our 3000 disk catalog. Pay only $5.00 shipping/handling.

INTERNATIONAL SOFTWARE LIBRARY
619-931-8111

**FREE CATALOG**
FOR IBM PD AND SHAREWARE SELECTED PROGRAMS
LATEST VERSIONS
as $1.50

**SOFTWARESHOPPE, INC.**
TEL: 800-829-2378 + 513-761-7638
FAX: 513-761-7639
P.O. Box 3678, ANN ARBOR, MI 48106

**SECURITY**

**SHAREWARE**

**FREE SOFTWARE FOR IBM®/clones**
Monthly, get 5 disks with 10+ latest programs plus catalog—FREE! Pay only $500 for 5.25" or $6.95 for 3.5" disks. Join today for only $19.95 membership fee and get your first volume of software—FREE!

SOFTWARE OF THE MONTH CLUB®
619-931-8111

**SOFTWARE/ACCOUNTING**

**Solomon III Software**
Integrated Accounting Software
Top rated last 6 years
No down time — No lost data
Unmatched Security System
Major Account discounts available

Can Debra J. Tucker
National Training Sol III Training
4420 Hotel Circle Dr. #30, San Diego CA 92120
(619) 224-9191 Fax: 619-229-6165

**SOFTWARE/BUSINESS**

**Network Multi User**

IDEA Computers, Inc. (Since 1982)
300 Jackson Street, Richmond, VA 23249
(703) 342-5848

**UNIX SOFTWARE**

**GNU, X Windows & More!**
Search our on-line catalog of Unix public domain software using keywords to find what you want quickly. Place your order on-line, and it is shipped to you on either Unix or DOS media—no costly downloading time. Just $2/MB for tapes ($75 minimum order) or $75/MB for floppies (minimum $65)

**SOFTPRO™ (818) 784-2070**
(500, 1200, 2400 baud; 8 bits; 1 stop bit; no parity)
SOFTWARE/ENGINEERING

**MATFOR**

**BEST VALUE FOR NUMERICAL COMPUTING**

An interpreter with a comprehensive set of functions for Applied Mathematics, Engineering, Analysis, Statistics, and Graphics. IEEE Software says that there is clearly significant scientific work embodied in the interpreter—the program is no lightweight. Use as a risk-free under 30-day unconditional guarantee. Lowest priced mathematical toolboxes. From $150. Protected Modes versions also available.

Computational Engineering Associates
3525 Del Mar Heights Road, Suite 183, San Diego CA 92130
(619) 259-8853

Inquiry 776.

SOFTWARE/GRAPHICS

**The Ultimate CAD/CAM Engine**

TurboGeometry Library 3.0. The most complete tool box of 2D & 3D routines available today! Over 300 routines. Surfacing, Solids, Hidden line, Volumes, Areas, Transforms, Perspectives, Decomp, Clipping, Tensors & more. 30 day guest, $19955 w/out S/W licence. Included. $25500. MS/PC DOS 2.0, Turbo Pascal, Turbo C, MFC, MK C, Zortech C++. VISIONS-PCE Edition:

Disk Software, Inc.
2118 E. Arapahoe Rd., P.O. Box 111, Richardson, TX 75081
(214) 423-7286, (800) 638-7766, FAX (214) 423-7288

Inquiry 782.

SOFTWARE/GRAPHICS

**EGAD Screen Print**

Prints contents of VGA, EGA, CGA displays on variety of dot-matrix, inkjet, and laser printers. Prints in gray tones or color. Drop box lets you print any region of the screen. Enhance graphics 1 to 4 times (reduction too). Setup program for picking printer colors, etc. $535.00 Postpaid. Call or write for free catalog.

LEYH VE SYSTEMS
4257 Banker Park Place, Woodbridge, VA 22192-5119
(703) 590-8890

Inquiry 783.

SOFTWARE/LANGUAGES

**IntegrAda**

Standard Air Force PC Ada Compilers & environments for MS-DOS and UNIX. Integrated programming systems include validated Ada compilers, language sensitive editors, complete libraries and other Ada programming tools. FREE demo.

AEETCH, Inc.
3600 Stevens Ave., S1. 212 Solana Beach, CA 92075
(800) 755-1277 Fax: (619) 755-7540

Inquiry 784.

SOFTWARE/MATHMATICS

**GRAPHIC TOOLS LIBRARY**


NOVA INC.
2500 W. Higgins Road, Suite 104
CHICAGO, IL 60645
CALL 773-882-4111

Inquiry 785.

SOFTWARE/SCIENTIFIC

**FREE CATALOG**

A great selection of scientific software products for plotting, non-linear curve fitting, chemical equilibria, simulation, statistics, symbolic algebra, and more. Prices range from $150-$1000.

1-800-942-MATH
MicroMath, Salt Lake City, UT 84121-0550

Inquiry 786.
Inquiry 794.

MS-DOS GRAPHING UTILITY

RP Plot allows quick graphing of scientific results by simply typing “plot” followed by the data file name(s). Numerous options are available. Major displays & printers are supported. Also callable from C. Order #79.

RSoft, Inc.
345 Riverside Drive Suite 2G
New York, NY 10025 { (212) 566-9595

Inquiry 794.

UNISTAT-IV Statistical Package

Menus/minimize data package featuring a fully-tailored spreadsheet, a wide range of statistics and powerful graphics. Export/import Lotus, dBase III, dBase IV, fixed and free form sect. Mining data and missing data handling. Full array of 2D and 3D plots, charts and histograms, curve and distribution fitting. More than 300 functions. Fast and powerful, UNISTAT IV provides all the tools to make the most out of your data. Complete documentation. OLS, weighted, polynomial and stepwise regressions. Bayesian/functional ANOVA, ANOCOV, etc. Same system and -4200 user's guide available separately.

US & Canada: 330 W. Superior St., Suite 2F, Chicago IL 60610. Tel: (312) 346-2920. Fax: (312) 346-9290
Elsewhere: 1220 E 60th Street, Dept. #6, Kansas City, MO 64123. Tel: (816) 561-7550. Fax: (816) 561-9510

Inquiry 799.

UNINTERRUPTIBLE POWER

HOW TO PROTECT YOUR COMPUTER

And Make It Last Longer

FREE money-saving literature tells you how to protect your computer and make it last longer with an uninterruptible power supply. 500VA through 1850VA models from the world's largest manufacturer at single-chair UPE

Best Power Technology, Inc.
PO Box 290, Necedah, WI 54646
Toll-Free (800) 386-5784, Ext. 2189
Telephone (608) 586-7656, Ext. 2189

Inquiry 800.

HYPER-LOCK

If you search for a powerful copy protection system, you also can have privileges of HYPER-LOCK.
- Protects on standard diskettes
- Full hard disk support
- Limited user's keys provided
- Cannot be bypassed by any means
- Any password protection
- Sub-program protection
- Flexible data protection
- Any disk can be protected

GUVEN COMPUTER LTD.
Talimyeri St., 75 Macka/Istanbul TURKEY
Phone: (212) 578-10 07 Fax: (212) 1-180 38 48

Inquiry 796.

UTILITY

YOUR 386 IS DEFECTIVE

You're not getting the 386 performance you paid for! PC-Kwik® will give you the total system performance that your hardware vendor left out.

Multisoft Corporation
1510 SW 3rd Place
Beaverton, OR 97006
Phone: (503) 644-3664
Fax: (503) 644-9376
Or call: (800) 950-8445
For a recorded message available 24-hour per day.

Inquiry 801.

OPT-TECH SORT/MERGE

Extremely fast Sort/Merge/Select utility. Runs as an MS-DOS command or CALL as a subroutine. Supports most languages and file types including Retrieve and dBASE. Unlimited file sizes, multiple keys and much more! MS-DOS $149, OS/2, XENIX, UNIX $245.

(702) 586-3737
Opt-Tech Data Processing
PO Box 676 Zapata Cove, NV 89448

Inquiry 797.

MULTI-VOICE® TOOLS

Multivoice Tools is a complete development Toolkit for Pascal or "C" to access all the features for most speech synthesizing boards available today. It helps you write MULTIVIOICE APPLICATIONS in minutes. A number of programming examples are provided. All programs and libraries are delivered with source code.

ITT Logiciel
1705 St. Joseph E. Suite 4, Montreal, Can. H3J IN1
(504) 867-0245 or (514) 867-0588

Inquiry 797.

COPYWRITE

CopyWrite
Reindows
Copy Protection
Not reverse-engineerable
 manuals or codes.
1000's of programs copied.

QUAUD SOFTWARE LIMITED
45 Charles St. E. 6th Fl.
Toronto, Ontario, Canada M4Y 1S2
(416) 961-8243

Inquiry 802.

Inquiry 803.

VOICE MAIL/AUTO ATTENDANT

Complete PC CAM® Users!

Upgrade to a Multiple-line ARC Voice (®)
This system picks up where the Complete Answering Machine leaves off with these added features:
- All lines share the same files
- Simultaneous recording quality
- Unlimited call transfer options
- Call participations messages
- Intercom capabilities
- Complete menu driven
- System installation is tremendously simple
- Only four items, no need more expansion
- Call (513) 438-3700
Versicom Communications®
316 Regency Ridge, Dayton, OH 45459

Inquiry 804.

WORD PROCESSING

Replace Proofreading
Key, edit, or proof any file on your PC with Word-Proofer™, then import to your application. New two-pass proofing is faster, more accurate than proofreading or document comparators. Single $89. Multicopy discounts. Network version.

Computer Keys
21529 Mahat Rd.
20877-9443
Woodway, WA 98020
Inquiry 805.

FARSI / GREEK / ARABIC / RUSSIAN

Greek, Hebrew, all European, Scandinavian, plus either Hindi, Punjabi, Bengali, Dari, Urdu, Tamil, Korean, Viet, or 885. Full-featured multi-language word processor supports on-screen foreign language characters and keyboarding with no hardware modifications, Includes Font Editor, $395 dot matrix; $135 dot laser; $10 demo. $95 in U.S. and $125. RISC, 64K, graphics, 30-day Guaranatee. MOVISAMAXEX

GAMMA PRODUCTIONS, INC.
710 Wilshire Blvd., Suite 600, Santa Monica, CA 90401
(213) 264-6922 Tlx: 510000828 Gamma Pro Skil

Inquiry 798.

STATISTICS

NCSS 5.x Series — $125

Easily-use menu & spreadsheet. Multiple regression, ANOVA, ANOCOV, etc. Reusable ASCII data. Many new add-on modules.

NCSS
329 North 1000 East, Kayenta, UT 84537
Phone: 801-546-0445 Fax: 801-546-3907

Inquiry 798.

CODEWRITE

CopyWrite
Reindows
Copy Protection
Not reverse-engineerable
 manuscripts or codes.
1000's of programs copied.

QUAUD SOFTWARE LIMITED
45 Charles St. E. 6th Fl.
Toronto, Ontario, Canada M4Y 1S2
(416) 961-8243 Fax (416) 961-8448

Inquiry 802.

Inquiry 803.

ANTI-VIRUS PRODUCTS

Don't give viruses a chance to attack your system memory, hard or floppy disk drives. Protect your computer with the best known solutions tocounter virus attacks. Use the Anti-Virus products to provide maximum protection against data loss due to virus invasion or unauthorized system access. Password protection with battery backup and keyboard lock for added security. Does not occupy any RAM or affect system performance. Provides up to 4 levels of security. Call or write for more information or to place an order. 1-800-774-3007 Prices range from $650 to $1580.

Information Systems to Increase Profits
PO Box 5528, Middletown, NY 10940

Inquiry 803.

YOUR SALES MESSAGE

about the special computer product or service that you provide

THE BUYER'S MART

can help you reach computer professionals and produce valuable inquiries for your company!

Call Joseph Mabe for more information
603-924-2656 or Fax: 603-924-2683
ANNOUNCING:
AN ADVANCE IN 9-TRACK OF VERY SMALL PROPORTIONS.

Overland Data's OD3210, the smallest autoloading 9-track tape drive in the world.

While everyone else is downsizing and simplifying computers and peripherals, 9-track tape drive manufacturers have somehow managed to buck this trend with drives that are huge and heavy or awkwardly manual loading. Too bad for them. Introducing the OD3210, designed and built by Overland Data to bring 9-track into the modern office. It's incredibly compact. Portable. Whisper quiet. Uses only 45 watts. And is extremely reliable. No other drive has fewer moving parts. Best of all, it's surprisingly affordable.

The OD3210 comes with a two year warranty, expert toll-free support, and the ODI Special Service Program. So call us. And find out why some of the best advances are the smallest ones.

See us at Comdex, West Hall, booth #4128

1-800-PC9-TRAK
(1-800-729-8725)

THE FASTEST 80486 & 80386/40 MHz
15 Mips, FASTER THAN EVEREX STEP & ALR

FEATUERS:
• 64250k Write Back Cache
• 8MB Main Design
• Shadow Ram on Video & Bios
• 64MB 32 Bit Memory Expansion
• Baby size with Eight Expansion Slot
• Unix, OS/2 & Novell 100% Compatible
• One Year Full Warranty
• Made In USA

COMPLETE DESK SYSTEM WITH
1.2 MB Floppy, HD/Floppy Controller, 101 Keybord And 4MB Memory
MODEL BASE MONO VGA
486/25 12.5 1925 2100 2375

NEW BABY SIZE

SUPER TOWER

FEATURES:
• 5 Half Ht. Drive Bay
• 2 Full Ht. Drive Bay
• 250 Watt UL/Power Supply
• Dual Fans
• Double Security Lock
• Wheels & Caster
• Front Display Panel
• Excellence For UNIX & NOVELL Server
• UPS Optional

Technology Power Ent., Inc.

47273 Fremont Blvd., Fremont, CA 94539
Tel: 415-623-3818 Fax: 415-623-3840

Circle 308 on Inquiry Card.
Circle 76 on Inquiry Card.

VOICE MASTER KEY® SYSTEM II
VOICE RECOGNITION & SPEECH RESPONSE
FOR IBM PC/XT/AT/386, PS/2, LAPTOPS, COMPATIBLES

FOR PRODUCTIVITY, PRESENTATIONS, SOFTWARE DESIGN, ENTERTAINMENT, LANGUAGE TRAINING, EDUCATION, MORE...

SPEECH/SOUND RECORDING AND PLAYBACK. Desk to pen audio sound editing allows you to create custom sound applications. Variable sample rate (to 20 KHz) and compression levels. A four-voice music synthesizer is included also! VOICE RECOGNITION TSR utility allows you to add voice command keyboard macros to your CAD, desktop publishing, word processing, spreadsheet, or entertainment programs. Up to 64 voice commands in RAM at once—from more than disk.

HARDWARE SYSTEM contains built-in speaker with separate volume and tone controls, external speaker and headphone jacks. Enclosure made of sturdy vinyl-covered steel. Attaches to parallel printer port without affecting normal printer operation (U.S. Patent 4,812,847). Headset microphone, printer cable, 9 volt AC adapter (110 volt UL/CSA listed), and comprehensive user manual included.

QUALITY MADE IN USA. ONLY $219.95

ORDER HOTLINE: (503) 342-1271 Mon-Fri, 8 AM to 5 PM PST
Visa/MasterCard, company checks. money orders, CODs (with prior approval) accepted. Personal checks subject to 3 week shipping delay. Return inquiries contact Covox for C&F/CIF quotes. OEM configurations available.

The TransTerm 5 is a work station data entry/display terminal for on-line, off-line shop floor data collection. The unit is one of a family of such terminals which feature LC displays for operator prompting and data entry via a membrane keyboard or an optional barcode wand (Code 39). A multi-terminal polling controller (up to 250 stations) and a dBASE III+ compatible software package are also available. System costs below $300.00 per station. Call for info.

Options—backlighting for display, RS-422 I/O, 20 Ma current loop I/O, dBASE is a registered trademark of Ashton Tate, Inc.

COVOX INC.
675 Conger Street
Eugene, Oregon 97402

TEI (503) 342-1271
FAX (503) 342-1283

Circle 71 on Inquiry Card.

The Power Of A 386 & 486 At Unbeatable Prices

The COMPACOM offers a choice of dBASE Data Entry and a variety of Modems for your needs.

9,600-38,400 bps MODEM...$169

NOW you can afford a SPEEDMODEM—The CHAMP has a raw speed of 300 - 9600 bps and 4:1 data compression for throughput up to 38,400 bps. Dynamic Impedance Stabilization—provides robust performance on noisy telephone circuits. The COMBO adds 9600 bps send/receive, full-featured FAX with VOICE MAIL upgrade...total communications capability—only $279. Both come with a 30-day money-back guarantee, 5-year warranty and made in USA. BYTE magazine said our 2400bps modem was "a real deal!"...well we've done it again! See for yourself...

CALL NOW 800 228 6648

Circle 108 on Inquiry Card.

Computerwise, INC.
302 N. Winchester • Olathe, KS 66061 • 913-829-0600 • Fax 913-829-0610

Circle 76 on Inquiry Card.

Circle 71 on Inquiry Card.
Memory Upgrade Boards for Laser Printers

"For the First Time, Cut Out the Middle Man, Buy Direct from the Manufacturer"

NOW YOU CAN AFFORD TO BUY AMERICAN!
YOU CAN'T BEAT OUR PRICES OR OUR QUALITY.

HEWLETT PACKARD II, I1D, IIP, III, IIIID
1MB $69.00
2MB $111.00
3MB $153.00
4MB $195.00

PANASONIC 4420/4450i
1MB $79.00
2MB $119.00
3MB $159.00
4MB $199.00

TEXAS INSTRUMENTS MICROLASER & MICROLASER PS
1MB $59.00

At GP Digital, Inc., we have some of the highest standards in the industry. That's because Made in the U.S.A. means something to us: Higher Quality and Reliability together with exceptional value (plus a lifetime replacement warranty!)

- Lowest Memory Pricing in the U.S.A.
- All Boards Manufactured in the U.S.A.
- Lifetime Replacement Warranty.
- We Offer Quality Service, Warranty and Technical Support.
- Same Day Shipping.
- PO's from Qualified Firms, Universities & Government Agencies, Fortune 1000.
- Dealers Inquiries Welcome.
- International Orders Accepted.
- 100% Compatible or your Money Back.
- We Accept Visa/MC.
- Follow your Package every step of the way!
- We Ship COD.
- 20% Restocking Fee on all Non-Defective Returns and Refused Orders. Authorization # Required.
- Se Habla Espanol.
BIX is more than just a great on-line information service. It's a community made up of thousands of the most serious computer users in the world; people like your customers, who are always on the look-out for the latest innovations and information regarding both hardware and software. Now you can set up shop in this electronic neighborhood with your own BIX Technical Support Conference. That way, you can give your customers all the product information and technical support they need. Use it to post updates or fixes for your customers to download at any time. If your company doesn't operate an 800 number, a BIX conference is an inexpensive alternative. Or it can back up an existing 800 line. And when you establish a BIX conference you'll enhance your product's value because you'll be able to offer your customers special rates on BIX subscriptions. For all the details, call Customer Service at: 1-800-227-2983 (in NH, call 603-924-7681).

BIX
DEVELOPER'S TOOLS

NICE-51 satisfies you, who expects excellent functions, attractive price and easy to use. What a surprise, now you have it!

- Up to 12 MHz Real-Time without including interrupt
- Serial Channel, 18 or Code
- Space
- Built-in programmer for EPROM & AT51
- Handles Binary, Hex. & Symbol File and down load data to external RAM
- High dump rate, field, code, data, internal data, index line address can be directly viewed and edited
- Complete menu-driven software without any tedious commands
- 16K tape buffer, 48 Bit w/ ADDR, DATA, PI, P0 and status upgrade
- 3.5 MHz Real-Time

Call us today for complete product line

TPT-100 $145
TLK-PIE PLOTTER Kit $85
TRE-200 $295
TUP-300 $595

Circle 288 on Inquiry Card.

Circle 330 on Inquiry Card.

Circle 211 on Inquiry Card.

Circle 12 on Inquiry Card.

Circle 323 on Inquiry Card.

Circle 232 on Inquiry Card.

Circle 329 on Inquiry Card.

Circle 328 on Inquiry Card.

Circle 104 on Inquiry Card.

Circle 260 on Inquiry Card.

Circle 285 on Inquiry Card.
PROTÉUS

...CAUSING A SEA CHANGE IN AFFORDABLE INSTRUMENTATION

As the Greek God Protéus could assume many forms, so can our Protéus. With various software modules and corresponding adapters, Protéus can transform itself into a Universal Device Programmer, Data Logger, Universal Controller, Programmable Power Supply, Universal Device Tester and PCB Tester.

The New Wave in Instrumentation Begins with Bold Features:

• Standard IBM-PC parallel printer port; Optional detachable IBM-PC compatible computer for stand-alone operation; Built-in Power Supply.

• Flexible yet powerful Algorithm Development System supporting Symbolic Pinout Mapping allows customization of all applications according to specific needs. Add new programming algorithms, implement On-Board Programming, create custom test programs.

• Up to 296 overcurrent protected mixed analog & digital pins/channels; Voltage Source & Sink.

• Universal Programmer supports virtually all devices on the market and features: True Self Calibration/ Diagnostics, Programmable Current Generator, Part Insertion Sensing, Continuity Test, True State Machine Testing, Handler Interface; Adapters for Gang, PLCC, etc...

from $995

[Basic Unit with Programming Adapter supporting up to 40 pin devices; Detachable computer shown in photo not included.]

(408) 730-5511
FAX (408) 730-5521

B&C MICROSYSTEMS INC.
750 North Pastoria Avenue, Sunnyvale, CA 94086 USA

Circle 42 on Inquiry Card.
DISTRIBUTORS WANTED
New Multi-Megabyte Disk Emulator

- For diskless systems, solid-state reliability and speed
- Flash File System or battery-backed SRAM
- 1/0 mapped 8-bit ISA bus—MS DOS
- Flash File System or battery-backed SRAM
- For diskless systems, solid-state reliability
- Other ROMDISK EPROM, Flash and SRAM
- PCF-1 with 1MB SIMM, $895 or 1MB SRAM, $995, 1MB Flash SIMM $395, 1MB SRAM SIMMs, $495
- Other ROMDISK EPROM, Flash and SRAM models

VERBATIM

100% CERTIFIED LIFETIME WARRANTY

- 5½ DS/DD $ .39 each
- 5½ DS/HD $.54 each
- 3½ DS/DD $.59 each
- 3½ DS/HD $.99 each
- Price based on mix/match qty. of 300 in bulk, includes Tyvek sleeves and label kits.

MEGA Soft

P.O. Box 710, Freehold, NJ 07728
800-222-0490
In NJ 908-462-7628
FAX 908-462-5658

New Schematic and PCB Software

With support for extended and expanded memory, HIWIRE II can handle your most demanding schematic and PCB designs quickly and easily. The unique HIWIRE editor allows you to display and edit schematics and PCBs simultaneously, using the same commands for each. HIWIRE II is $995, and is guaranteed.
WE GUARANTEE LOWEST PRICING ON:*

- SEAGATE, CONNER MICROSCROLL HARD DRIVES
- INTEL COPROCESSORS
- 84 & 101 KEY KEYBOARDS
- ALL ADVERTISED MEMORY UPGRADES
- ALL OTHER COMPUTER ITEMS IN THIS AD

**2MB FOR IBMP2**
- Equivalent to 640K (or 384K) (SPECIFY)**5 Year Warranty**
- Your Price 129**

HEWLET PACKARD MEMORY BD
- Available for HP-SP-80 or HP 3 D (SPECIFY) Expandable to 4MB
- Your Price 138**

COMPAG MODULES & BOARDS

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Low Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESKPRO 286</td>
<td>8MB</td>
<td>115989-001</td>
</tr>
<tr>
<td>DESKPRO 386</td>
<td>8MB</td>
<td>118689-001</td>
</tr>
<tr>
<td>DESKPRO 386C</td>
<td>8MB</td>
<td>118690-001</td>
</tr>
<tr>
<td>DESKPRO 388/32X</td>
<td>8MB</td>
<td>118691-001</td>
</tr>
<tr>
<td>DESKPRO 386/16</td>
<td>8MB</td>
<td>118692-001</td>
</tr>
<tr>
<td>DESKPRO 386</td>
<td>16MB</td>
<td>118693-001</td>
</tr>
<tr>
<td>DESKPRO 386C</td>
<td>16MB</td>
<td>118694-001</td>
</tr>
<tr>
<td>DESKPRO 386E</td>
<td>16MB</td>
<td>118695-001</td>
</tr>
<tr>
<td>DESKPRO 386S</td>
<td>16MB</td>
<td>118696-001</td>
</tr>
<tr>
<td>PORTABLE II</td>
<td>8MB</td>
<td>107031-001</td>
</tr>
<tr>
<td>PORTABLE II</td>
<td>16MB</td>
<td>107032-001</td>
</tr>
<tr>
<td>PORTABLE II</td>
<td>32MB</td>
<td>107033-001</td>
</tr>
<tr>
<td>PORTABLE SUPER II</td>
<td>8MB</td>
<td>107034-001</td>
</tr>
<tr>
<td>PORTABLE SUPER II</td>
<td>16MB</td>
<td>107035-001</td>
</tr>
<tr>
<td>PORTABLE SUPER II</td>
<td>32MB</td>
<td>107036-001</td>
</tr>
</tbody>
</table>

SIMM MODULES

<table>
<thead>
<tr>
<th>Description</th>
<th>2MB</th>
<th>4MB</th>
<th>8MB</th>
<th>16MB</th>
<th>32MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>2MB Module</td>
<td>386</td>
<td>757</td>
<td>1514</td>
<td>4306</td>
<td>13036</td>
</tr>
<tr>
<td>4MB Module</td>
<td>777</td>
<td>1514</td>
<td>4306</td>
<td>13036</td>
<td>39106</td>
</tr>
<tr>
<td>8MB Module</td>
<td>1514</td>
<td>4306</td>
<td>13036</td>
<td>39106</td>
<td>118789</td>
</tr>
</tbody>
</table>

TOSHIBA MEMORY

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Low Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC2273</td>
<td>1MB</td>
<td>753549</td>
</tr>
<tr>
<td>TC2274</td>
<td>2MB</td>
<td>1505076</td>
</tr>
<tr>
<td>TC2275</td>
<td>4MB</td>
<td>3010152</td>
</tr>
</tbody>
</table>

IBM PS/2 (BOARDS & MODULES)

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Low Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2MB Module</td>
<td>386</td>
<td>757</td>
</tr>
<tr>
<td>4MB Module</td>
<td>777</td>
<td></td>
</tr>
<tr>
<td>8MB Module</td>
<td>1514</td>
<td></td>
</tr>
</tbody>
</table>

BOCA MEMORY BOARDS

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Low Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOCA-BM-40</td>
<td>2MB</td>
<td>190507</td>
</tr>
<tr>
<td>BOCA-BM-80</td>
<td>4MB</td>
<td>3810152</td>
</tr>
</tbody>
</table>

SIMM MODULES

<table>
<thead>
<tr>
<th>Description</th>
<th>2MB</th>
<th>4MB</th>
<th>8MB</th>
<th>16MB</th>
<th>32MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>2MB Module</td>
<td>386</td>
<td>757</td>
<td>1514</td>
<td>4306</td>
<td>13036</td>
</tr>
<tr>
<td>4MB Module</td>
<td>777</td>
<td>1514</td>
<td>4306</td>
<td>13036</td>
<td>39106</td>
</tr>
<tr>
<td>8MB Module</td>
<td>1514</td>
<td>4306</td>
<td>13036</td>
<td>39106</td>
<td>118789</td>
</tr>
</tbody>
</table>

DAISY WHEEL PRINTER

- 10 & 20 MEG HARD DRIVES
- Works off X-T & HP Hard Drive Controller
- Your Price 2950
- High Quality (by Matrox)
- Color Graphics (by Matrox)

VGA CARD w/2400 BAUD MODEM

- Automatic Group II Digital Fax & Dial Operation
- Two unscaled, screen images, scan, page, print, in modem built on fax
- No extra size modem built on fax
- Your Price 3490

SEAGATE HARD DRIVES

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Low Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10MB</td>
<td>10MB</td>
<td>130507</td>
</tr>
<tr>
<td>20MB</td>
<td>20MB</td>
<td>2610152</td>
</tr>
<tr>
<td>40MB</td>
<td>40MB</td>
<td>5220304</td>
</tr>
</tbody>
</table>

WE OFFER:

- SAME DAY SHIPPING ON 98% OF ORDERS
- IN-STORE ORDERS RECEIVED WITHIN 7 DAYS BY DHL
- FAX ORDERS TO 702-294-1246
- PURCHASE ORDERS FROM QUALIFIED FIRMS BY FAX
- QUANTITY PRICING, WE STOCK WHAT WE SELL

COMPAG MODULES

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Low Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS/2 P2</td>
<td>1MB</td>
<td>150507</td>
</tr>
<tr>
<td>PS/2 P3</td>
<td>2MB</td>
<td>3010152</td>
</tr>
</tbody>
</table>

We also purchase excess inventories

- NO SURCHARGE FOR MCMUSA
- WE ALSO PURCHASE EXCESS INVENTORY—FAX OR CALL
- NO PROCUREMENT AGENCY
- NO MARK-UP
- ALL PRICES FINAL
- NO REFUND AFTER 30 DAYS
- EXCHANGE ONLY
- NO PURCHASE ORDERS

CONTROLLERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory</th>
<th>Low Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>8MB</td>
<td>150507</td>
<td></td>
</tr>
<tr>
<td>16MB</td>
<td>3010152</td>
<td></td>
</tr>
</tbody>
</table>

MOBILITY

60 MEG TAPE BACKUPS

- 5.25"/4.7" format
- Warranty: 5/5/5
- Compaq cartridge
- Easy installation
- List 9999
- Your Price 429

200 WATT POWER SUPPLY

- Quick Replacement
- Lighter, less bulky
- List 9999
- Your Price 499

COOL KEY BOARD

- High quality by Matrox
- List 799

SUNSTAR HAND SCANNER

- New 5" (128mm) (above)
- Serial interface
- Includes interface card, utility software, manual (software warranty)
- List 249
- Your Price 349

DESKTOP CONTROL SYSTEMS

- Complete systems
- Latest price
- List 2999
- Your Price 1399

WE GUARANTEE LOWEST PRICING ON:

- SEAGATE, CONNER MICROSCROLL HARD DRIVES
- INTEL COPROCESSORS
- 84 & 101KEY KEYBOARDS
- ALL ADVERTISED MEMORY UPGRADES
- ALL OTHER COMPUTER ITEMS IN THIS AD

800-654-7762
TECHNICAL CUSTOMER SERVICE CENTER
702-294-0214 • FAX 702-294-1168
INTL: 702-294-1246
Circle 213 on Inquiry Card.

JUNE 1991 • BYTE 391
## Warranty

OukPro 386-33, 486-33
64MB Pro
Vectra Btavo -286, Worh t1 11on
Prem 1”386-20
3.92 BYTE • JUNE 1991

---

## Hewlett Packard Memory

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>256X10</td>
<td>$139.00</td>
<td></td>
</tr>
<tr>
<td>256X20</td>
<td>$225.00</td>
<td></td>
</tr>
<tr>
<td>256X40</td>
<td>$500.00</td>
<td></td>
</tr>
<tr>
<td>512X10</td>
<td>$185.00</td>
<td></td>
</tr>
<tr>
<td>512X20</td>
<td>$369.00</td>
<td></td>
</tr>
<tr>
<td>512X40</td>
<td>$1050.00</td>
<td></td>
</tr>
</tbody>
</table>

## IBM PS/2 Memory

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>286E</td>
<td>$199.00</td>
<td></td>
</tr>
<tr>
<td>386SX</td>
<td>$392.00</td>
<td></td>
</tr>
<tr>
<td>486SX</td>
<td>$785.00</td>
<td></td>
</tr>
</tbody>
</table>

## LapTop and Portable Memory

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperSIP/3</td>
<td>$329.00</td>
<td></td>
</tr>
<tr>
<td>SuperSIP/4</td>
<td>$455.00</td>
<td></td>
</tr>
<tr>
<td>SuperSIP/5</td>
<td>$579.00</td>
<td></td>
</tr>
</tbody>
</table>

## Compact Memory

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>316X10</td>
<td>$125.00</td>
<td></td>
</tr>
<tr>
<td>316X20</td>
<td>$250.00</td>
<td></td>
</tr>
</tbody>
</table>

## Laser Printer Memory

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PORTABLE</td>
<td>$299.00</td>
<td></td>
</tr>
<tr>
<td>SLT/280</td>
<td>$299.00</td>
<td></td>
</tr>
</tbody>
</table>

## Math Co-processors

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTEL 8087</td>
<td>$499.00</td>
<td></td>
</tr>
<tr>
<td>INTEL 8089</td>
<td>$699.00</td>
<td></td>
</tr>
</tbody>
</table>

## CPU Chips

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>80386-20</td>
<td>$200.00</td>
<td></td>
</tr>
<tr>
<td>80486-20</td>
<td>$300.00</td>
<td></td>
</tr>
</tbody>
</table>

---

## One Year Warranty

AMT INTERNATIONAL
2393 QUME DRIVE, SAN JOSE, CA 95131
(408) 432-0552 • (408) 432-1790 • Fax: (408) 944-9801

---

## Computer Systems

**AMT 486-25 MHz w/128K Cache**
- 1MB RAM
- 100 MB HARD DISK
- MATH Co-PROCESSOR SOCKET
- 1.2 OR 144 HDIPI DRIVE
- I/O 25PPG PORT
- 101 KEYBOARD
- FULL TOWER CASE w/20 K PSI
- SUPPORT UNIX, XENIX, DOS, OS/2, NETWORK

***$2469***

**AMT 386-33 MHz w/64K Cache**
- 1MB RAM
- 40 MB HARD DISK
- INTEL 386-33 MHz CPU
- MATH Co-PROCESSOR SOCKET
- 1.2 OR 144 HDIPI DRIVE
- I/O 25PPG PORT
- 101 KEYBOARD
- MINE-TOWER CASE w/200 PSI
- SUPPORT UNIX, XENIX, DOS, OS/2, NETWORK

***$1399***

**AMT 386-25 MHz w/40 MB Hard Disk**
- 1MB RAM
- 40 MB HARD DISK
- INTEL 386-25 MHz CPU
- MATH Co-PROCESSOR SOCKET
- 1.2 OR 144 HDIPI DRIVE
- I/O 25PPG PORT
- 101 KEYBOARD
- AT CASE W/200 PSI
- SUPPORT UNIX, XENIX, DOS, OS/2, NETWORK

***$1249***

**AMT 386SX-16 MHz w/40 MB Hard Disk**
- 1MB RAM
- 40 MB HARD DISK
- MATH Co-PROCESSOR SOCKET
- 1.2 OR 144 HDIPI DRIVE
- I/O 25PPG PORT
- 101 KEYBOARD
- AT CASE W/200 PSI
- SUPPORT UNIX, XENIX, DOS, OS/2, NETWORK

***$995***

---

## Memory Upgrades

**Sarah Storage**, Workstation
- 512K Kit: $60.00
- 256K Kit: $56.00
- 128K Kit: $52.00

**Premium Memory**
- 512K Kit: $72.00
- 256K Kit: $68.00
- 128K Kit: $64.00

**Brew-CMSX**
- 256X10: $172.00
- 256X20: $341.00

**Hewlett-Packard Memory**
- Vectra OS: 3400
- Vectra OS/2: 3450

**IBM PS/2 Memory**
- 2MB 20M: $69.00
- 2MB 10M: $65.00

**Hewlett-Packard LaserJet III/IV**
- 316X: $120.00
- 316X: $150.00

**IBM Laser Printer Memory**
- 410X: $210.00
- 410X: $250.00

**NEC Memory**
- 316X: $375.00
- 316X: $400.00

**Hewlett-Packard LaserJet III/IV**
- 316X: $130.00
- 316X: $150.00

**Zenith Memory**
- 316X: $199.00
- 316X: $229.00

**Add Shipping**
- 256X10: $49.00
- 256X20: $49.00
- 256X40: $49.00
- 512X10: $50.00
- 512X20: $50.00
- 512X40: $50.00
- 1024X10: $100.00
- 1024X20: $100.00
- 1024X40: $100.00

---

## COMPUTER SYSTEMS

**IBM PS/2 Monitor and VGA**
- 16 BIT CARD (1024 x 768)...

***$425***
9-Track Tape Subsystem for the IBM PC/XT/AT

Now you can exchange data files between your IBM PC and any mainframe or mini-computer using IBM compatible 800 or 6250 BPI 9-track tape. System can also be used for disk backup. Transfer rate is up to 4 mebibytes per minute on PCs and compatibles. Subsystems include 7" or 10½" streaming tape drive, tape coupler card and DOS compatible software. For more information, call us today!

Qualstar
9621 Irondale Ave., Chatsworth, CA 91311
Telephone: (818) 882-5822

Circle 18 on Inquiry Card.
Circle 264 on Inquiry Card.
Circle 342 on Inquiry Card.
Circle 38 on Inquiry Card.
Circle 264 on Inquiry Card.
Circle 177 on Inquiry Card
(RESSELLERS: 178).
Circle 396 on Inquiry Card
(RESSELLERS: 997).

Program Your Chips
In Sets of 4 for $495.00

Doun your chips get started with CUPL™ for only $149.95

Now you can have a PLD Starter Kit that gives you all the horsepower that the CUPL PLD compiler offers, at a fraction of the cost. For more information, call 1-800-331-7766 or 305-974-0967.

Logical Devices, Inc.
1-800-331-7766

Circle 177 on Inquiry Card

ROM Based AT Systems

Single Board Computer
Run DOS and AT object code from ROM. Serial, Video, Flop, Keybd, Print, options. NEC V53 up, runs AT Code, 16MHz, SI=16.
Use off-the-shelf PClA/XT cards on backplane.
4MB RAM, 2MB ROM, 512K SRAM battery. 5 Serial, 2 Parallel ports, Clock, Watchdog.
$395 q-100

Kila
303-444-7737
655 Hawthorne Ave Beverly CO 80304 Fax: 303-786-9983

Circle 172 on Inquiry Card.
Circle 366 on Inquiry Card.

SUPER UNIVERSAL PROGRAMMER

New! SUPERPRO $785

FREE MULTIPLIER SPECIAL
- program PAL, PLD, GAL,PEEL, FPL.
- (up to 50 jic PLCC)
- 386 PROM, Flash EPROM up to 4 Mbit (40 pin)
- MC6800, Microprocessor, Bipolar PROM
- Test TTL,CMOS, Logic, D/S Memory Devices.
- High speed card to PC/XT/AT/386.
- Pull down menu driven, Library Operating software.
- Fast device update on user's request.
- 20-pin Gold JIC Socket.
- Attractive Free Display (BHS).
- User Device Library Generator (optional)
- Call 1-800-541-1975

Xceltek
264 San Alena Ave.
Sunshine, CA 94936
TEL: (415)371-3704
FAX: (415)374-1401

9 Track Tape Subsystem for PC/XT/AT/386/PS2

$1995 for 1600 BPI
$3695 for 1600/6250 BPI
$7695 for 800/1600/3200/6250 BPI
CALL 1-800-266-4827

Laguna Conversion Systems
2694 Cabot Road
Laguna Hills, CA 92653
Tel: 714-367-0497, Fax: 714-367-0508

Circle 172 on Inquiry Card.
UNIVERSAL PROGRAMMER

It

• Flexshiel’d” Keyboard Protectors
• Relegendable
• Custom Labels to your specs
• Custom Templates to your specs
• Templates for most popular software
• Keytop Labels for most popular software
• Key Imprinting to your specs

$475

PAL
EPROM
GAL
PROM
8748/49
87CS1...
87CS751
5ns PALs
4 Meg EPRoms
16 bit EPRoms

Parts added at your request.
FREE software updates on BBS.
Powerful menu driven software.
Call: (201) 994-6669

Link Computer Graphics, Inc.
4 Sparrow Dr., Livingston, NJ 07039
FAX (201) 994-0730

CUSTOM KEY CAPS

IBM®, Key Tronic®, Macintosh®, Cherry®, & More

• Key imprinting to your specs
• Keytop Labels for most popular software
• Templates for most popular software
• Custom Templates to your specs
• Custom Labels to your specs
• Relegendable Keys—IBM®, Cherry®, Key Tronic®, Wygur
• Flexshield® Keyboard Protectors

Express Turn-around services on Custom!

Call for your FREE CATALOG!

Fax: 800 937-1337
602 634-7515 • FAX: 602 634-4820

Hooleon
CORPORATION
909 230 Unit BYTE
Gonville, AZ 85235

BUILT-IN UPS

220/230 WATTS DC
100 WATTS AC

$365

The POWER SOURCE replaces the power supply in your AT/386/486. Its auto-charge-recovery battery powers PC and monitor for up to 15 minutes. Surge suppression. Audible alarm. Full-size and Baby models. Desktop and Tower versions. Call today for immediate delivery!

PUISSANCE INC.
35 Basswood Ave., Agoura CA 91301
(818) 707-3613 Visa/MC/PO

"PUISSANCE means POWER"

ICs

DYNAMIC RAM

4M Board for sp L3’s w/64K $149.00
SIMM 4Mx16 60 ns 160.00
SIMM 1Mx4 60 ns 60.00
5Mbit 4Mx1 60 ns 50.00
1Mbit 1Mx4 60 ns 30.00
1Mbit 1Mx1 60 ns 50.00
128Mx64 80 ns 60.00
256Mx64 160 ns 1.50
128Mx128 160 ns 1.50
256Kx128 160 ns 1.50
1Mbit 128Kx128 160 ns 1.50
27C512 64Kx8 120 ns 1.50
27C100 128Kx8 150 ns 1.50
512Kx4 100 ns 1.50
EPROM

DYNAMIC RAM

27C4001 256x128 150 ns $55.00
27C864 64Kx8 200 ns 5.00
27C100 1024x8 250 ns 8.00
27C320 4Kx32 120 ns 2.50
27C640 16Kx32 120 ns 5.00
27C128 512x32 120 ns 1.00
32Kx128 120 ns 2.50
256Kx128 120 ns 1.50

FREE software updates on BBS.
Powerful menu driven software.

For Info call:

Australia
(02) 654 1873
(02) 387 6383
Belgium
(011) 947 8085
Canada
(011) 947 8085
Denmark
(02) 387 6383
Finland
(011) 947 8085
France
(011) 947 8085
Germany
(011) 947 8085
Great Britain
(011) 947 8085
Israel
(011) 947 8085
Italy
(011) 947 8085
Korea
(011) 947 8085
New Zealand
(011) 947 8085
Portugal
(011) 947 8085
Scandinavia
(011) 947 8085
Singapore
(011) 947 8085
Spain
(011) 947 8085
Sweden
(011) 947 8085
Switzerland
(011) 947 8085
Taiwan
(011) 947 8085
Thailand
(011) 947 8085

NOHAU CORPORATION
51 S. Campbell Ave. • Campbell, CA 95008
(408) 866-1829 FAX (408) 767-7869

IF YOU CAN'T TRY IT, DON'T BUY IT!

TapeWare is a new, exceptionally friendly user interface for most popular 9 track tape controllers. No more typing filenames, botched backups or one-at-a-time file transfers. Call for Demo Disk. See for yourself. We also supply 9 track hardware and software up to 6250 BPI which includes TapeWare. Compare before you buy.

AK Systems Inc.
818/709-8100 (v) 818/475-8989 (fax)

40+ MHz Operation!

486BSBC

i486 Single-Board Computer for passive backplane systems

On-board features include:
• 6046 processor
• IDE hard disk controller
• floppy disk controller
• up to 32MB DRAM
• optional: local 32-bit data bus
• real-time clock
• 1 parallel port
• 2 serial ports
• keyboard port

Customer’s choice of operation speed. Inquire about our other 8046 products available shortly. Also available, EGA/CGA backplanes.

BECTERM INC.
3333, Boul. de la Rivière-Sud
Levis, Québec G6V 4Z2
Tel: (418) 835-1551
Fax: (418) 837-9869

IF YOU CAN'T TRY IT, DON'T BUY IT!

TapeWare is a new, exceptionally friendly user interface for most popular 9 track tape controllers. No more typing filenames, botched backups or one-at-a-time file transfers. Call for Demo Disk. See for yourself. We also supply 9 track hardware and software up to 6250 BPI which includes TapeWare. Compare before you buy.

AK Systems Inc.
818/475-8989 (fax)

Circle 261 on Inquiry Card.

Circle 175 on Inquiry Card.

Circle 261 on Inquiry Card.

Circle 140 on Inquiry Card.

Circle 44 on Inquiry Card.

Circle 14 on Inquiry Card.

Circle 195 on Inquiry Card.

Circle 261 on Inquiry Card.

Circle 174 on Inquiry Card.

Circle 175 on Inquiry Card.

Circle 140 on Inquiry Card.

Circle 14 on Inquiry Card.
## IBM MEMORY

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512K</td>
<td></td>
<td>$100</td>
</tr>
<tr>
<td>2MB</td>
<td></td>
<td>$210</td>
</tr>
<tr>
<td>Model 30-266, Exp. Board</td>
<td>16MB</td>
<td>$490</td>
</tr>
<tr>
<td>330K</td>
<td></td>
<td>$390</td>
</tr>
<tr>
<td>2MB</td>
<td></td>
<td>$120</td>
</tr>
<tr>
<td>Model 70-641/122</td>
<td>32MB</td>
<td>$990</td>
</tr>
<tr>
<td>1MB</td>
<td></td>
<td>$290</td>
</tr>
<tr>
<td>Models 8 DX, 65K, 384K, and 2048</td>
<td>4MB</td>
<td>$390</td>
</tr>
<tr>
<td>4MB</td>
<td></td>
<td>$120</td>
</tr>
</tbody>
</table>

## COMPAQ MEMORY

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeskPro 386-1, 386-20/20/25</td>
<td>2MB</td>
<td>$390</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## LAPTOP MEMORY

### TOSHIBA

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1000E, LE, and 2000EX</td>
<td>1MB</td>
<td>$199</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### AST EXECUTIVE NOTEBOOK

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1200EX</td>
<td>2MB</td>
<td>$299</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## PRINTER MEMORY

<table>
<thead>
<tr>
<th>Model</th>
<th>Memory Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hewlett-Packard Laserjet</td>
<td>4MB</td>
<td>$269</td>
</tr>
<tr>
<td>IBM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## HEWLETT-PACKARD MEMORY

### Zenith MEMORY

<table>
<thead>
<tr>
<th>Zenith</th>
<th>Memory Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zenith Z-386/20/25/33 &amp; 386</td>
<td>1MB</td>
<td>$175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SIMM MODULES

<table>
<thead>
<tr>
<th>SIMM</th>
<th>IBM COMPATIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4MB</td>
<td>$269</td>
</tr>
<tr>
<td>8MB</td>
<td>$299</td>
</tr>
<tr>
<td>16MB</td>
<td>$349</td>
</tr>
</tbody>
</table>

## WE ACCEPT INTERNATIONAL ORDERS AND PO's!

- 3 DAY INTERNATIONAL DELIVERY VIA FEDERAL EXPRESS, UPS, OR DHL
- ALL USER INSTALLABLE
- QUALITY PRODUCTS
- GREAT PRICES
- SUPERIOR SERVICE
- FLEXIBLE PAYMENT OPTIONS

## PRINTERS

- IBM 4019 and 4019e
- HP LaserJet II and IIe
- HP LaserJet II, II+, and IIl
- Canon LBP-4
- Canon LBP-810, 811, and 811R
- Canon LBP-11
- Canon LBP-10
- Dell Laserwriter
- Epson LQ 850
- Epson FX-80
- Epson FX-100
- Epson FX-1200
- IBM 5100
- IBM 5110
- IBM 5150
- IBM 5320
- IBM 5320/1000
- IBM 5320/1000G
- IBM 5320/1000G

## WE WILL BEAT ANY ADVERTISED PRICE! - WHY CALL ANYONE ELSE?

## EXPANSION BOARDS

- Everex RAM 3000 Deluxe
  - $139
- BacoRom/AT Plus
  - $199
- Orchid 8/16
  - $299

## DRAM CHIPS

- 1MBX1
  - $199
- 4MBX4
  - $299
- 2MBX8
  - $349

## ORDER NOW!

1-800-535-5892

TOLL FREE FROM ANYWHERE IN THE US OR CANADA

WE ACCEPT VISA, MASTERCARD, AND AMERICAN EXPRESS!

Circle 110 on Inquiry Card (RESELLERS: 111).
**X.25, SDLC, QLLC, HDLC, ADCCP, PAD**

- C source code
- ROM-able
- Full porting provided
- No optional requirements

GCOM, Inc.
1776 E. Washington
Urbana, IL 61801
(217) 337-4471

Specialists in Computer Communications
FAX 217-337-4740

---

**SuperSound TurboSound**

SoundFX-III - Stereo - Mono - Eng - Jr SoundBytes SoundJr, SoundCard, Digital Audio Authoring Workstation, MSC/TurboC/Windows 3.0 Libraries, Custom Sound Hardware/Software

**ALL WE DO IS SOUND!**

**IBM-PC DIGITAL VOICE / SOUND**

- from only $20 to 5000 dollars (depending on kit)

SuperSound TurboSound
1520 Campbell Ave. #112, San Jose, CA 95130.

Technical: 408-446-4521

# Free leaflets and catalogues

**Info**
**Topic**
00011 Printer buffers. Perhaps the simplest way to speed up a computer system.
00021 The ideal interface is like a cable: Easy to install. Invisible in use.
00031 T-Switches and Auto-switches. Optimized for easy operation.
00041 Data cables. Highly flexible. Simple to install. A well thought-out system.
00051 Interface Cards. Carefully developed to eliminate application problems.
00401 ToolArt: Useful art for computer professionals.
00511 Brauns beats money. Enhancements you can install yourself.
00521 UNIX-Installations. Tips & products.
00531 The right way to install a computer.

---

**Remove Hardware Locks**

Software utility that allows for the removal of hardware locks. Don’t wait for your lock or key device to fail or be stolen.

**EASY - SIMPLE - GUARANTEED**

The following packages are available:
- Microstation $399.00 CadKey $399.00
- Cadvance $ 99.00 PCAD $ 99.00
- MicroCadami $150.00 Pads PCB $99.00
- SmartCam $250.00 Pspice $250.00
- MasterCam $250.00 Tango $99.00
- Maxroute $250.00 Superroute $150.00

Call for other Products
All prices in U.S. Funds Plus Shipping
VISA · Mastercard -AMEX, Welcome
SafeSoft Systems Inc.
202-1100 Concordia Ave.
Winnipeg,MB R2K 4B8 CANADA
Phone (204) 669-4639
Fax (204) 668-5566
**EVEREX**

**LOW PRICES SINCE 1983**

International Orders
We Honor Manufacturer's Warranties
Call for details

---

**EVEREX System I**
CALL
Everex Step 386SX-2 meg
40 meg VGA card and monitor

**EVEREX System II**
CALL
Everex Step 386/33-4 meg
150 meg VGA card and monitor
*Call for models & configurations*

---

**AGI COMPUTER**
AGI 386SX-1 meg
40 meg VGA card and monitor
CALL FOR OTHER MODELS

---

**LAPTOP**
Texas Instruments TM2000 ................................ 1995
Texas Instruments TM3000 ................................ 3495
AST Exec. 386SX/20-40 meg ............................. 3150
Compaq LTE/286-40 meg ................................. 2875
Compaq LTE/386-60 meg .................................. 4995
Sharp 6260-20 meg ....................................... 2195

**CALL FOR OTHER BRANDS**

---

**LAPTOP MEMORY**
2 meg Toshiba 3100SX ................................ 179
2 meg Toshiba 5200 ..................................... 185
2 meg Toshiba 3200SX ................................ 180
1 meg Compaq SLT/LTE .................................. 220

---

**SOFTWARE SPECIAL**
dBase IV .................................................. 455
Wordperfect 5.1 ........................................ 260
Aldus Pagemaker ......................................... 495
Ventura Publisher ........................ 525
Clipper .................................................. 535
Wordstar 5.1 ........................................... 150
EasyExtra ................................................. 40

---

**HARD DISKS**
CONNER CP3044 40 meg .................................. 305
CP3104 100 meg ......................................... 525
CP30104 120 meg ........................................ 575
CP3204F 220 meg ......................................... 845

---

**MAXTOR**
XTB760E 676 meg ...................................... 1895
XTB760S 676 meg ....................................... 2150
Call for Optical and W.O.R.M. Drives
Call for other brands

---

**PACIFIC DATA PRODUCTS**
P. Page II ............................................. 345
P. Page IIP ............................................ 355
P. 1-2-4 Mem II ..................................... 140
P. One Meg IIP ....................................... 145
P. 25 in One .......................................... 250
P. Headlines .......................................... 245

---

**LAN BOARDS**
8 bit Acorn ........................................... 110
16 bit Acorn ........................................... 220
8 bit Ethernet .......................................... 190
16 bit Ethernet ......................................... 275
8 port Active Hub .................................... 325
Token Ring Card ...................................... 399
Tokenhub 4-port ...................................... 355
Call for other LAN Accessories

---

**SPECIALS**
HP Scan Jet ........................................... 1425
HP Paint Jet ........................................... 965
Lotus Ver. 3.1 ........................................ 365
Kodak 150P ............................................ 345
Canon BJ 10 .......................................... 345
Intel Satisfaction .................................. 425
Okidata 391 .......................................... 615
Epson LP 1050 ......................................... 625
HP-7475 Plotter ...................................... 1495
IBM Token-Ring ..................................... 655
Panasonic 1124 ....................................... 299
Intel 80387-33 ......................................... 565

---

**LASER PRINTERS**
HP Laser IIID ........................................ 2565
HP Laser 2P ......................................... 995
HP Laser III .......................................... 1650
Panasonic 4450 ....................................... 1395
NEC 2 Model 90 ...................................... 1695
NEC 2 Model 290 .................................... 2675
TI PS17 ................................................. 1595

---

**MODEMS**
Everex 2400 Int/Mulp --------- 179
Hayes 2408 ........................................ 315
Hayes 9600 ........................................... 875
USRrobotics Hdl/Dual ........................... 1150
More in stock ...................................... Call

---

**COMPUTERLANE**

Outside California: 1-800-526-3482
Inside California: 818-884-8644 • FAX: 818-884-8253

22107 Roscoe Blvd., Canoga Park, CA 91304 • 1/2 Block west of Topanga Hours: Monday - Friday 9 - 6 Saturday 10 - 6

Compaq is a Registered Trademark of Compaq. IBM is a Registered Trademark of International Business Machines.

Circle 75 on Inquiry Card.

JUNE 1991 • BYTE 397
Circle 394 on Inquiry Card.

Circle 145 on Inquiry Card.

Circle 363 on Inquiry Card.

Circle 355 on Inquiry Card.

Circle 26 on Inquiry Card.

Circle 395 on Inquiry Card.

Circle 166 on Inquiry Card.

Circle 169 on Inquiry Card.

Circle 256 on Inquiry Card.
### LAPTOPS

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toshiba</td>
<td>Toshiba 1000</td>
<td></td>
<td>$650</td>
</tr>
<tr>
<td></td>
<td>Toshiba 1000GE</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Toshiba 1200/1200XE</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Toshiba 2000</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Toshiba 1600/20</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Toshiba 3100SX/40</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Toshiba 3100E/40</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Toshiba 3200/3200SX</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Toshiba 5200/40/100</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td>Compaq</td>
<td>Compaq LTE-20</td>
<td></td>
<td>$1,945</td>
</tr>
<tr>
<td></td>
<td>Compaq LTE-286/20</td>
<td></td>
<td>$2,495</td>
</tr>
<tr>
<td></td>
<td>Compaq LTE-286/40</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Compaq SLT-286/20</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Compaq SLT-286/40</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td>Panasonic</td>
<td>Panasonic CF-150</td>
<td></td>
<td>$599</td>
</tr>
<tr>
<td></td>
<td>Panasonic CF-120</td>
<td></td>
<td>$1,999</td>
</tr>
<tr>
<td></td>
<td>Panasonic CF-270</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td>Texas Instruments</td>
<td>TM2000 Notebook 286/20MB VGA</td>
<td></td>
<td>$2,399</td>
</tr>
<tr>
<td></td>
<td>LT286 VGA:20MB/40MB</td>
<td></td>
<td>$2,249/2,349</td>
</tr>
<tr>
<td>Sharp</td>
<td>Sharp MZ-100</td>
<td></td>
<td>$695</td>
</tr>
<tr>
<td></td>
<td>Sharp MZ-200</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Sharp MZ-250</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Sharp PC-4741</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Sharp PC-5741</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Sharp PC-6220</td>
<td></td>
<td>$2,495</td>
</tr>
<tr>
<td>Epson</td>
<td>286E 20MB Removable</td>
<td></td>
<td>$2,198</td>
</tr>
<tr>
<td></td>
<td>286E 40MB Removable</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>286SX 20MB Removable</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>286SX 40MB Removable</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>286SX Notebook</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td>Sharp</td>
<td>Sharp MZ-100</td>
<td></td>
<td>$695</td>
</tr>
<tr>
<td></td>
<td>Sharp MZ-200</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Sharp MZ-250</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Sharp PC-4741</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Sharp PC-5741</td>
<td></td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>Sharp PC-6220</td>
<td></td>
<td>$2,495</td>
</tr>
<tr>
<td>LEADING EDGE</td>
<td>386SX-40MB VGA:1MB</td>
<td></td>
<td>$1,999</td>
</tr>
<tr>
<td></td>
<td>386SX-40MB VGA:2MB</td>
<td></td>
<td>$2,149</td>
</tr>
<tr>
<td>Mitsu</td>
<td>Mitsu CTH-100</td>
<td></td>
<td>$3,499</td>
</tr>
<tr>
<td></td>
<td>Mitsu CTH-120</td>
<td></td>
<td>$3,999</td>
</tr>
<tr>
<td></td>
<td>Mitsu CTH-286</td>
<td></td>
<td>$3,999</td>
</tr>
<tr>
<td></td>
<td>Mitsu CTH-310</td>
<td></td>
<td>$4,999</td>
</tr>
<tr>
<td></td>
<td>Mitsu CTH-520</td>
<td></td>
<td>$6,555</td>
</tr>
<tr>
<td></td>
<td>Mitsu CTH-1000</td>
<td></td>
<td>$1,550</td>
</tr>
<tr>
<td>NEC</td>
<td>ProSpeed 286/386SX-18</td>
<td>1MB</td>
<td>$499</td>
</tr>
<tr>
<td></td>
<td>ProSpeed 386SX-18</td>
<td>2MB</td>
<td>$650</td>
</tr>
<tr>
<td></td>
<td>ProSpeed 386SX-18</td>
<td>8MB</td>
<td>$1,675</td>
</tr>
<tr>
<td></td>
<td>Sharp MultiSync 2A VGA</td>
<td></td>
<td>$499</td>
</tr>
<tr>
<td></td>
<td>Sharp MultiSync 3D VGA</td>
<td></td>
<td>$579</td>
</tr>
<tr>
<td></td>
<td>Sharp MultiSync 40 VGA</td>
<td></td>
<td>$990</td>
</tr>
<tr>
<td></td>
<td>Sharp MultiSync 5D VGA</td>
<td></td>
<td>$2,245</td>
</tr>
<tr>
<td>NEC</td>
<td>NEC multiSync 2A VGA</td>
<td></td>
<td>$499</td>
</tr>
<tr>
<td></td>
<td>NEC multiSync 3D VGA</td>
<td></td>
<td>$579</td>
</tr>
<tr>
<td></td>
<td>NEC multiSync 40 VGA</td>
<td></td>
<td>$990</td>
</tr>
<tr>
<td></td>
<td>NEC multiSync 5D VGA</td>
<td></td>
<td>$2,245</td>
</tr>
</tbody>
</table>

### PRINTER SPECIALS

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citizen</td>
<td>1200/1800</td>
<td>$275/158</td>
</tr>
<tr>
<td></td>
<td>GSX-140/200GXS</td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>GSX-145</td>
<td>CALL</td>
</tr>
<tr>
<td>HP</td>
<td>LaserJet Series III</td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>LaserJet IID</td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>LaserJet 150</td>
<td>CALL</td>
</tr>
<tr>
<td></td>
<td>DeskJet 500</td>
<td>CALL</td>
</tr>
<tr>
<td>Panasonic</td>
<td>1120/1180</td>
<td>$257/158</td>
</tr>
<tr>
<td></td>
<td>1141</td>
<td>$257/158</td>
</tr>
<tr>
<td></td>
<td>1162/1665</td>
<td>$355/410</td>
</tr>
<tr>
<td></td>
<td>4420</td>
<td>$789</td>
</tr>
<tr>
<td></td>
<td>4450</td>
<td>$1,195</td>
</tr>
<tr>
<td></td>
<td>4455</td>
<td>$1,998</td>
</tr>
</tbody>
</table>

### HARD DRIVES

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seagate</td>
<td>ST157A IDE 28MB 44MB 3.5&quot;</td>
<td>$225</td>
</tr>
<tr>
<td></td>
<td>ST1102 IDE 19MB 89MB 3.5&quot;</td>
<td>$375</td>
</tr>
<tr>
<td></td>
<td>ST1144 IDE 19MB 125MB 3.5&quot;</td>
<td>$460</td>
</tr>
<tr>
<td></td>
<td>ST1259 IDE 15MB 210MB 3.5&quot;</td>
<td>$750</td>
</tr>
<tr>
<td>Conner</td>
<td>C2002 IDE 27ms 21MB 3.5&quot;</td>
<td>$275</td>
</tr>
<tr>
<td></td>
<td>C2005 IDE 27ms 42MB 3.5&quot;</td>
<td>$275</td>
</tr>
<tr>
<td></td>
<td>C3000 IDE 27ms 84MB 3.5&quot;</td>
<td>$275</td>
</tr>
<tr>
<td></td>
<td>C2010 IDE 27ms 104MB 3.5&quot;</td>
<td>$450</td>
</tr>
</tbody>
</table>

### Laptop Memory

<table>
<thead>
<tr>
<th>Model</th>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toshiba</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Terms & Conditions:** VISA, MC, UPS, C.O.D. or Prepayment, 20%. Additional $15 per shipping carton, cash or cashier’s check. A.C.T. is no longer serving the continental U.S. and Europe. Prices and availability subject to change. Net 30 F.O.B. accepted from local, state, and federal government agencies, all other net 30 requests are subject to approval.

**American Computer Technology**

**Hours:** Monday - Friday
7:30-5:00 (PST)
(714)354-5144 Fax (714)354-5803
12492 Galway # E, Garden Grove, CA 92646

Circle 19 on Inquiry Card (RESELLERS: 20).

JUNE 1991 • BYTE 399
In an effort to make your telephone purchasing a more successful and pleasurable activity, The Microcomputer Marketing Council of the Direct Marketing Association, Inc. offers this advice, "A knowledgeable buyer will be a successful buyer." These are specific facts you should know about the prospective seller before placing an order:

**Ask These Important Questions**
- How long has the company been in business?
- Does the company offer technical assistance?
- Is there a service facility?
- Are manufacturer's warranties handled through the company?
- Does the seller have formal return and refund policies?
- Is there an additional charge for use of credit cards?
- Are credit card charges held until time of shipment?
- What are shipping costs for items ordered?

Reputable computer dealers will answer all these questions to your satisfaction. Don't settle for less when buying your computer hardware, software, peripherals and supplies.

**Purchasing Guidelines**
- State as completely and accurately as you can what merchandise you want including brand name, model number, catalog number.
- Establish that the item is in stock and confirm shipping date.
- Confirm that the price is as advertised.
- Obtain an order number and identification of the sales representative.
- Make a record of your order, noting exact price including shipping, date of order, promised shipping date and order number.

If you ever have a problem, remember to deal first with the seller. If you cannot resolve the problem, write to MAIL ORDER ACTION LINE, c/o DMA, 6 E. 43rd St., New York, NY 10017.

This message is brought to you by:
the MICROCOMPUTER MARKETING COUNCIL of the Direct Marketing Association, Inc.
6 E. 43rd St.,
New York, NY 10017
H. Co. Computer Products
America's Largest Selection of Memory

Orders: 1-800-726-2477 Ext 200
Tech Support: 1-714-833-3364
Information: 1-714-833-3222
FAX: 1-714-833-3389
Irvine, CA 92714

MATH CO-PROCESSORS

GyriX (Up to 50% faster than Intel)

Part | PRICE
--- | ---
83374-16 | $259.00
83378-05 | $299.00
83371-07 | $329.00
83367-20 | $369.00
83375-33 | $459.00

CALL FOR INTEL PRICES

LAPTOP MEMORY

Model | Memory Added | Part # | PRICE
--- | --- | --- | ---
TOSHIBA T1000SE, XE & 2000SX | 4MB KIT | PC14-PA2031U | $199.00
| 8MB KIT | PC14-PA2032U | $299.00
T1200 | 2MB KIT | PC28-PA2034U | $169.00
| 4MB KIT | PC28-PA2035U | $249.00
T1300SX | 2MB KIT | PC16-PA2036U | $169.00
| 4MB KIT | PC16-PA2037U | $249.00
T1001 | 2MB KIT | PC9-PA2041U | $169.00
| 4MB KIT | PC9-PA2042U | $249.00
T3000 | 2MB KIT | PC12-PA2051U | $169.00
| 4MB KIT | PC12-PA2052U | $249.00
T3500 | 2MB KIT | PC7-PA2081U | $169.00
| 4MB KIT | PC7-PA2082U | $249.00
8500 | 4MB KIT | PC16-PA2083U | $259.00

COMPAC

Portable III Model/Interface
- 4-MB BD PC3-503E | $159.00
- 5-1/4 HD PC3-504E | $199.00
- 4-MB BD PC3-505E | $199.00
- 5-1/4 HD PC3-506E | $219.00
- 8-MB BD PC3-508E | $259.00

PROSPECT S200
- 4-MB BD PC4-521 | $289.00
- 8-MB BD PC4-522 | $329.00
- 16-MB BD PC4-524 | $529.00

PROSPECT 266
- 4-MB BD PC2-521 | $219.00
- 8-MB BD PC2-522 | $319.00
- 16-MB BD PC2-524 | $519.00

INTEL LIFETIME WARRANTY ON ALL MODULES

LIFETIME WARRANTY ON ALL MODULES

TERMS:
- We accept POs from universities, government agencies, and qualified firms.
- MC, VISA, COO, prepay and approved POs only.
- We accept international orders.
- We accept orders through the FAX.
- 15% restocking fee on returns within 30 days. No returns after 30 days.
- No software return.
- All prices are final after sale.
- Trademarks are registered with their respective companies. Prices are subject to change.

Circle 141 on Inquiry Card (RESELLERS: 142).
JUNE 1991 • BYTE 401
INDEX BY COMPANY

Index of companies covered in articles, columns, or news stories in this issue.
Each reference is to the first page of the article or section in which the company name appears.

<table>
<thead>
<tr>
<th>Company, Page #</th>
<th>Inquiry #</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Access Technology, 171</td>
<td>1208</td>
</tr>
<tr>
<td>Acer America, 25</td>
<td>1206</td>
</tr>
<tr>
<td>Adobe Systems, 311, 325</td>
<td>1036</td>
</tr>
<tr>
<td>Advanced Logic Research, 36, 199, 255, 282</td>
<td>1075</td>
</tr>
<tr>
<td>Advanced Micro Devices, 10, 36</td>
<td>1172</td>
</tr>
<tr>
<td>Agfa Compugraphic, 325</td>
<td>1036</td>
</tr>
<tr>
<td>Alcom, 74</td>
<td>1308</td>
</tr>
<tr>
<td>Aldus, 325</td>
<td>112</td>
</tr>
<tr>
<td>Alliant Computer Systems, 231, 255</td>
<td>1035</td>
</tr>
<tr>
<td>American Robotics, 199</td>
<td>1106</td>
</tr>
<tr>
<td>American Society for Artificial Intelligence, 139</td>
<td>1077</td>
</tr>
<tr>
<td>American Megatrends, 231, 255</td>
<td>1037</td>
</tr>
<tr>
<td>American Micabit, 255</td>
<td>1036</td>
</tr>
<tr>
<td>Amkly Systems, 25</td>
<td>1039</td>
</tr>
<tr>
<td>Apco Group, 25</td>
<td>1242</td>
</tr>
<tr>
<td>Apple Computer, 25, 42, 124, 139, 151, 337</td>
<td>1165</td>
</tr>
<tr>
<td>Applied Engineering, 68</td>
<td>1226</td>
</tr>
<tr>
<td>Applied Micro, 325</td>
<td>1283</td>
</tr>
<tr>
<td>ArtelSoft, 151, 255</td>
<td>1041</td>
</tr>
<tr>
<td>Astronomical Network Research, 88</td>
<td>1148</td>
</tr>
<tr>
<td>AT&amp;T, 124, 139, 245</td>
<td>1244</td>
</tr>
<tr>
<td>AT&amp;T Computer Systems, 255</td>
<td>1042</td>
</tr>
<tr>
<td>Atari, 124</td>
<td>1287</td>
</tr>
<tr>
<td><strong>B</strong> Beame &amp; Whiteside, 25</td>
<td>1209</td>
</tr>
<tr>
<td>Bitstream, 311</td>
<td>1220</td>
</tr>
<tr>
<td>Blue Sky Software, 80</td>
<td>1273</td>
</tr>
<tr>
<td>Bynoth Software, 151</td>
<td>1228</td>
</tr>
<tr>
<td>Borland International, 25, 52, 89, 139, 151, 171, 301</td>
<td>1157</td>
</tr>
<tr>
<td><strong>C</strong> Cadmus, 153</td>
<td>1206</td>
</tr>
<tr>
<td>California Institute of Technology, 199</td>
<td>1229</td>
</tr>
<tr>
<td>Candlelight Software, 151</td>
<td>1157</td>
</tr>
<tr>
<td>Canon, 25</td>
<td>1170</td>
</tr>
<tr>
<td>CaxiWork, 151</td>
<td>1226</td>
</tr>
<tr>
<td>Cheetah Computer Systems, 89</td>
<td>1229</td>
</tr>
<tr>
<td>Chiron America, 369</td>
<td>1150</td>
</tr>
<tr>
<td>Chisholm, 70</td>
<td>1302</td>
</tr>
<tr>
<td>Chorus International, 153</td>
<td>1233</td>
</tr>
<tr>
<td>Chrysler, 153</td>
<td>1227</td>
</tr>
<tr>
<td>Cigna, 139, 151</td>
<td>1310</td>
</tr>
<tr>
<td><strong>D</strong> DasEasy, 171</td>
<td>1047</td>
</tr>
<tr>
<td>Data General, 255</td>
<td>1048</td>
</tr>
<tr>
<td>Dassault Systèmes, 255</td>
<td>1084</td>
</tr>
<tr>
<td>DDI, 25</td>
<td>1105</td>
</tr>
<tr>
<td>DFM Systems, 66</td>
<td>1105</td>
</tr>
<tr>
<td>Diamonz, 25</td>
<td>1230</td>
</tr>
<tr>
<td>Digital Communications Associates, 74</td>
<td>1233</td>
</tr>
<tr>
<td>Digital Equipment, 25, 139, 199, 209, 255</td>
<td>1234</td>
</tr>
<tr>
<td>Digital Research, 89, 124, 151</td>
<td>1152</td>
</tr>
<tr>
<td>Easle, 139, 151</td>
<td>1039</td>
</tr>
<tr>
<td>Echelon, 153</td>
<td>1094</td>
</tr>
<tr>
<td>Echelon Development, 139, 151</td>
<td>1095</td>
</tr>
<tr>
<td>EE International Computer, 255</td>
<td>1096</td>
</tr>
<tr>
<td>Electronic Arts, 256</td>
<td>1097</td>
</tr>
<tr>
<td>Encore Computer, 219, 255</td>
<td>1098</td>
</tr>
<tr>
<td>Ergo Computing, 25</td>
<td>1100</td>
</tr>
<tr>
<td>Eureka, 70</td>
<td>1099</td>
</tr>
<tr>
<td>Everex Systems, 25, 255, 282</td>
<td>1100</td>
</tr>
<tr>
<td>Excel Software, 80</td>
<td>1101</td>
</tr>
<tr>
<td>Extended Systems, 74, 1310</td>
<td>1102</td>
</tr>
<tr>
<td><strong>F</strong> Ferrari, 153</td>
<td>1237</td>
</tr>
<tr>
<td>Ford, 153</td>
<td>1238</td>
</tr>
<tr>
<td>FormalSoft, 171</td>
<td>1239</td>
</tr>
<tr>
<td>FTP Software, 25</td>
<td>1124</td>
</tr>
<tr>
<td>Fujitsu, 10, 25</td>
<td>1289</td>
</tr>
<tr>
<td><strong>G</strong> Gage Applied Sciences, 70</td>
<td>1243</td>
</tr>
<tr>
<td>GCC Technologies, 67</td>
<td>1244</td>
</tr>
<tr>
<td>General Motors, 139, 151</td>
<td>1253</td>
</tr>
<tr>
<td>Genesis Integrated Systems, 67</td>
<td>1254</td>
</tr>
<tr>
<td>GenSoft Development, 151</td>
<td>1240</td>
</tr>
<tr>
<td>Geoworks, 151</td>
<td>1241</td>
</tr>
<tr>
<td>Gilshkensh, 139</td>
<td>1279</td>
</tr>
<tr>
<td>Great Lakes Business Forms, 70</td>
<td>1280</td>
</tr>
<tr>
<td>Grid Systems, 282</td>
<td>1168</td>
</tr>
<tr>
<td>Guptta Technologies, 139, 151</td>
<td>1169</td>
</tr>
<tr>
<td><strong>H</strong> Harris, 10</td>
<td>1210</td>
</tr>
<tr>
<td>Hercules Computer Technology, 258</td>
<td>1211</td>
</tr>
<tr>
<td>Hewlett-Packard, 25, 52, 124, 139, 151, 311, 325, 351</td>
<td>1168</td>
</tr>
<tr>
<td>Hitachi, 25</td>
<td>1212</td>
</tr>
<tr>
<td>Hitachi Sales Corp. of America, 369</td>
<td>1169</td>
</tr>
<tr>
<td><strong>I</strong> IBM, 25, 139, 151, 343</td>
<td>1170</td>
</tr>
<tr>
<td>IBM Japan, 25</td>
<td>1245</td>
</tr>
<tr>
<td>IGC, 25</td>
<td>1286</td>
</tr>
<tr>
<td>Image Communications, 78</td>
<td>1124</td>
</tr>
<tr>
<td>ImageSoft, 151</td>
<td>1125</td>
</tr>
<tr>
<td>Information Resources, 171</td>
<td>1126</td>
</tr>
<tr>
<td>Informix Software, 171</td>
<td>1127</td>
</tr>
<tr>
<td>Integrated Computer Solutions, 139, 151</td>
<td>1128</td>
</tr>
<tr>
<td>Intel, 10, 25, 36, 89, 245</td>
<td>1129</td>
</tr>
<tr>
<td>Intel Multiprocessor Consortium, 196, 245</td>
<td>1130</td>
</tr>
<tr>
<td>Intel Scientific Computers, 231, 255</td>
<td>1131</td>
</tr>
<tr>
<td>IntelliCorp, 139, 151, 351</td>
<td>1132</td>
</tr>
<tr>
<td>Intellinlink, 82</td>
<td>1133</td>
</tr>
<tr>
<td>InterCon, 151</td>
<td>1134</td>
</tr>
<tr>
<td>Interlink, 25</td>
<td>1135</td>
</tr>
<tr>
<td>IXI, 139, 151</td>
<td>1136</td>
</tr>
<tr>
<td><strong>J</strong> Jensen &amp; Partners International, 139</td>
<td>1137</td>
</tr>
<tr>
<td>JPI, 151</td>
<td>1138</td>
</tr>
<tr>
<td><strong>K</strong> Kinetix, 88</td>
<td>1220</td>
</tr>
<tr>
<td>Knowledge Garden, 139, 151, 351</td>
<td>1139</td>
</tr>
<tr>
<td>Kobuta, 25</td>
<td>1140</td>
</tr>
<tr>
<td><strong>L</strong> Laboratory Technologies, 68</td>
<td>1246</td>
</tr>
<tr>
<td>Language Systems, 89</td>
<td>1153</td>
</tr>
<tr>
<td>Laser Magnetic Storage International, 369</td>
<td>1154</td>
</tr>
<tr>
<td><strong>M</strong> Massachusetts General Hospital, 351</td>
<td>1155</td>
</tr>
<tr>
<td>Mathematica, 256</td>
<td>1156</td>
</tr>
<tr>
<td>Matsushita, 25</td>
<td>1236</td>
</tr>
<tr>
<td>MCAE Technologies, 305</td>
<td>1157</td>
</tr>
<tr>
<td>MDBS, 151</td>
<td>1257</td>
</tr>
<tr>
<td>Megahertz, 25, 107</td>
<td>1160</td>
</tr>
<tr>
<td>Meiko Scientific, 25, 1058</td>
<td></td>
</tr>
<tr>
<td>Mercury Computer Systems, 255</td>
<td>1240</td>
</tr>
<tr>
<td>Micro Solutions Computer Products, 369</td>
<td>1161</td>
</tr>
<tr>
<td>Microsoft, 25, 139, 151, 171, 209</td>
<td>1241</td>
</tr>
<tr>
<td>MicroWay, 255</td>
<td>1162</td>
</tr>
<tr>
<td>MIPS Computer Systems, 255</td>
<td>1163</td>
</tr>
<tr>
<td>MIT, 351</td>
<td>1164</td>
</tr>
<tr>
<td>Mitsubishi, 25</td>
<td>1165</td>
</tr>
<tr>
<td>Motorola, 153</td>
<td>1166</td>
</tr>
<tr>
<td>Mozait Systems, 139, 151</td>
<td>1167</td>
</tr>
<tr>
<td>Mylex, 255</td>
<td>1168</td>
</tr>
<tr>
<td><strong>N</strong> NEC, 25, 245, 294</td>
<td>1205</td>
</tr>
<tr>
<td>NEC, 25</td>
<td>1206</td>
</tr>
<tr>
<td>NEC Technologies, 369</td>
<td>1207</td>
</tr>
<tr>
<td>NeuralWare, 255</td>
<td>1169</td>
</tr>
<tr>
<td>Next, 25, 151, 297</td>
<td>1208</td>
</tr>
<tr>
<td>Nippon Denso, 153</td>
<td>1209</td>
</tr>
<tr>
<td>NKK, 25</td>
<td>1210</td>
</tr>
<tr>
<td>Northgate Computer Systems, 25</td>
<td>1211</td>
</tr>
<tr>
<td>Novell, 255</td>
<td>1170</td>
</tr>
<tr>
<td>NTT, 25, 363</td>
<td>1212</td>
</tr>
<tr>
<td>NTTTS L's Commercial Test Division, 171</td>
<td>1213</td>
</tr>
<tr>
<td>Nth Graphics, 86</td>
<td>1214</td>
</tr>
<tr>
<td>Numonica, 258</td>
<td>1409</td>
</tr>
<tr>
<td><strong>O</strong> Oki Electric, 25</td>
<td>1215</td>
</tr>
<tr>
<td>Olddata, 245</td>
<td>1216</td>
</tr>
<tr>
<td>Olivetti, 25, 245</td>
<td>1217</td>
</tr>
<tr>
<td>Open Software Foundation, 124, 151, 153, 255, 369</td>
<td>1218</td>
</tr>
<tr>
<td>Oracle, 25, 343</td>
<td>1219</td>
</tr>
<tr>
<td>Orange Micro, 68</td>
<td>1220</td>
</tr>
<tr>
<td>Oregon Advanced Computing Institute, 369</td>
<td>1221</td>
</tr>
<tr>
<td>Outbound Systems, 357</td>
<td>1164</td>
</tr>
</tbody>
</table>
A Message to Our Subscribers

From time to time we make the BYTE subscriber list available to other companies who wish to send our subscribers material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services, or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

Many BYTE subscribers appreciate this controlled use of our mailing list, and look forward to finding information of interest to them in the mail. Used are our subscribers’ names and addresses only (no other information we may have is ever given).

While we believe the distribution of this information is of benefit to our subscribers, we firmly respect the wishes of any subscriber who does not want to receive such promotional literature. Should you wish to restrict the use of your name, simply send your request to the following address.

BYTE Magazine
ATTN: Subscriber Service
P.O. Box 555
HIGHTSTOWN, NJ 08520
To get further information on the products advertised in BYTE, fill out the reader service card by circling the numbers on the card that correspond to the inquiry number listed with the advertiser. This index is provided as an additional service by the publisher, who assumes no liability for errors or omissions.
# INDEX TO ADVERTISERS BY PRODUCT CATEGORY

<table>
<thead>
<tr>
<th>Inquiry No.</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HARDWARE</strong></td>
<td></td>
</tr>
<tr>
<td>406</td>
<td>ADD-INS</td>
</tr>
<tr>
<td>384</td>
<td>A.P.D.</td>
</tr>
<tr>
<td>21</td>
<td>AMERICAN MEGATRENDS</td>
</tr>
<tr>
<td>22</td>
<td>AMERICAN MEGATRENDS</td>
</tr>
<tr>
<td>47</td>
<td>AUTOMATED COMPUTER</td>
</tr>
<tr>
<td>48</td>
<td>BOFFIN LTD</td>
</tr>
<tr>
<td>225</td>
<td>BRIER TECHNOLOGY (N.A.)</td>
</tr>
<tr>
<td>21</td>
<td>BRIER TECHNOLOGY (N.A.)</td>
</tr>
<tr>
<td>67</td>
<td>CIPHER DATAPRODUCTS</td>
</tr>
<tr>
<td>134</td>
<td>CITYONIC TECHNOLOGIES</td>
</tr>
<tr>
<td>468</td>
<td>COMPAC (INT'L)</td>
</tr>
<tr>
<td>134</td>
<td>COMPUTER SYSTEMS, INC.</td>
</tr>
<tr>
<td>126</td>
<td>CONNECTIC TECHNOLOGY</td>
</tr>
<tr>
<td>33</td>
<td>CRYPTO TECHNOLOGIES</td>
</tr>
<tr>
<td>45</td>
<td>DAEWOO</td>
</tr>
<tr>
<td>55</td>
<td>DATA SECURITY</td>
</tr>
<tr>
<td>55</td>
<td>DATA SECURITY</td>
</tr>
<tr>
<td>135</td>
<td>DATATRANS SYSTEMS</td>
</tr>
<tr>
<td>631</td>
<td>DATATRANS SYSTEMS</td>
</tr>
<tr>
<td>829</td>
<td>DATAWARE</td>
</tr>
<tr>
<td>830</td>
<td>DATEX SYSTEMS</td>
</tr>
<tr>
<td>332</td>
<td>DATEX SYSTEMS</td>
</tr>
<tr>
<td>584</td>
<td>DATATRANS SYSTEMS</td>
</tr>
<tr>
<td>154</td>
<td>DELL (N.A.)</td>
</tr>
<tr>
<td>94</td>
<td>DIGITAL DECISION SERVICES</td>
</tr>
<tr>
<td>71</td>
<td>COMPUCOM</td>
</tr>
<tr>
<td>45</td>
<td>DIGITAL DECISION SERVICES</td>
</tr>
<tr>
<td>308</td>
<td>TECHNOLOGY POWER ENT</td>
</tr>
<tr>
<td>310</td>
<td>TEKTRONIX</td>
</tr>
<tr>
<td>311</td>
<td>TEKTRONIX</td>
</tr>
<tr>
<td>243</td>
<td>TOUCHBASE SYSTEMS</td>
</tr>
<tr>
<td>822</td>
<td>STB SYSTEMS, INC</td>
</tr>
<tr>
<td>601</td>
<td>STB SYSTEMS, INC</td>
</tr>
<tr>
<td>602</td>
<td>STB SYSTEMS, INC</td>
</tr>
<tr>
<td>238</td>
<td>PERISCOPE CO., THE</td>
</tr>
<tr>
<td>234</td>
<td>PC TECH, INC.</td>
</tr>
<tr>
<td>294</td>
<td>STEC ELECTRONICS</td>
</tr>
<tr>
<td>299</td>
<td>SUMMAGRAPHICS</td>
</tr>
<tr>
<td>301</td>
<td>SUMMAGRAPHICS</td>
</tr>
<tr>
<td>304</td>
<td>SUMMAGRAPHICS</td>
</tr>
<tr>
<td>305</td>
<td>TALKING TECHNOLOGY</td>
</tr>
<tr>
<td>218</td>
<td>NORAD CORPORATION</td>
</tr>
<tr>
<td>217</td>
<td>NORAD CORPORATION</td>
</tr>
<tr>
<td>388</td>
<td>KNAPCO</td>
</tr>
<tr>
<td>150</td>
<td>INTEGRATED INFO TECH</td>
</tr>
<tr>
<td>140</td>
<td>HOULEONCORP</td>
</tr>
<tr>
<td>39</td>
<td>APO</td>
</tr>
<tr>
<td>299</td>
<td>SUMMAGRAPHICS</td>
</tr>
<tr>
<td>413</td>
<td>BEHAVIOR TECH COMP., CORP.</td>
</tr>
<tr>
<td>14</td>
<td>ALA</td>
</tr>
<tr>
<td>226</td>
<td>SAGE</td>
</tr>
<tr>
<td>366</td>
<td>XELTEK</td>
</tr>
<tr>
<td>326</td>
<td>PLUS DEVELOPMENT</td>
</tr>
<tr>
<td>157</td>
<td>LINKCOMPUTER</td>
</tr>
<tr>
<td>128</td>
<td>GTEK</td>
</tr>
<tr>
<td>134</td>
<td>HAYES</td>
</tr>
<tr>
<td>810</td>
<td>CADRE TECHNOLOGIES</td>
</tr>
<tr>
<td>39</td>
<td>APO</td>
</tr>
<tr>
<td>438</td>
<td>GETRONICS</td>
</tr>
<tr>
<td>248</td>
<td>QUA TECH</td>
</tr>
<tr>
<td>211</td>
<td>NCI</td>
</tr>
<tr>
<td>210</td>
<td>NATIONAL INSTRUMENTS</td>
</tr>
<tr>
<td>271</td>
<td>RAINBOW</td>
</tr>
<tr>
<td>278</td>
<td>SAFESOFT SYSTEMS</td>
</tr>
<tr>
<td>595</td>
<td>ONTRACK COMPUTER SYSTEMS</td>
</tr>
<tr>
<td>598</td>
<td>ONTRACK COMPUTER SYSTEMS</td>
</tr>
<tr>
<td>309</td>
<td>TEKTRONIX</td>
</tr>
<tr>
<td>458</td>
<td>NEWGEN SYSTEMS CORP</td>
</tr>
<tr>
<td>312</td>
<td>TRIBAL MICROSYSTEMS</td>
</tr>
<tr>
<td>442</td>
<td>INTEROUAD</td>
</tr>
<tr>
<td>174</td>
<td>LINKCOMPUTER</td>
</tr>
<tr>
<td>129</td>
<td>GTEK</td>
</tr>
<tr>
<td>477</td>
<td>EIZO CORP</td>
</tr>
<tr>
<td>476</td>
<td>v.o.s.</td>
</tr>
<tr>
<td>478</td>
<td>GFK HAMBURG</td>
</tr>
<tr>
<td>150</td>
<td>INTEGRATED INFO TECH</td>
</tr>
<tr>
<td>140</td>
<td>HOULEONCORP</td>
</tr>
</tbody>
</table>

| **GRAPHICS TABLETS** | |
| 298 | SUMMAGRAPHICS | 304 |
| 299 | SUMMAGRAPHICS | 304 |
| 300 | SUMMAGRAPHICS | 304 |
| 301 | SUMMAGRAPHICS | 304 |

| **HARDWARE PROGRAMMERS** | |
| 38 | ANABOOS | 344 |
| 53 | AUTOMATED COMPUTER | 243 |
| 128 | GTEK | 266,267 |

---

* Correspond directly with company.
Inquiry
943 APPLE/MAC APPLICATIONS
To get further information on the products advertised in BYTE, fill out the reader number listed with the advertiser. This index is provided as an additional service.

293 SPSS ...
298 STATSOFT ...
328 TRANS ERA ...
382 WINTEK ...

947 IBM/MSDOS APPLICATIONS

234 ZVLAB CORPORATION ...
375 ZVLAB CORPORATION ...

949 IBM/MSDOS - CAD

100 DIVERSIFIED COMPUTER SYSTEMS ...
119 GALACTICOMM, INC ...
328 WINTEK ...

948 IBM/MSDOS APPLICATIONS

181 AMERICAN SMALL BUSINESS ...
190 GENERICA SOFTWARE ...
348 VERMONT CREATIVE SOFTWARE ...

952 IBM/MSDOS - LAN

373 LOGICAL DEVICES ...
382 LOGICAL DEVICES ...

953 IBM/MSDOS - LANGUAGES

792 ALPC ...
793 ALPC ...

954 IBM/MSDOS APPLICATIONS - Utilities

194 ALPC ...
195 ALPC ...

955 IBM/MSDOS APPLICATIONS - Miscellaneous

156 AMERICAN BUSINESS ...
187 AMERICA MICRO ...
216 AMERICA MICRO ...

956 MISCELLANEOUS

390 OPERATING SYSTEMS

404 ON-LINE SERVICES
There are plenty of places to get information in this industry. Too many. But if you want the best quality information, there's only one that rises to the top: BYTEWEEK.

BYTEWEEK is a weekly newsletter from the same professionals who produce BYTE Magazine. Each week, the most important news and information from the previous week is presented in a readable and concise manner. BYTEWEEK offers you what no other publication can: timely news on the rapidly-evolving computer industry as it happens with the interpretation and evaluation that only BYTE's experienced editorial staff can provide.

Subscribe now and take advantage of a special subscription rate of $395 ($495 outside the U.S. and Canada). Your subscription to BYTEWEEK also includes a free subscription to BIX, BYTE's exclusive on-line conferencing system. Don't miss this opportunity!

For fastest service, call toll-free 1-800-258-5485 [in N.H., call 603-924-9281] and charge to a major credit card or we'll bill you.

BYTEWEEK offers a money-back guarantee if you are not completely satisfied.
## Dynamic RAM

<table>
<thead>
<tr>
<th>PART#</th>
<th>SIZE</th>
<th>SPEED</th>
<th>Pins</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4116-100</td>
<td>16Kx1</td>
<td>150ns</td>
<td>16</td>
<td>1.49</td>
</tr>
<tr>
<td>4141-100</td>
<td>16Kx1</td>
<td>150ns</td>
<td>16</td>
<td>1.39</td>
</tr>
<tr>
<td>4141-120</td>
<td>16Kx1</td>
<td>120ns</td>
<td>16</td>
<td>1.29</td>
</tr>
<tr>
<td>4141-200</td>
<td>16Kx1</td>
<td>200ns</td>
<td>16</td>
<td>2.05</td>
</tr>
<tr>
<td>4142-200</td>
<td>16Kx1</td>
<td>200ns</td>
<td>16</td>
<td>2.05</td>
</tr>
<tr>
<td>4142-250</td>
<td>16Kx1</td>
<td>250ns</td>
<td>16</td>
<td>2.15</td>
</tr>
<tr>
<td>4142-350</td>
<td>16Kx1</td>
<td>350ns</td>
<td>16</td>
<td>2.59</td>
</tr>
</tbody>
</table>

## SIMM/SIP Modules

<table>
<thead>
<tr>
<th>PART#</th>
<th>SIZE</th>
<th>SPEED</th>
<th>Pins</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4144S-80</td>
<td>512Kx8</td>
<td>60ns</td>
<td>24</td>
<td>249.95</td>
</tr>
<tr>
<td>4144S-120</td>
<td>512Kx8</td>
<td>120ns</td>
<td>24</td>
<td>249.95</td>
</tr>
<tr>
<td>4144S-160</td>
<td>512Kx8</td>
<td>160ns</td>
<td>24</td>
<td>249.95</td>
</tr>
<tr>
<td>4144S-200</td>
<td>512Kx8</td>
<td>200ns</td>
<td>24</td>
<td>249.95</td>
</tr>
</tbody>
</table>

## Upright Case

**$249.95**

- For standard, full size and mini-motherboards
- 250 watt power supply
- Mounts for 3 floppy and 4 hard drives
- Turbo and reset switches
- Speed display, power led's
- Mounting hardware, faceplates for daughter and son included.

**CASE-100** — $249.95

### More Cases...

| CASE-200 | UPRIGHT HOLDS 11 DRIVES | $499.95 |
| CASE-120 | MINIUPRIGHT W/200 WATT PS | $199.95 |
| CASE-70 | FULL-SIZE 266-STYLE CASE | $99.95 |
| CASE-50 | MINI-SIZE 266-STYLE CASE | $99.95 |
| CASE-FLIP | FLIP-TOP 8086 STYLE CASE | $99.95 |
| CASE-SLIDE | SLIDE-TYPE 8086 STYLE CASE | $99.95 |
| CASE-JP-200 | J-PARTS WITH 200W PSU | $169.95 |

### Replacement Power Supplies...

| PS-135 | 135 WATT PS FOR 6808 (110/220V) | $59.95 |
| PS-200X | 200 WATT PS FOR 6808 (110/220V) | $89.95 |
| PS-200X | 200 WATT PS FOR 6808 (110/220V) | $89.95 |
| PS-200X | 200 WATT PS FOR 6808 (110/220V) | $89.95 |

### EPROMs

<table>
<thead>
<tr>
<th>PART#</th>
<th>SIZE</th>
<th>SPEED</th>
<th>Vpp</th>
<th>Pins</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2716A-200</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2728A</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2730A</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2764A-200</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2764A-800</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2764A-800</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2716A-200</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2728A</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2730A</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>2764A-200</td>
<td>2048</td>
<td>20ns</td>
<td>28</td>
<td>3.95</td>
<td></td>
</tr>
</tbody>
</table>

### MCT’s Modular Programming System

**$499.95**

- Use 1 slot to program EPROMS, PROMS, PALS & More!

### Host Adaptor Card/Cable

**$29.95**

- Universal interface for all of MCT’s modular cards & modules - Selectable addresses prevent conflicts.

### Universal Module

**$499.95**

- Includes PROMS, EPROMS, PALS, BI-POLAR PROMS, EPROM BURNER, PROM PROGRAMMER, PAL PROGRAMMER, 8085 PROM PROGRAMMER, BIL POLAR PROM PROGRAMMER.

### EPROM Module

**$119.95**

- PROGRAMS 24-32 PIN EPROMS, CMOS EPROMS & 16K TO 256K EPROMS - HEX TO DIP CONVERTER - AUTO. BLANK CHECK/PROGRAM/VERIFY - YYF.5, 5.1, 7.25, 12.75, 13.21, 60V, 78V, 12V - STATIC RAM/L-OAD DISK, DAVE, DSK. ED, BLANK. CHECK, PROGRAM, AUTO., READ MASTER, VERIFY & COMPARISON TO TEXT, ASCII.

### Other Programming Modules...

- MOD-MPP
- MOD-MEP
- MOD-MEP-4

### Pal Development Software

**$99.95**

- Entry level CPU, PAL development software.

**BUY WITH CONFIDENCE FROM JDR!**

- 30-DAY MONEY BACK GUARANTEE
- 1 YEAR WARRANTY
- TOLL-FREE TECH SUPPORT
**Circle 6 on Inquiry Card (RESSELLERS: 7).**

**2400 BAUD MODEM**
- **$89.95**
  - **2400/1200/300 BAUD OPERATION**
  - **HAYES AT COMMAND SET COMPATIBLE**
  - **PROCAM COMMUNICATIONS SOFTWARE COMPLIANT**

**VIVA 2400 BAUD MODEM**
- **$119.95**
  - **2400/1200/300 BAUD OPERATION**
  - **HAYES AT COMMAND SET COMPATIBLE**
  - **MORE ACCESSORIES COMPATIBLE**

**COLOR HAND SCANNER!**
- **$599**
  - **400 DPI COLOR PHOTOCOPIER MODE**
  - **295 1/2 X 240-GRAY SCALE MODE**
  - **MOMO MODE FOR BOTH LINE ART AND TEXT**

**MONITORS**
- **NEC-MULTI-3D**
  - **$499**
  - **1024 X 768 RESOLUTION**
  - **28MM DOT PITCH**
  - **COMPATIBLE WITH 85/4A SUPER VGA, APPLE MAC, VEGA, EGA & CGA**

**1.44MB FLOPPY CONTROLLER**
- **$49.95**
  - **BASED ON EPIK 388**
  - **COMPATIBLE WITH 386, 286, 128 & 1.44 MB**
  - **USER SELECT AS PRIMARY OR SECONDARY (3RD OR 4TH)**
  - **286/386/486 COMPATIBLE**

**INTERFACE CARDS**
- **SYSTEM DIAGNOSTICS CARD**
  - **$49.95**
  - **WORKS WHEN SOFTWARE CYANIC**
  - **286/386/486 COMPATIBLE**
  - **PLUG INTO SLOT, READ LED**
  - **DISPLAY AND CHECK YOUR BIOS**

**BARGAIN HUNTER'S CORNER**
- **WHILE SUPPLIES LAST**
  - **40MB 28MS HARD DISK**
  - **$299**
  - **INcredible Savings ON TWO OF OUR MOST FAVORITE HARD DISK COMPONENTS!**
  - **INCLUDES FAST W1060-V2 MMG FLOPPY/HARD DISK CONTROLLER WITH 80-LOOK-AHEAD TRACK CACHE**
  - **SEAGATE 40MB 28MS HARD DISK DRIVE**
  - **ALL NEW COMPONENTS + NO REFURBS!**
  - **BACKED BY OUR 1 YEAR WARRANTY**

**CIRCLE 6 ON INQUIRY CARD**
Listing 3: The functions for finding and adding words to the trie.

(a) Function FindWord(w:string[l .. n] of characters):LetterNodePointer;
{This function will find the right leaf corresponding to a path from
the root to the nth character of w.}
var
  CurrentNode:LetterNodePointer;
  CurrentLevel:integer;
begin
  Set CurrentNode to the root corresponding to w[1].
  CurrentLevel:=2;
  StillSearching:=true;
  {We are now at a list of the branches at CurrentLevel.}
  while w[CurrentLevel) is not past the end of the word do begin
    Scan along this list started by CurrentNode until the letter
    corresponding to w[CurrentLevel) is found.
    If the letter is found, then set CurrentNode to the down pointer
    here. Increment CurrentLevel.
    Otherwise, exit.
  end;
  if the loop exits because it finds the leaf of the last letter,
  return this leaf.
  else return nil;
end;

(b) Function AddWord(w:string[l .. n] of characters):LetterNodePointer;
{This function will add a word. It is similar to FindWord, except it
will insert new nodes.}
var
  CurrentNode:LetterNodePointer;
  CurrentLevel:integer;
begin
  Set CurrentNode to the root corresponding to w[1].
  CurrentLevel:=2;
  StillSearching:=true;
  {we are now at a list of the branches at CurrentLevel.}
  while w[CurrentLevel) is not past the end of the word do begin
    Scan along this list started by CurrentNode until the letter
    corresponding to w[CurrentLevel] is found.
    If the letter is found, then set CurrentNode to the down pointer
    here. Increment CurrentLevel.
    Otherwise, add the correct letter and the rest of the word.
    end;
  when the loop exists because it finds (or adds) the leaf of the last
  letter, return this leaf.
end;

Nodes Structures

Figure 3: (a) The packing structure for a list node: 22 bits for the pointer and 10 for
the value. (b) The packing structure for a letter node: 3 bytes for a pointer, a bit for a
Boolean, and a byte to hold a character.

continued from page 322
value1; value2; value3;... value_stop
value

This can save plenty of space, but it is not
easy to add and remove values when the
index is being constructed or updated.
The lists can also easily grow into each
other as new values are added, and the
program must be able to repack them—
another bit of complexity. In my index,
there are over 35,000 of these continually
changing lists, and it just doesn't make
sense to try and keep track of the begin-
nings and ends of these lists as they
merge into each other. On the other
hand, if you are indexing a CD-ROM and
the lists will never change, a simple
string of values is quite appropriate.

Memory Management
For each of the three major structures of
this index application, the program uses
data structure nodes that include point-
ers, and these nodes are allocated as
needed. It is possible to use the native
malloc or new functions to create new
nodes on the fly, but this is often very
slow because these memory allocation
routines must maintain many system-
wide tables.

This implementation does its own
memory management for the sake of
speed. At the beginning of the program,
a new memory block is built for each of
the three sections. Large segments of
memory are allocated in one step and
broken up into nodes by the implemen-
tation. The pointers are not absolute but
simply measure the offset from the be-
ginning of the memory chunk. On one
hand, this slows down the program,
because looking up a value at a pointer
cannot happen until the relative location of
the pointer can be converted in the real
location in memory. On the other hand, it
makes node allocation much faster.

The memory chunks are initialized by
filling them with a chain of empty nodes
of the appropriate size. One of the point-
ers in each node points to the next empty
node in the chain. When a new node is
required, the program calls its own inter-
nal memory allocation routine, which
pulls off one of the nodes from the front
of the list. When a node becomes free, it
is placed at the front of the list. This
primitive form of garbage collection
manages and recycles memory by using
the actual structures.

Limiting the List
The current implementation of the pro-
gram stores only the uppercase version of
the words (recall that there are only 26
roots in the trie). Lowercase letters are
converted into their uppercase equivalents, and punctuation and other non-letter characters are converted into spaces. This substantially reduces the keyword list size by increasing the redundancy in the sources. A function it adds is that the searches do not need to be case specific.

Even with all the efficiencies built in, the index may be too large to be efficient. A smaller index means a less precise index, but if compactness is what you want, the word gets deleted. This leaves out slippery, sanguine, and some assembly required. This substantially reduces the keyword list size by increasing the redundancy in the sources. A function it adds is that the searches do not need to be case specific.

Even with all the efficiencies built in, the index may be too large to be efficient. A smaller index means a less precise index, but if compactness is what you want, the word gets deleted. This leaves out slippery, sanguine, and some assembly required. This substantially reduces the keyword list size by increasing the redundancy in the sources. A function it adds is that the searches do not need to be case specific.

Even with all the efficiencies built in, the index may be too large to be efficient. A smaller index means a less precise index, but if compactness is what you want, the word gets deleted. This leaves out slippery, sanguine, and some assembly required. This substantially reduces the keyword list size by increasing the redundancy in the sources. A function it adds is that the searches do not need to be case specific.

Even with all the efficiencies built in, the index may be too large to be efficient. A smaller index means a less precise index, but if compactness is what you want, the word gets deleted. This leaves out slippery, sanguine, and some assembly required. This substantially reduces the keyword list size by increasing the redundancy in the sources. A function it adds is that the searches do not need to be case specific.

Even with all the efficiencies built in, the index may be too large to be efficient. A smaller index means a less precise index, but if compactness is what you want, the word gets deleted. This leaves out slippery, sanguine, and some assembly required. This substantially reduces the keyword list size by increasing the redundancy in the sources. A function it adds is that the searches do not need to be case specific.

Another way to reduce the ambiguity is to compress similar entries into one. The disadvantage of this technique is that the ambiguity must be resolved when the word is looked up, and the returning filenames must be searched to see if they really contain the correct word. For an extreme example of this technique, only the first letter of each word would be stored. The words slow and sanguine would be converted into $s$. The index would be very small—26 entries—but when it came time to look up slippery, the index would return a list of files that contained at least one word beginning with the letter $s$. Obviously, an extreme such as this would not be very useful, but a conservative application of this method can produce a useful index.

This index program has several parameters for controlling the size of the index. The parameters set minimum and maximum bounds on the length of the words that are stored. There are many small words like and, or, a, and the, which are used repeatedly in almost all files. Setting the minimum word length to four characters removes these.

The maximum word count can also affect the size of the index in different ways depending on how the program deals with larger-than-normal words. The program can be set to truncate long words or to break them into overlapping (or non-overlapping) chunks. For example, if the maximum word length is set to three characters, the word Carter is stored as CAR if you choose to truncate. If you choose the overlapping option, it is stored as CAR, ART, RTE, and TER. If you choose the nonoverlapping option, it is stored as CAR and TER. Naturally, when the words are truncated, information is lost. (FOOTBALL and FOOTODOR index as the same word if the maximum word size is set to four letters.)

An advantage of using a trie for the word list is that you can easily find words that begin with a specific prefix by finding the roots underneath the prefix. That means you can easily search for all words that begin with post. The subtree contains post, postal, post office, and many others. Many hashing schemes lose the information about the structure of the words, because they are tuned to give an even distribution.

Freely Available

A working version of this indexing program is available on BIX or in a variety of formats (see page 5 for details). The source code is about 10,000 lines of Think Pascal for the Macintosh. Anyone who wishes to port the code to another system must pay particular attention to the memory allocation routines. It is substantially easier to deal with large blocks of memory on the Macintosh than on DOS machines. My 5-MB system will build an 1800K-byte index without much problem. This amount of memory is becoming more common, so I did not try to save any more by making the structures more efficient. Implementing the program on a smaller system without virtual memory will require building in some swapping of structures to disk or using tighter structures. Implementing it under another operating system also requires modifying the file access routines.

This index system is nearly complete, but it is by no means finished or perfect. For further reading, see The Design and Analysis of Computer Algorithms (Aho, Alfred; Hopcroft, John; and Ullman, Jeffrey. Reading, MA: Addison-Wesley, 1974). It is possible to use other algorithms (e.g., hashing) to build smaller indexes, but they would probably have some degradation in performance. It is also possible to add a third pointer to the alphabet trie to try the list of letters at the same level into a binary tree. This would certainly speed things up, but at the expense of memory. There are many other possibilities for the optimal trade-off between speed and space, but this is an exercise left for the ambitious reader.

Peter Wayner is working toward a Ph.D. in computer science at Cornell University. You can contact him on BIX as "pwayner."

JUNE 1991 • BYTE 413
A Passage from India

East meets West on the level plane of mathematics, as described in the biography of an Indian genius.

In *A Mathematician's Apology* (1940), intensely personal though it plainly is, G. H. Hardy discloses next to nothing about himself. So, 20 years after Hardy's death, to orient readers of a fourth printing, his friend C. P. ("Two Cultures") Snow supplied a biographical foreword. And since Hardy once said that discovering Ramanujan was "the one romantic incident in his life," Snow gave eight pages to the Ramanujan story. His 2000-word version is the one most nonmathematicians know. In its mythic simplicity it has proven pretty hard to forget.

Briefly: A 25-year-old clerk in Madras, India, nearly devoid of formal education, mails 10 handwritten pages to G. H. Hardy at Cambridge. The package arrives early in 1913. The covering letter requests Hardy's opinion of some mathematical discoveries. All the rest of the sheets are crammed with theorems, "most of them wild or fantastic-looking, one or two already well-known, laid out as though they were original. There were no proofs of any kind." Hardy, at 36 already world famous, was routinely pestered by cranks. Therefore, he shrugged and resumed his usual routine: check the cricket scores in the *Times*, do 4 hours' work, lunch lightly, play some tennis. But the letter nagged at him, and that evening he thought it worth showing to his colleague and collaborator, Edward Littlewood.

"Before midnight they knew, and knew for certain. The writer of these manuscripts was a man of genius." (Hardy would later class Ramanujan's natural gifts with those of Gauss and Euler; of one group of unproven theorems he remarked, "They must be true because, if they were not true, no one would have the imagination to invent them.") So Ramanujan must be brought to England! And Hardy went into action.

The rest is lamentably brief. Ramanujan arrived in April 1914. Hardy had to teach him math elements English schoolboys learned in the upper forms. But soon they were in collaboration: "Five papers of the highest class." At 30, Ramanujan was a Fellow of the Royal Society, a Fellow of Trinity. Then he came down with tuberculosis. "It was difficult, in war-time, to move him to a kinder climate." So he shivered in English hospitals till war's end, then took a boat home, to die.

(Hardy would visit his wasting protégé in a Putney hospital. One day he was fumbling for small talk: "The number of my taxi-cab was 1729. It seemed to me rather a dull number." And Ramanujan: "No, Hardy! No, Hardy! It is a very interesting number. It is the smallest number expressible as the sum of two cubes in two different ways!")

You can see why that's held the attention even of readers whom a whiff of algebra can stun. Why Ken Russell never made a film version is unclear. (Perhaps for lack of someone to play Hardy? Leslie Howard was a look-alike, but he's long dead.) More important: Why did no one, in all these years, ever undertake a book-length expansion? Well, Robert Kanigel has; and it's a pleasure to report that *The Man Who Knew Infinity: A Life of the Indian Genius Ramanujan* (Charles Scribner's Sons, 1991, $24.95) is in the "1729" class: the most luminous expression ever of two three-dimensional lives along both per-
sonal and professional axes. As a presentation of genius interacting with genius, I've seen nothing to compare with it.

The theme of interaction stimulates Kanigel. His *Apprentice to Genius*, subtitled *The Making of a Scientific Dynasty*, details the web of relationship—sponsor, colleague, apprentice—in a front-rank biology lab. And Hardy did all his best work in collaboration. (Forced to listen to some pompous bore, he would say to himself, “Well, I have done one thing you could never have done, and that is to have collaborated with both Littlewood and Ramanujan on something like equal terms.”)

Call him “Rah-MAH-na-jun,” the stress on that second syllable very light. Situate him a thousand miles south of the Ganges, in Kumbakonam, where they wove silk saris and detailed fine metalwork, and supported a fine English-language high school, to which he was admitted at age 10. His parents eked out meager funds by boarding college students, whom he’d pest for math books from the college library. By 13 he’d mastered a tirz text and somehow glimpsed something that it didn’t offer: That trig functions are more than line ratios; they emerge from infinite series.

And at 16 Ramanujan came upon a magic book: G. S. Carr’s *Synopsis of Elementary Results in Pure and Applied Mathematics*: simply, some 5000 theorems—known results—so arranged that if you understood, say, the first 47, you were ready to tackle number 48. There were no proofs; the thing was meant simply as a cram-book for the notorious Cambridge math exam, the Tripos, one’s ranking in which could shape one’s career for life. Ramanujan set out to work his way through it, devising methods and notation—as he went along. By 20, when his refusal to bother with anything but math had flunked him out of two colleges, he’d accumulated much of the famous notebooks from which he’d skinned what he sent to Hardy: on hypergeometric series, continued fractions, singular moduli. . . . He was short, and squat, and bulky like a sumo wrestler. And jobless.

As to how we know all this, and much, much more—well, anyone who wants insight into the methodology of a solid job should study Kanigel’s source-notes. His narrative is woven from many dozen sources, including much gleaned during five weeks in South India. (“I toured the house in which he grew up, participated in opening exercises at his alma mater, wandered through the grounds of the temple in Namakkal to which he came at a turning point in his life, and saw the room in which he died in Madras.”) He even talked with Ramanujan’s very aged widow.

And if India is a strange country, so is England; hence, much of the story’s tension. So a 50-page mini-biography of Hardy locates him in Britain’s class and academic structure, where he’s in some ways as much of an oddity as his Brahman protégé was in India.

Ramanujan indulged “in mystical disquisitions that few understood, and in mathematics that no one did.” And Hardy? Blessed with gorgeous good looks, yet “to his own eyes so repulsively ugly” he couldn’t bear a mirror, “Always, he kept the world at bay. The obsession with cricket, the bright conversation, the studied eccentricity, the fierce devotion to mathematics—all of these made for a beguiling public persona, but none encouraged real closeness.”

Hardy was proud to claim that not a particle of his math—“real” math, and rigorous—was even remotely “useful.” No, it was solely art. And after two eminent Cambridge mathematicians had brushed aside written appeals from Ramanujan, it was Godfrey Harold Hardy who said yes.

Which brings us to another strength of Kanigel’s book, that he’ll not omit equations from his pages, nor shirk the task of helping his reader understand why such things fired the passion of his two heroes. You’ll not learn number theory from the book, but you’ll learn, via specific instances, what it’s about, and gather how it might consume someone’s life. Contrast the strategy of bubbly popularizers like Pamela McCorduck, placing human color in the foreground, hiding technicalities under any handy rug. No, the technicalities were what these persons lived for; there’s no evading that, short of settling for melodrama.

A quotable instance: “Proof is no mere icing on the cake. Take the sequence of integers 31, 331, 3331, 33331, 333331, 3333331. Each is a prime number. So is the next in the sequence. Have we hit upon some hidden pattern? No, the pattern self-destructs with the next in line,” which is divisible by 17.

“A mathematician with an insufficiently ironclad proof is a little like the police lieutenant in the movies, convinced of the butler’s guilt but brought up short by his boss’s caution, Yeah, but that won’t convince a jury.”

And Ramanujan in his notebooks “had proclaimed a thousand versions of the butler did it.” Most of the time he was right, and the butler had done it. But, so Littlewood remarked, “the clear-cut idea of what is meant by a proof. . . he perhaps did not possess at all.” Luckily, Hardy’s insistence on rigor “had sent him off almost singlehandedly to reform English mathematics.” He had told Bertrand Russell how happy a real proof made him: “If I could prove by logic that you would die in five minutes, I should be sorry you were going to die, but my sorrow would be very much mitigated by pleasure in the proof.” So, “Ramanujan, Intuition Incarnate, had run smack into Hardy, the Apostle of Proof.”

And, “In what, in some ways, was his greatest achievement, Hardy brought Ramanujan mathematically up to speed without muzzling his creativity or damping the fires of his enthusiasm. It would have been easy to sniff at his shortcomings and dutifully correct them, like a bad editor who cruelly blue-pencils his way through a delicate manuscript. But he knew that Ramanujan’s insight was rarer by far than even the most formidable technical mastery.”

For math is not a deductive art. It checks its intimations by deduction. But you need the intuition. You need a theorem to prove in the first place. Some of Ramanujan’s are still being worked on.

His miserable last years are tactfully handled; the epilogue is wise in locating on the map of learning the importance of what we’ve read. And everywhere, the story C. P. Snow outlines is enhanced by countless new details. For instance, take the “1729” anecdote. In what two different ways can we express the sum of two cubes? Snow omits to tell us; Kanigel doesn’t. Try 12 and 15, or else 10 and 9. A proof that 1729 is the smallest such number may be left (Hardy would have said) as an exercise.

Hugh Kenner is a professor of English at Johns Hopkins University. He writes for publications ranging from the New York Times to Art & Antiques. His recent books include Mazes and Historical Fictions. He can be contacted on BIX as “hkenner.”

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.
Over the past five years, the disabled have enjoyed a new electronic independence in the form of the personal computer. We achieved an electronic bill of rights (see “Opening Doors for the Disabled” in the August 1990 BYTE). As a person who is legally blind, I believe that some of this newly obtained and hard-won freedom is in danger of being revoked in the name of the graphical user interface (GUI). To retain this freedom, we need to take some bold steps toward adaptation.

Thousands of blind, deaf, and physically handicapped people now benefit from many forms of adaptive technology, including speech synthesis, large-print processing, braille desktop publishing, TDD modems, voice recognition, and custom switches. The sad fact, however, is that almost none of this exotic hardware and software is GUI-compatible.

According to the World Institute on Disability in Oakland, California, there are over 1.7 million blind or severely visually impaired Americans. Unfortunately, the talking hardware and software products used by the blind to access computers work in a text-only mode and are mute if you use graphics.

The implementation of GUls and GUI-related applications may actually benefit some groups (e.g., the motor-disabled, who do not usually thrive in a keyboard-intensive environment). However, GUls may effectively lock the blind out of future personal computing, because currently there is no method to add voice synthesis to graphics.

Speech-synthesis systems allow the blind user full access to every byte on the screen, but they are powerless to describe icons, images, and complex graphics. If the GUI becomes the accepted standard for all computer software, the blind will be confined to using only specially written talking programs, and they will gradually pursue a path away from the mainstream. And they may not be on this road alone.

Hundreds of thousands of learning-disabled people also find graphics confusing, and a picture does not mean the same thing to everybody. Does that cylinder at the bottom of your screen mean a “trash can” or a “coffee cup”? This question may sound ridiculously simplistic, but it is a valid issue for those with learning disabilities. Even if the user is not learning-disabled, every person does not interpret pictures in the same way, and adding speech to GUls could help learning-disabled users solve this problem.

The use of a mouse for GUI systems also may present a potential stumbling block to those with dyslexia, because dyslexics often have a difficult time with eye-hand coordination. Therefore, does the adoption of GUI systems mean the end of personal computing for the learning-disabled as well?

Just as Scrooge was given a second chance, this state of affairs does not have to spell disaster, and there are many ways to avoid this potentially gloomy future. If we take the time to adapt the GUI for the disabled, the future is undoubtedly one we can all look forward to. It is essential that hardware and software companies do such adaptation, especially if they want to market their products to the federal government. Section 508 of the Federal Rehabilitation Act states that no vendor can market to the government unless its equipment is fully accessible to the disabled community.

It won’t take a great deal of effort to implement this all-important adaptation process. For example, the mouse was a lonely creature until it became an accepted standard among software developers. All it took was the writing of some device drivers and the generation of extra code in the application to make the rodent come to life. A speech synthesizer is just another device that, with major vendor support, would rapidly become an industry mainstay.

You can configure a speech synthesizer to emulate a parallel or serial port. For these devices to become widely accepted, software developers need only write code to support them. Programmers could write software with built-in voice labels for icons. The disabled could then enjoy the power and flexibility that voice-accessible GUls have to offer. This type of environment for the disabled would forever slam this potential window of vulnerability.

Joseph J. Lazaro is the cofounder of Talking Computer Systems in Watertown, Massachusetts. He is currently project director for the adaptive-technology program at the Massachusetts Commission for the Blind in Boston. You can reach him on BIX as “lazaro.”

Stop Bit is a forum for informed opinion on personal computing topics. The opinions expressed are those of the author and not necessarily those of BYTE. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.
You can automate your system with 30-year old technology, or...

BRING IT TO LIFE WITH LABVIEW® 2

Tired of wrestling with cryptic text-based programming languages? Then make the switch to LabVIEW 2 on the Macintosh. LabVIEW 2 is the most celebrated application software for data acquisition and instrument control. It recently won the MacUser magazine Editors' Choice award. Five years ago, LabVIEW introduced the combination of front panel interfaces and graphical programming. Today, engineers and scientists around the world use LabVIEW 2 for a broad spectrum of applications.

Unlike other graphical packages, LabVIEW 2 does not sacrifice power and flexibility for ease of use. With LabVIEW 2, you quickly build block diagram programs and add your own blocks to expand upon our libraries. You also create front panel user interfaces and import pictures to customize the panels. Yet LabVIEW 2 virtual instruments run as quickly as compiled C programs. Call us to find out how LabVIEW 2 can bring life to your system.

For a free LabVIEW 2 Demo disk, call:
(512) 794-0100 or
(800) 433-3488
(U.S. and Canada)

In 1983, we introduced the world's first laptop computer. We went on to engineer built-in software, easy-to-read screens and hard drives in notebook-size PCs.

AND NOW...

THE NEW TANDY® 2810 HD NOTEBOOK PC,

286 Power
The 80C286 microprocessor runs at 16 MHz for speed-intensive applications like Microsoft® Windows.

VGA Graphics
Brilliant clarity with 640 x 480 graphics and a sharp 16/12-gray scale.

Built-In Hard Drive
20 megabytes of internal storage for rapid access, plus a 3.5" 144MB floppy drive.

MS-DOS® 4.01
The latest version of MS-DOS (4.01) comes already installed on the built-in hard drive.

DeskMate® Interface
The DeskMate Graphical User Interface with ten applications is installed on the hard drive for instant on ease of use.

Resume Mode
Lets you shut off and come back right where you left off—also shuts down automatically to save battery life.

External Support
Attach a 101-key keyboard, a VGA color monitor, a printer, an external floppy drive and more.

1MB Memory
Expandable to five megabytes.

DESKTOP PERFORMANCE IN A 6.7-lb. PORTABLE

Continuing our tradition of innovation, the Tandy 2810 HD is a lightweight laptop for heavy use—at the office, at home, or on the road. With extremely durable construction, it's built for travel—but it can also support a full-size keyboard and monitor for true desktop power. AT® compatibility, stunning VGA graphics and DeskMate® productivity software. Only at Radio Shack. Again.